



**The biennial Australian Colloid and Interface  
Symposium and the 10th Australia-Japan Colloid  
and Interface Science Symposium**

**Stamford Grand, Glenelg, Adelaide, South Australia**

**1-5 February 2009**

**Program and Abstracts**



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# ACIS 2009 Welcome

It is my pleasure, as Chair of the Organising Committee, to welcome you to the Australian Colloid and Interface Symposium (ACIS), 2009. This is the fourth in a series of biennial conferences and the first to be held in Glenelg, one of Adelaide's great suburban beaches. In moving away from Sydney, the host point for our past three conferences, we have opened up a new opportunity for the colloid and interface science community associated with both academic institutions and industry in the Adelaide environs to have more involvement in the conference. This is a very positive change. In addition to the ACIS symposium, we are delighted to host the 10<sup>th</sup> Australia-Japan Colloid and Interface Science Symposium. We are lucky enough to have Professors Neil Furlong and Toyoki Kunitake with us at the conference. They were the founding 'fathers' and drive behind the Australia-Japan symposia and I would like to take this opportunity to acknowledge their decades of input.

We hope that you will enjoy several days of discussing top quality science and we also hope that you enjoy your visit to this wonderful venue. The main purpose of ACIS is to serve as the national meeting for the Australian colloid and surface science community. The ACIS meetings held in Sydney in 2003, 2005 and 2007 reflected the high level of collaboration of the Australian scientific community internationally and this continues into this symposium, with almost 40% of our delegates being international visitors, representing 14 different countries. Given the number of post doctoral and other researchers with an Australian name plate but a non-Australian heritage, the symposium has a wonderful international flavour.

The level of interest has in ACIS 2009 has been very high and this has put demands on the organizing committee to create a program that provides lots of opportunity for people to present their work, whilst at the same time providing as much opportunity as possible for someone to take in all the presentations in which they have an interest. Although the need for parallel sessions has become inevitable, we have tried as much as possible to separate sessions that may be of common interest. I apologise in advance if you are faced with a dilemma as to which presentation you would like to attend.

The program has been arranged into a number of themes, each organised by two or three volunteers, whose names are listed overleaf. We are deeply grateful to them, and to the theme sponsors, for making such a strong program possible. The sponsorship allows us to invite key people in the field from around the world to be part of ACIS, many for the first time. I know that you will join with me in thanking them for taking on the keynote and plenary responsibility and wish them luck in their exploration of new directions for colloid and interface science into the future.

In addition to the theme chairs and theme sponsors, special thanks are due to our other sponsors whose logos appear on the back cover; to Jane Yeaman from Tulips Meetings Management who has looked after countless details of the conference organisation; and above all to my colleagues on the conference organising committee. They have done a great job to prepare the ground for a memorable conference. Please enjoy the science, the social engagement and the wonderful environs of Adelaide.

Peter Scales

ACIS 2009 Chair

# Organising Committee

Dr David Beattie (University of South Australia)  
Dr Gayle Morris (Victoria University)  
Prof Paul Mulvaney (University of Melbourne)  
Dr Patrick Hartley (CSIRO Molecular & Health Technologies)  
Prof Peter Scales (University of Melbourne)  
Prof Ian Gentle (University of Queensland)  
Prof Russell Crawford (Swinburne University of Technology)  
Dr Jamie Schulz (Australian Nuclear Science and Technology Organisation)

## Theme Chairs

### Spectroscopy and Scattering

#### Chairs:

**Dr David Beattie**  
(University of South Australia)  
**A/Prof Jim McQuillan**  
(University of Otago, NZ)  
**Dr Mark Tobin**  
(Australian Synchrotron)

### Surface Forces and Nanotribology

#### Chairs:

**Dr Vince Craig**  
(Australian National University)  
**Dr Ray Dagastine**  
(University of Melbourne)

### Mineral & Materials Processing

#### Chairs:

**A/Prof George Franks**  
(University of Melbourne)  
**Dr Gayle Morris**  
(Victoria University)

### Life Sciences Applications

#### Chairs:

**Prof Frank Caruso**  
(University of Melbourne)  
**Dr Andrew Price**  
(University of Melbourne)  
**Dr Laurence Meagher**  
(CSIRO Molecular and Health Technologies)

### Nanofabrication and Microfluidics

#### Chairs:

**Prof John Ralston**  
(University of South Australia)  
**Prof Paul Mulvaney**  
(University of Melbourne)

### Soft Matter Self Assembly

#### Chairs:

**Dr Patrick Hartley**  
(CSIRO Molecular & Health Technologies)  
**A/Prof Erica Wanless**  
(University of Newcastle)

### Frontiers of Colloid and Interface Science

#### Chairs:

**Prof Peter Scales**  
(University of Melbourne)  
**Dr Chiara Neto**  
(University of Sydney)  
**A/Prof Joe Shapter**  
(Flinders University)

### Australia-Japan Colloid and Interface Science Symposium

#### Chairs:

**Prof Ian Gentle**  
(University of Queensland)  
**Prof Russell Crawford**  
(Swinburne University of Technology)  
**Prof Kazue Kurihara**  
(Tohoku University, Japan)

# ACIS 2009 General Information

## Venue

Stamford Grand Adelaide  
Moseley Square, 2 Jetty Road, Glenelg SA 5045  
Tel: +61 8 8376 1222 Fax: +61 8 8376 1111

## Registration Desk

*The registration desk will be open in the Ballroom Foyer as follows:*

<i>Sunday 1 February</i>	<i>3:00pm to 5:00pm</i>
<i>Monday 2 February</i>	<i>8:00am to 5:30pm</i>
<i>Tuesday 3 February</i>	<i>8:00am to 3:00pm</i>
<i>Wednesday 4 February</i>	<i>8:00am to 6:00pm</i>
<i>Thursday 5 February</i>	<i>8:30am to 4:30pm</i>

## Messages and Emergency Contact Details

Messages may be left for you during the conference by phoning Stamford Grand Adelaide on +61 8 8376 1222 and asking for the message to be delivered to the ACIS 2009 Conference Registration Desk. Faxes may be sent to +61 8 8376 1111. Emergency messages ONLY may be left by phoning 0408 498 860. A message board will be located near the registration desk.

## RACI Colloid and Surface Science Annual General Meeting

The RACI Colloid and Surface Science Annual General Meeting will be held in Ballroom 1 from 5:00pm to 6:00pm on Wednesday 4 February 2009. All RACI members are encouraged to attend this members-only event.

## Oral Presenters

PowerPoint presentations should be handed into the Presenters Desk on arrival either on CD or USB Drive. They will be pre-loaded onto the notebook in advance of your session. Presenters should ensure that their PowerPoint presentation is loaded and operating NO LATER than 3 hours before the presentation.

## Poster Presenters

The poster session will be held on Monday night. Posters should be placed on the marked poster board between 7.45am and 10.30am on Monday morning. Posters will need to be removed from the poster boards at the completion of the Poster Session on Monday night. Posters should be in place before the commencement of morning tea. Poster presenters must be present for the first 90 minutes of the poster session.

## Prizes

During ACIS 2009 three prizes of \$300 each will be awarded for the best poster presentations, as judged by the Committee. The ACIS is awarding these prizes to encourage a high standard of preparation and presentation for the poster session. Recipients will be determined on the basis of scientific content and presentation. Prizes will be presented during the Conference Dinner on Wednesday night.

## General Dress

We recommend delegates dress in smart casual attire for the conference and social events.

## Accommodation Deposits

All pre-paid accommodation deposits have been credited to your hotel accounts. You are required to pay the balance of your account, plus any incidentals, upon departure. If a credit card number was supplied to guarantee the reservation, this is being used as a guarantee only (unless requested otherwise) and the full account will need to be settled upon departure.

Stamford Grand Adelaide, Moseley Square, 2 Jetty Road, Glenelg SA 5045  
Tel: +61 8 8376 1222, Fax: +61 8 8376 1111, Email: [reservations@sga.stamford.com.au](mailto:reservations@sga.stamford.com.au)

Oaks Plaza Pier, 16 Holdfast Promenade, Glenelg SA 5045

Tel: +61 8 8350 6688, Fax: +61 8 8350 6699, Email: [respier@theoaksgroup.com.au](mailto:respier@theoaksgroup.com.au)

Best Western Ensenada Motor Inn, 13 Colley Terrace, Glenelg SA 5045

Tel: +61 8 8294 5822, Fax: +61 8 8294 3393, Email: [info@ensenada.com.au](mailto:info@ensenada.com.au)

Comfort Inn Haven Marina, 6-10 Adelphi Tce, Glenelg North 5045

Tel: +61 8 8350 5199, Fax: +61 8 8350 5299, Email: [admin@haveninn.com.au](mailto:admin@haveninn.com.au)

## Catering

**The fourth biennial Australian Colloid Interface Symposium** - Includes attendance at Welcome Mixer on Sunday evening, morning tea, lunch and afternoon tea from Monday to Thursday and the fourth biennial Australian Colloid Interface Symposium Dinner on Wednesday evening.

**Australia Japan Symposium** - Includes attendance at Welcome Mixer on Sunday evening, morning tea, lunch and afternoon tea on Monday and Tuesday and the Australia-Japan Symposium dinner on Monday evening. The Social Tour on Sunday is also available at a subsidized rate of \$44 for the Australia Japan Symposium or Combined Symposium delegates only.

**Combined Symposia: Australia Japan Symposium plus Wednesday and Thursday attendance at The fourth biennial Australian Colloid and Interface Symposium** - Includes the Welcome Mixer on Sunday evening, morning tea, lunch and afternoon tea from Monday to Thursday, Australia-Japan Symposium dinner on Monday evening and the fourth biennial Australian Colloid Interface Symposium Dinner on Wednesday evening.

Additional tickets to the Welcome Mixer and Symposium Dinner are available to purchase for guests. If you are not attending the Welcome Mixer or Symposium Dinner please advise the registration desk at your earliest convenience. If you have purchased guest tickets for the Welcome Mixer and / or Symposium Dinner you will have a ticket in the back of your name badge. If you haven't booked for your guest to attend the Symposium Dinner and would like them to attend, please book at the registration desk before the end of lunch on Monday.

## Special Dietary Requirements

If you have special dietary requirements that you have not listed on your registration form, please advise the team at the registration desk at your earliest convenience.

## Local Attractions

**Glenelg Markets:** The Glenelg Markets operate on the weekend from 9am - 5pm. Located in Moseley Square close to the Town Hall.

**Jetty Road Shopping:** Adelaide's premier beachside shopping strip, offering over 300 amazing shops and cafes with something for everyone!

**Harbour Town:** Harbour Town brand outlet shopping centre, is just 10 minutes from Glenelg on Tapleys Hill Road, West Beach.

**Holdfast Marina:** Holdfast Marina offers beautiful seaside and marina view and sunset vistas of great beauty. You can also enjoy a stroll around the Holdfast Shores Marina Promenade, where you will find contemporary cuisine many featuring South Australia's finest seafood.

**Haigh's – Chocoholic Heaven:** Visit Haigh's Chocolates Visitor Centre, home of Australia's oldest chocolate-making company and one of only a handful worldwide still making chocolate directly from cocoa beans. Take a free, 20-minute tour of the factory and check out the heritage displays before getting down to business in the tasting room. Location: Greenhill Road, Parkside (just south of the city centre).

**Adelaide Hills:** The cool-climate wines of the Adelaide Hills are among the most prestigious in Australia. Discover them at more than 20 cellar doors from Macclesfield in the south to Kersbrook in the north. The region is home to more than 200 grape growers and 50 wine labels: look out for famous names like Petaluma, Nepenthe, Shaw & Smith, Ashton Hills and Chain of Ponds at Gumeracha.

**Barossa Valley:** The Barossa offers everything you'd expect from Australia's most famous wine region. Winemakers waiting to share their secrets at the cellar door; landscapes etched with manicured vineyards; passionate food producers proffering their wares at country markets; and grand chateaux surrounded by ornate gardens. And it's all just an hour from Adelaide.

## Conference Secretariat

Tulips Meetings Management ABN:32 003 901 657  
PO Box 116, Salamander Bay NSW 2317 Australia  
Telephone: +61 2 4984 2554  
Facsimile: +61 2 4984 2755  
Mobile: +61 408 498 860  
Email: [acis@pco.com.au](mailto:acis@pco.com.au)  
Website: [www.colloid-oz.org.au](http://www.colloid-oz.org.au)

# ACIS 2009 Sponsors

## Plenary Speaker Sponsors

*The Royal Australian Chemical Institute,  
Colloid and Surface Science Division*



**The  
University  
of Sydney**

## Keynote Sponsors



Nuclear-based science benefiting all Australians



University of  
South Australia



Australian Synchrotron  
[synchrotron.vic.gov.au](http://synchrotron.vic.gov.au)



Cooperative Research Centre for  
**Polymers**

*Solutions for a better world*



Rheological Consulting Services

## Gold Sponsors



## Compendium & Poster Session Sponsor



## Conference Dinner Sponsor



## Exhibitors



Group Scientific and Wiley will also be displaying brochures during the conference

## Student Funding and Bursary Sponsors



**The biennial Australian Colloid and Interface Symposium and the  
10th Australia-Japan Colloid and Interface Science Symposium**

**Stamford Grand, Glenelg, Adelaide, South Australia**

**1-5 February 2009**

**PL – Plenary**

**KN – Keynote**

**OC - Oral Communication**

**PP - Poster Presentation**

**Program at a Glance**

<b>Sunday 1 February 2009</b>	
10:00 - 16:00	AUSTRALIA-JAPAN SYMPOSIUM EXCURSION
15:00 – 17:00	REGISTRATION, Stamford Grand (ACIS and A-J)
17:00 – 19:00	WELCOME MIXER, The Beachouse (ACIS and A-J)

<b>Monday 2 February 2009</b>			
	<b>Ballroom 1/2</b>		
8:30	<b>Welcome and opening remarks</b>		
8:40	<b>PL001 RACI Colloid Division Plenary Lecture: Prof Martien Cohen Stuart</b> <i>Networking Polymers and the Forces they Generate</i> <b>Sponsored by the Royal Australian Chemical Institute, Colloid and Surface Science Division</b> Chair: Peter Scales		
9:30	<b>PL002 Alexander Lecture: Prof Franz Grieser</b> <i>How ultrasound and bubbles interact to give rise to "exotic" chemical reactions</i> <b>Sponsored by The University of Sydney</b> Chair: Peter Scales		
10:30	<b>TEA/COFFEE BREAK</b>		
	<b>Ballroom 1</b>	<b>Ballroom 2</b>	<b>Ballroom 4</b>
	<b>THEME 1: Minerals &amp; Material Processing</b>	<b>THEME 2: Life Science Applications</b>	<b>Australia-Japan Symposium</b>
	<i>Session Chair: George Franks</i>	<i>Session Chair: Frank Caruso</i>	<i>Session Chair: Ian Gentle</i>
11:00	<b>KN001 Jennifer Lewis</b>	<b>KN002 Kristi Anseth</b>	<b>KN003 Kohei Uosaki</b>
11:40	OC001 Linnea Andersson	OC004 Benjamin Thierry	OC007 Sally McArthur
12:00	OC002 Diana Tran	OC005 Laurence Meagher	OC008 Atsushi Muramatsu
12:20	OC003 Kazimierz Malysa	OC006 Adam Feiler	OC009 Elena Ivanova
12:40	<b>LUNCH (Promenade Restaurant and Ballroom 3)</b>		
	<b>THEME 1: Minerals &amp; Material Processing</b>	<b>THEME 2: Life Science Applications</b>	<b>Australia-Japan Symposium</b>
	<i>Session Chair: Gayle Morris</i>	<i>Session Chair: Laurence Meagher</i>	<i>Session Chair: Kazue Kurihara</i>
13:40	<b>KN004 James Finch</b>	<b>KN005 Jay Groves</b>	<b>KN006 Justin Gooding</b>
14:20	OC010 Marlene Cran	OC013 Timothy Barnes	OC016 Yoshio Okahata
14:40	OC011 Audrey Beaussart	OC014 Angus Johnston	OC017 Lisbeth Grondahl
15:00	OC012 Agnieszka Mierczynska-Vasilev	OC015 Ronald Clarke	OC018 Sumio Ozeki
15:20	<b>TEA/COFFEE BREAK</b>		
	<i>Session Chair: Jonas Addai-Mensah</i>	<i>Session Chair: Angus Johnston</i>	<i>Session Chair: Yoshio Okahata</i>
15:50	OC019 Miao Chen	OC024 Christopher Bowman	OC029 Kazue Kurihara
16:10	OC020 Thanh Tam Chau	OC025 Bronwyn Battersby	OC030 Roger Horn
16:30	OC021 Chandra Angle	OC026 Ingo Koeper	OC031 Ko Higashitani
16:50	OC022 George Franks	OC027 Clive Prestidge	OC032 Chris Honig
17:10	OC023 Jason Du	OC028 Peter Kingshott	OC033 Jun Oshitani
17:30	Talks end		
17:45-19:45	<b>POSTER SESSION: Colley, Hindmarsh and Moseley (PP001 - PP055)</b> <b>Sponsored by Davies Collison Cave</b>		
19:30			<b>A-J Dinner, Esca Restaurant</b>

<b>Tuesday 3 February 2009</b>			
	<b>Ballroom 1</b>	<b>Ballroom 2</b>	<b>Ballroom 4</b>
	<b>THEME 3: Spectroscopy and Scattering</b>	<b>THEME 4: Nanofabrication and Microfluidics</b>	<b>Australia-Japan Symposium (Cont)</b>
	<i>Session Chair: Mark Tobin</i>	<i>Session Chair: Paul Mulvaney</i>	<i>Session Chair: Russell Crawford</i>
8:30	<b>KN007 John White</b>	<b>KN008 Michelle Simmons</b> (presented by Giordano Scappucci)	<b>KN009 Max Lu</b>
9:10	OC034 Sarah Harmer	OC037 Leslie Yeo	OC040 Naoki Toshima
9:30	OC035 Jim McQuillan	OC038 Chiara Neto	OC041 Peter Scales
9:50	OC036 Robert Corkery	OC039 Jiufu Lim	OC042 Lok Kumar Shrestha
10:10	<b>TEA/COFFEE BREAK</b>		
	<i>Session Chair: Jim McQuillan</i>	<i>Session Chair: Paul Mulvaney</i>	<i>Session Chair: Sumio Ozeki</i>
10:40	OC043 David Beattie	OC048 John Ralston	OC053 Toyoki Kunitake
11:00	OC044 Dave Warren	OC049 Mihail Popescu	OC054 Patrick Hartley
11:20	OC045 Tich-Lam Nguyen	OC050 Shaun Hendy	OC055 Shigeru Deguchi
11:40	OC046 Kathryn McGrath	OC051 Rosen Sedev	OC056 Cathy McNamee
12:00	OC047 Liliana de Campo	OC052 Geoff Willmott	OC057 Nobuo Kimizuka
12:20	<b>LUNCH (Promenade Restaurant and Ballroom 3)</b>		
	<b>THEME 3: Spectroscopy and Scattering</b>	<b>THEME 4: Nanofabrication and Microfluidics</b>	<b>Australia-Japan Symposium</b>
	<i>Session Chair: David Beattie</i>	<i>Session Chair: John Ralston</i>	<i>Session Chair: Vincent Craig</i>
13:20	<b>KN010 Nitash Balsara</b>	<b>KN011 Patrick Tabeling</b>	OC062 Kaoru Tsujii
13:40			OC063 Ivan Vakarelski
14:00	OC058 Bill Hamilton	OC060 Pramith Priyananda	OC064 Hirofumi Kanoh
14:20	OC059 Connie Liu	OC061 Craig Priest	OC065 Greg Warr
14:40	<b>TEA/COFFEE BREAK</b>		
15:00	<b>BEACH TIME</b>		

<b>Wednesday 4 February 2009</b>		
	<b><i>Ballroom 1</i></b>	<b><i>Ballroom 2</i></b>
	<b>THEME 5: Soft Matter Self Assembly</b>	<b>Theme 6: Frontiers of Colloid &amp; Interface Science</b>
	<i>Session Chair: Patrick Hartley</i>	<i>Session Chair: Peter Scales</i>
8:50	<b>KN012 Marcus Textor</b>	<b>KN013 Lennart Bergström</b>
9:30	OC066 Peter Kingshott	OC069 Paul Mulvaney
9:50	OC067 Durga Acharya	OC070 Nirmesh Jain
10:10	OC068 Ben Boyd	OC071 Drew Evans
10:30	<b>TEA/COFFEE BREAK</b>	
	<i>Session Chair: Rob Atkin</i>	<i>Session Chair: Chiara Neto</i>
11:00	OC072 William Hamilton	OC077 James Beattie
11:20	OC073 Catherine Whitby	OC078 Vincent Craig
11:40	OC074 Qin Li	OC079 Lee San Puah
12:00	OC075 Patrick Fairclough	OC080 Yansen Lauw
12:20	OC076 Brigitte Stadler	OC081 Jairo Garnica-Rodriguez
12:40	<b>LUNCH (Promenade Restaurant and Ballroom 3)</b>	
	<i>Session Chair: Grant Webber</i>	<i>Session Chair: Joe Shapter</i>
13:40	OC082 Stephen Hyde	OC086 Meifang Zhou
14:00	OC083 Jacob Kirkensgaard	OC087 Benjamin Wong
14:20	OC084 Tam Greaves	OC088 Madhavan Jagannathan
14:40	OC085 Rob Atkin	OC089 Adrian Trinchi
15:00	<b>TEA/COFFEE BREAK</b>	
	<b><i>Ballroom 1</i></b>	<b><i>Ballroom 2</i></b>
	<b>THEME 5: Soft Matter Self Assembly</b>	<b>Theme 6: Frontiers of Colloid &amp; Interface Science</b>
	<i>Session Chair: Erica Wanless</i>	<i>Session Chair: James Beattie</i>
15:30	<b>KN014 Rein Ulijn</b>	OC092 Michal Borkovec
15:50		OC093 Wade Mosse
16:10	OC090 Danielle Kennedy	OC094 Mihail Popescu
16:30	OC091 Tony Aitchison	OC095 Alison Funston
17:00	<b>RACI Colloid and Surface Science Annual General Meeting (Ballroom 1)</b>	
19:30	<b>CONFERENCE DINNER and POSTER PRIZE PRESENTATIONS (Ballroom 3-5) Sponsored by Scientific Solutions</b>	

<b>Thursday 5 February 2009</b>		
	<b>Ballroom 1</b>	<b>Ballroom 2</b>
	<b>THEME 7: Surface Forces and Nanotribology</b>	<b>Theme 6: Frontiers of Colloid &amp; Interface Science (cont)</b>
	<i>Session Chair: Ray Dagastine</i>	<i>Session Chair: Greg Warr</i>
9:00	<b>KN015 Clemens Bechinger</b>	<b>KN016 Hiroshi Yokoyama</b>
9:40	OC096 Marta Krasowska	OC098 Tim Wooster
10:00	OC097 Adam Feiler	OC099 Mani Paneru
10:20	<b>TEA/COFFEE BREAK</b>	
	<i>Session Chair: Vince Craig</i>	<i>Session Chair: James Friend</i>
10:50	<b>KN017 Masashi Mizukami</b>	OC103 Yagya Bhatt
11:10		OC104 Leslie Yeo
11:30	OC100 Shannon Notley	OC105 Guangming Liu
11:50	OC101 Jason Stokes	OC106 Mikel Duke
12:10	OC102 Renate Fetzer	OC107 Erica Wanless
12:30	<b>LUNCH (Promenade Restaurant and Ballroom 3)</b>	
	<i>Session Chair: Marta Krasowska</i>	<i>Session Chair: Kathryn McGrath</i>
13:40	OC108 Ray Dagastine	OC112 Alison Funston
14:00	OC109 Elmar Bonaccorso	OC113 Iliana Sedeva
14:20	OC110 Christine Henry	OC114 Ru-Jong Jeng
14:40	OC111 Luke Parkinson	OC115 Hemayet Uddin
15:00	<b>TEA/COFFEE BREAK</b>	
	<i>Session Chair: Shannon Notley</i>	<i>Session Chair: Leslie Yeo</i>
15:20	OC116 Rogerio Manica	OC118 Leonora Velleman
15:40	OC117 Ian Larson	OC119 Bruce Law
16:05	<b>CLOSING REMARKS (Ballroom 1)</b>	
16:15	ACIS CONFERENCE CLOSES	



# ACIS 2009 Full Program

## Sunday 1 February 2009

- 10.00am-4.00pm      **Australia Japan Symposium Excursion**
- 3.00-5.00pm          **Registration Open, *Stamford Grand Glenelg***
- 5.00-7.00pm          **Welcome Reception, *The Beachouse***

8.30am

Ballroom 1/2

Ballroom 1/2

PL001 8.40

Welcome and opening remarks  
Plenary Presentations

**RACI Colloid Division Plenary Lecture**

**Networking Polymers and the forces they generate**

Martien A. Cohen Stuart<sup>1</sup>, J. van der Gucht<sup>1</sup>, J. Sprakel<sup>1</sup>, P. Skrzeczewska<sup>1</sup>, E. Spruijt<sup>1</sup>, M. Lemmers<sup>1</sup>

<sup>1</sup>Wageningen University, Netherlands

**Sponsored by the Royal Australian Chemical Institute,  
Colloid and Surface Science Division**



Prof Martien Cohen Stuart graduated from Groningen State University with a degree in polymer chemistry and a minor in physical chemistry. In 1975, he joined Wageningen University, doing a PhD in colloid science under supervision of Gerard Fleer and Bert Bijsterbosch, investigating adsorption of flexible polymers at solid/liquid interfaces. He obtained his degree in 1980 and then was appointed assistant professor in the physical chemistry & colloid science group. Following a sabbatical/post doctoral year in the group of Pierre Gilles de Gennes in Paris, where he worked on wetting and spreading experiments, he became associate professor in Wageningen and in 1996 he succeeded Hans Lyklema in the Chair of Physical Chemistry and Colloid Science at Wageningen University. In 2007 he was awarded the Ostwald Medal of the German Kolloid Gesellschaft in recognition of his seminal work on polymers in colloidal systems and self-assembly. His interests cover a wide spectrum, from statics and dynamics of macromolecules, interfaces, wetting, phase behaviour, self-assembly, networks and gels, emulsions and coalescence, and the physics of macromolecules in living cells. He is editor of the European Physical Journal E (Soft Matter), and member of the Royal Dutch Academy of Sciences (KNAW).

PL002 9.30

**A.E. Alexander Lecture**

**How ultrasound and bubbles interact to give rise to  
“exotic” chemical reactions**

Franz Grieser<sup>1</sup>, <sup>1</sup>ARC Particulate Fluids Processing  
Centre, School of Chemistry, University of Melbourne,  
Australia

**Sponsored by The University of Sydney**



Franz Grieser is a Professor of Chemistry in the School of Chemistry at the University of Melbourne. He is a Deputy Director of the ARC Special Research Centre, Particulate Fluids Processing Centre and the Program Leader of its Liquid-Liquid Systems research activities. He is the Associate Dean (Research and Industry) in the Faculty of Science and is Chair of the Research and Industry Committee. Franz completed his undergraduate (BSc(Hons), 1973) and postgraduate studies (PhD, 1977) at the University of Melbourne. He undertook postdoctoral studies at the University of Notre Dame, Indiana, and the Hahn-Meitner Institute in Berlin. He was a QEII Fellow prior to taking up a lectureship at the University of Melbourne in 1984. He maintains an extensive collaborative network with major research groups locally and internationally and has published over 200 research articles. His major research interests cover a wide range of topics in surface and colloid chemistry. In recent years he has developed several research programs examining the use of ultrasound to initiate chemical reactions in aqueous systems.

*The A.E. Alexander Lecture was established in 1978 as a result of an appeal by the University of Sydney and the RACI Division of Colloid and Surface Chemistry to commemorate Professor Albert “Alex” Alexander FAA FRACI, who was Professor of Physical Chemistry at the University of Sydney from 1957-1970. The Alexander Lecturer is an eminent scientist who has contributed particularly to Colloid and Surface Science in Australia.*

10.30am Morning Tea

11.00am

## Ballroom 1 THEME 1: Minerals and Material Processing

**KN001** 11.00 **Novel Inks for Direct-Write Assembly of Functional Materials**  
Jennifer Lewis<sup>1</sup>, <sup>1</sup>*University of Illinois, United States*

*Sponsored by AMSRI (Australian Mineral Science Research Institute)*



**OC001** 11.40 **The Quest for a Versatile Process Route for Macroporous Ceramics - Exploring Expandable Spheres**

Linnéa Andersson<sup>1</sup>, Mark A. Knackstedt<sup>2</sup>, Lennart Bergström<sup>1</sup>, <sup>1</sup>*Department of Physical, Inorganic and Structural Chemistry, Materials Chemistry Research Group, Stockholm University, Sweden*, <sup>2</sup>*Department of Applied Mathematics, Research School of Physical Sciences and Engineering, Australian National University, Australia*

**OC002** 12.00 **Particle-Stabilised Foams**

Diana Tran<sup>1</sup>, Catherine Whitby<sup>1</sup>, Daniel Fornasiero<sup>1</sup>, John Ralston<sup>1</sup>, <sup>1</sup>*University of South Australia, Ian Wark Research Institute, Australia*

**OC003** 12.20 **Influence of Surface Charge and Hydrophobicity on Stability of Thin Liquid Film during Bubble Collision with TiO<sub>2</sub> Surface**

Marta Krasowska<sup>1</sup>, Anna Niecikowska<sup>2</sup>, John Ralston<sup>1</sup>, Kazimierz Malysa<sup>2</sup>, <sup>1</sup>*Ian Wark Research Institute, University of South Australia, Australia*, <sup>2</sup>*Institute of Catalysis and Surface Chemistry Polish Academy of Sciences, Poland*

## Ballroom 2 THEME 2: Life Science Applications

**KN002** 11.00 **Dynamic Surfaces that Modulate Cell Interactions**

April Kloxin<sup>1</sup>, Julie Benton<sup>1</sup>, Kristi Anseth<sup>1,2</sup>, <sup>1</sup>*University of Colorado, United States*, <sup>2</sup>*Howard Hughes Medical Institute, United States*

*Sponsored by CRC for Polymers*



**OC004** 11.40 **Integration of Plasmonic Nanoparticles into Hybrid Multifunctional Colloidal Nanostructures**

Benjamin Thierry<sup>1</sup>, Jane Phui Mun Ng<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, Australia*

**OC005** 12.00 **Surface Initiated Polymer Coatings for the Control of Cell-Surface Interactions**

Laurence Meagher<sup>1</sup>, Helmut Thissen<sup>1</sup>, Paul Pasic<sup>1</sup>, Richard A. Evans<sup>1</sup>, Suzie Pereira<sup>1</sup>, Graham Johnson<sup>2</sup>, Gail McFarland<sup>2</sup>, Kelly Tsang<sup>1</sup>, Thomas Gengenbach<sup>1</sup>, Keith McLean<sup>1</sup>, <sup>1</sup>*CSIRO Molecular and Health Technologies, Australia*, <sup>2</sup>*CSIRO Molecular and Health Technologies, Australia*

**OC006** 12.20 **Biolubrication of Mucin studied with Quartz Crystal Microbalance (QCM-D) and AFM Friction Force Microscopy**

Adam Feiler<sup>1</sup>, Anna Sahlholm<sup>2</sup>, Tomas Sandberg<sup>2</sup>, Karin Caldwell<sup>2</sup>, <sup>1</sup>*YKI, Institute for Surface Chemistry, Sweden*, <sup>2</sup>*Uppsala University, Sweden*

11.00am

**Ballroom 4**

**Australia-Japan Symposium**

- KN003** 11.00 **Interfacial Molecular Structure at Solid/Liquid Interfaces by SFG Spectroscopy**  
Kohei Uosaki<sup>1</sup>, Hidenori Noguchi<sup>1</sup>, Satoshi Nihonyanagi<sup>1</sup>, Rie Yamamoto<sup>1</sup>, Hiroshi Minowa<sup>1</sup>, Jian Ping Gong<sup>1</sup>, Yoshihito Osada<sup>1</sup>, <sup>1</sup>*Hokkaido University, Japan*
- OC007** 11.40 **Surface Modification of Microfluidics for Protein Assays and Separation**  
Malinda Salim<sup>1</sup>, Gautam Mishra<sup>2</sup>, Simon Forster<sup>2</sup>, Greg Fowler<sup>2</sup>, Ana Pereira<sup>1</sup>, Phillip Wright<sup>1</sup>, Sally McArthur<sup>3</sup>, <sup>1</sup>*The University of Sheffield, Department of Chemical and Process Engineering, United Kingdom*, <sup>2</sup>*The University of Sheffield, Department of Engineering Materials, United Kingdom*, <sup>3</sup>*Swinburne University of Technology, Faculty of Engineering and Industrial Sciences, Australia*
- OC008** 12.00 **Monodispersed ITO Nanoparticles Precisely Controlled in Size and Shape**  
Atsushi Muramatsu<sup>1</sup>, Takafumi Sasaki<sup>1</sup>, Yosuke Endo<sup>1</sup>, Kiyoshi Kanie<sup>1</sup>, <sup>1</sup>*Tohoku University, Japan*
- OC009** 12.20 **Bacterial Interactions with Nano-Smooth Surfaces**  
Elena Ivanova<sup>1</sup>, Russell Crawford<sup>1</sup>, <sup>1</sup>*Swinburne University of Technology, Australia*

12.40pm

**Lunch**

1.40pm

**Ballroom 1**

**THEME 1: Minerals and Material Processing**

- KN004** 13.40 **Frothers and Flotation**  
James Finch<sup>1</sup>, <sup>1</sup>*McGill University, Canada*
- Sponsored by Victoria University**
- OC010** 14.20 **Effect of Dispersant Functional Groups on the Interaction with Mineral Oxide Particles**  
Marlene Cran<sup>1</sup>, Gayle Morris<sup>1</sup>, Leanne Brichter<sup>2</sup>, <sup>1</sup>*Institute for Sustainability and Innovation, Victoria University, Australia*, <sup>2</sup>*Ian Wark Research Institute, University of South Australia, Australia*
- OC011** 14.40 **Investigation of Dextrin Adsorbed on Hydrophobic Mineral Surfaces**  
Audrey Beaussart<sup>1</sup>, Agnieszka Mierczynska-Vasilev<sup>1</sup>, David Beattie<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, UniSA, Australia*
- OC012** 15.00 **In Situ Atomic Force Microscopy of Carboxymethyl Cellulose Adsorption on Talc and Chalcopyrite: Correlation Between Adsorbed Layer Properties and Flotation Performance.**  
Agnieszka Mierczynska-Vasilev<sup>1</sup>, David Beattie<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute University of South Australia, Australia*



1.40pm

## Ballroom 2

## THEME 2: Life Science Applications

**KN005 13.40 Programming lateral interactions in quasi two-dimensional lipid bilayer membranes**

Jay Groves<sup>1</sup>, <sup>1</sup>*HHMI, UC Berkeley, United States*

*Sponsored by The Innovation Group and Phillips Ormonde Fitzpatrick*



**OC013 14.20 Nanostructured Porous Silicon: A Novel Delivery System for Poorly Soluble Drugs**

Tim Barnes<sup>1</sup>, Frank Peddie<sup>2</sup>, Clive Prestidge<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, University of South Australia, Australia*, <sup>2</sup>*Sansom Institute, University of South Australia, Australia*

**OC014 14.40 Targeted Drug Delivery Using Bioinspired Nanoengineered Capsules**

Angus Johnston<sup>1</sup>, Lillian Lee<sup>1</sup>, Christina Cortez<sup>1</sup>, Frank Caruso<sup>1</sup>, <sup>1</sup>*The University of Melbourne, Australia*

**OC015 15.00 Dimers are forever: The importance of the membrane in ion pump function**

Ronald Clarke<sup>1</sup>, <sup>1</sup>*University of Sydney, Australia*

## Ballroom 4

## Australia-Japan Symposium

**KN006 13.40 Making silicon water friendly: an approach to producing stable oxide free silicon for biophotonic and bioelectrochemical applications**

J. Justin Gooding<sup>1</sup>, Kris Kilian<sup>1</sup>, Till Boecking<sup>1</sup>, Simone Ciampi<sup>1</sup>, Guillaume Le Saux<sup>1</sup>, Jarred Shein<sup>1</sup>, Leo Lai<sup>1</sup>, Michael James<sup>2</sup>, Jason Harper<sup>1</sup>

<sup>1</sup>*The School of Chemistry, The University of New South Wales, Sydney, NSW, Australia*, <sup>2</sup>*The Bragg Institute, Australian Nuclear Science and Technology Organisation, Lucas Heights, NSW, Australia*

*Sponsored by Swinburne University*



**OC016 14.20 Simultaneous Anomalous Reflection and Quartz-Crystal Microbalance Measurements of Biomolecule Bindings on a Gold Surface**

Yoshio Okahata<sup>1</sup>, Takayoshi Kawasaki<sup>1</sup>, <sup>1</sup>*Tokyo Institute of Technology, Japan*

**OC017 14.40 Adsorption of Well-Defined Fluorine-Containing Polymers onto PTFE**

Lisbeth Grondahl<sup>1</sup>, Shuko Suzuki<sup>1,2</sup>, Michael Whittaker<sup>1</sup>, Michael Monteiro<sup>1</sup>, Edeline Wentrup-Byrne<sup>2</sup>, <sup>1</sup>*The University of Queensland, Australia*, <sup>2</sup>*Queensland University of Technology, Australia*

**OC018 15.00 Magnetic Field Control of Structures and Functions of Colloidal Assemblies**

Sumio Ozeki<sup>1</sup>, Koichi Hashikawa<sup>1</sup>, Suguru Yamaguchi<sup>1</sup>, Kana Kubota<sup>1</sup>, Govindachetty Saravanan<sup>1</sup>, Atom Hamasaki<sup>1</sup>, <sup>1</sup>*Shinshu University, Japan*

3.20pm

## Afternoon Tea

3.50pm

## Ballroom 1

## THEME 1: Minerals and Material Processing

- OC019** 15.50 **Sulphide Mineral Surfaces in the Presence and Absence of Microorganisms Studied by Imaging Electrochemistry**  
Miao Chen<sup>1</sup>, Jing Zhao<sup>1</sup>, Jjinfeng Liu<sup>1</sup>, Bart Follink<sup>1</sup>, <sup>1</sup>*CSIRO Minerals, Australia*
- OC020** 16.10 **Wetting Characterisation in Porous Media**  
Thanh Tam Chau<sup>1</sup>, Leanne K. Smith<sup>1</sup>, Fuping P. Hao<sup>1</sup>, Peter T.L. Koh<sup>1</sup>, <sup>1</sup>*CSIRO Minerals, Australia*
- OC021** 16.30 **Effects of Clay-Organics in Structure and Rheology of Mature Fine Oilsands Tailings**  
Chandra W. Angle<sup>1</sup>, Hassan A. Hamza<sup>2</sup>, <sup>1</sup>*Natural Resources Canada, Canada*, <sup>2</sup>*Natural Resources Canada, Canada*
- OC022** 16.50 **Smart Polymers for Improved Mineral Processing**  
George Franks<sup>1</sup>, <sup>1</sup>*University of Melbourne, Australia*
- OC023** 17.10 **Control of Aggregate Structure, Settling and Dewatering in Mineral Tailings Processing**  
Jianhua (Jason) Du<sup>1</sup>, Roger Smart<sup>1</sup>, Rada Pushkarova<sup>2</sup>, <sup>1</sup>*Applied Centre for Structural and Synchrotron Studies, UniSA, Australia*, <sup>2</sup>*Ian Wark Research Institute, UniSA, Australia*

## Ballroom 2

## THEME 2: Life Science Applications

- OC024** 15.50 **Polymerization-Based Signal Amplification for Detection of Molecular Recognition**  
Christopher Bowman<sup>1</sup>, Ryan Hansen<sup>1</sup>, Leah Johnson<sup>1</sup>, Heather Avens<sup>1</sup>, Raveesh Shenoy<sup>1</sup>, <sup>1</sup>*University of Colorado, United States*
- OC025** 16.10 **Particle-Based Biosensors for Cancer and Infectious Disease Detection**  
Bronwyn Battersby<sup>1</sup>, Darby Kozak<sup>1</sup>, Annie Chen<sup>1</sup>, Matt Trau<sup>1</sup>, <sup>1</sup>*The University of Queensland, Australia*
- OC026** 16.30 **Tethered Bilayer Lipid Membranes as Versatile Model Membrane Systems**  
Ingo Köper<sup>1</sup>, <sup>1</sup>*Max Planck Institute for Polymer Research, Germany*
- OC027** 16.50 **Hybrid Microcapsules Engineered from Submicron Lipid Droplets and Silica Nanoparticles – Applications in Pharmaceutical Delivery**  
Spomenka Simovic<sup>1</sup>, Clive Prestidge<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, Australia*
- OC028** 17.10 **Binary Colloidal Crystals as Templates for Simple Generation of Highly Ordered Chemical Patterns used for Controlled Location of Proteins**  
Gurvinder Singh<sup>1</sup>, Saju Pillai<sup>1</sup>, Vijay Gothri<sup>1</sup>, Morten Foss<sup>1</sup>, Peter Kingshott<sup>1</sup>, <sup>1</sup>*Aarhus University, Denmark*

3.50pm

**Ballroom 4**

**Australia-Japan Symposium**

- OC029** 15.50 **New Surface Forces Apparatus Using Two-beam Interferometry**  
Kazue Kurihara<sup>1</sup>, Hiroshi Kawai<sup>1</sup>, Hiroshi Sakuma<sup>1</sup>, Masashi Mizukami<sup>1</sup>, Takashi Abe<sup>1</sup>,  
Yasuhiro Fukao<sup>1</sup>, Haruo Tajima<sup>1</sup>, <sup>1</sup>*IMRAM, Tohoku University, Japan*
- OC030** 16.10 **Factors Affecting the Stability of Surfactant-Free Liquid Films**  
Vassili Yaminsky<sup>1</sup>, Satomi Ohnishi<sup>1</sup>, Roger Horn<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute,  
University of South Australia, Australia*
- OC031** 16.30 **Cations on Silica Surface Act as “Abrasive Molecules”?**  
Ivan Vakarelski<sup>1</sup>, Naofumi Teramoto<sup>1</sup>, Cathy McNamee<sup>1</sup>, Ko Higashitani<sup>1</sup>, <sup>1</sup>*Kyoto  
University, Japan*
- OC032** 16.50 **Lubrication Forces on Colloidal Particles**  
Christopher Honig<sup>1</sup>, William Ducker<sup>1</sup>, <sup>1</sup>*University of Melbourne, Australia*
- OC033** 17.10 **Surfactant-assisted Formation of Whisker and Rod-shaped Nano-particles of Hydroxyapatite (HAp)**  
Jun Oshitani<sup>1</sup>, Nobuhide Kataoka<sup>1</sup>, Mikio Yoshida<sup>1</sup>, Kuniaki Gotoh<sup>1</sup>, <sup>1</sup>*Okayama  
University, Japan*

**5.45-7.45pm** **Poster Session** **Moseley / Colley / Hindmarsh**

*Sponsored by Davies Collision Cave*



DAVIES COLLISION CAVE

**7.30-10.30pm** **A-J Dinner** **Esca Restaurant**

## Tuesday 3 February 2009

8.30am

### Ballroom 1

### THEME 3: Spectroscopy and Scattering

**KN007 8.30 The Structure of Isolated Monomolecular Films of Proteins at the Air-water interface**

John White<sup>1</sup>, Jinminh Lin<sup>1</sup>, <sup>1</sup>*Australian National University, Australia*

*Sponsored by The Australian Synchrotron*



Australian Synchrotron  
synchrotron.vic.gov.au

**OC034 9.10 The Effect of Crystal Habit on the Surface Speciation and Reactivity of Pyrite Fracture Surfaces**

William Skinner<sup>1</sup>, Wayne Nesbitt<sup>2</sup>, Sarah Harmer<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, University of South Australia, Australia*, <sup>2</sup>*University of Western Ontario, Canada*

**OC035 9.30 Adsorption/desorption kinetics from ATR-IR spectra of oxalate on anatase TiO2 particle films – an alternative route to adsorption equilibrium constants?**

Jim McQuillan<sup>1</sup>, Aidan Young<sup>1</sup>, <sup>1</sup>*University of Otago, New Zealand*

**OC036 9.50 On the Structure of Foams: Structure factor of foams and synchrotron scattering from nanofoams**

Robert Corkery<sup>1</sup>, Keiichi Miyasaka<sup>2</sup>, Andrew Kraynik<sup>3</sup>, <sup>1</sup>*YKI, Institute for Surface Chemistry, Sweden*, <sup>2</sup>*Ahrrenius Laboratory, Stockholm University, Sweden*, <sup>3</sup>*Sandia National Laboratories, United States*

### Ballroom 2

### THEME 4: Nanofabrication and Microfluidics

**KN008 8.30 Scanning probes: from imaging to fabrication**  
Michelle Simmons<sup>1</sup>, <sup>1</sup>*University of New South Wales, Australia*

(presented by Dr Giordano Scappucci)

*Sponsored by The Ian Wark Research Institute*



**OC037 9.10 Vibration-Induced Microfluidic Colloidal Island Self-Assembly and Erasure**  
Leslie Yeo<sup>1</sup>, Haiyan Li<sup>1</sup>, James Friend<sup>1</sup>, <sup>1</sup>*Monash University, Australia*

**OC038 9.30 Surface Patterning and Structuring through Self-Assembly of Nanowires**  
Kyle Joseph<sup>1</sup>, Chiara Neto<sup>1</sup>, <sup>1</sup>*University of Sydney, Australia*

**OC039 9.50 Torque Generation via Boundary Shaping in an Electrodynamic Brownian rotor**  
Jiufu Lim<sup>1</sup>, John Sader<sup>1</sup>, Paul Mulvaney<sup>1</sup>, <sup>1</sup>*University of Melbourne, Australia*

## Ballroom 4

## Australia-Japan Symposium (continued)

- KN009** 8.30 **Nanoparticles and Photocatalysis: Enabling technologies for Plugging into the Sun**  
Max Lu<sup>1</sup>, <sup>1</sup>*The University of Queensland, Australia*
- OC040** 9.10 **Nafion®-Protected Pt Monometallic and Au-Pt Bimetallic Nanoparticles for Fuel Cells**  
Naoki Toshima<sup>1</sup>, Hideo Naohara<sup>2</sup>, Takahiro Yoshimoto<sup>1</sup>, <sup>1</sup>*Tokyo University of Science, Yamaguchi, Japan*, <sup>2</sup>*Toyota Motor Corporation, Japan*
- OC041** 9.30 **The Yielding of Concentrated Coagulated Particulate Suspensions**  
Jonathan Foong<sup>1</sup>, Peter Scales<sup>1</sup>, <sup>1</sup>*The University of Melbourne, Australia*, <sup>2</sup>*The University of Melbourne, Australia*
- OC042** 9.50 **Structure of Nonionic Surfactant Micelles in Organic Solvents: A SAXS Study**  
Lok Kumar Shrestha<sup>1</sup>, Takaaki Sato<sup>2</sup>, Otto Glatter<sup>3</sup>, Kenji Aramaki<sup>1</sup>, <sup>1</sup>*Yokohama National University, Japan*, <sup>2</sup>*Shinshu University, Japan*, <sup>3</sup>*Universität Graz, Austria*

10.10am

Morning Tea

10.40am

## Ballroom 1

## THEME 3: Spectroscopy and Scattering

- OC043** 10.40 **In Situ ATR-FTIR Studies of SO<sub>4</sub> Adsorption on Goethite in the Presence of Copper Ions**  
David Beattie<sup>1</sup>, Julie Chapelet<sup>1</sup>, Markus Grafe<sup>2</sup>, Bill Skinner<sup>1</sup>, Euan Smith<sup>3</sup>, <sup>1</sup>*Ian Wark Research Institute, University of South Australia, Australia*, <sup>2</sup>*Faculty of Agriculture, Food & Natural Resources, University of Sydney, Australia*, <sup>3</sup>*Centre for Environmental Risk Assessment and Remediation, University of South Australia, Australia*
- OC044** 11.00 **A Combined In-Situ ATR-IR/Surface Photovoltage Spectroscopy Study of TiO<sub>2</sub> Thin Films in an Aqueous Environment.**  
Dave Warren<sup>1</sup>, Jim McQuillan<sup>1</sup>, Yoram Shapira<sup>2</sup>, <sup>1</sup>*University of Otago, New Zealand*, <sup>2</sup>*Tel Aviv University, Israel*
- OC045** 11.20 **Tunable light emission using Quantum dot coated Upconverters**  
Tich-Lam Nguyen<sup>1</sup>, Paul Spizzirri<sup>1</sup>, Gerry Wilson<sup>2</sup>, Paul Mulvaney<sup>1</sup>  
<sup>1</sup>*University of Melbourne, Melbourne, Vic, Australia*, <sup>2</sup>*CSIRO, Melbourne, Vic, Australia*
- OC046** 11.40 **Probing Monolayer/Subphase Interactions and Real Time Crystallisation Using Synchrotron Radiation**  
Conrad Lendrum<sup>1,2</sup>, Bridget Ingham<sup>2</sup>, Michael Toney<sup>3</sup>, Kathryn McGrath<sup>1</sup>, <sup>1</sup>*MacDiarmid Institute for Advanced Materials and Nanotechnology, School of Chemical and Physical Sciences, Victoria University of Wellington, New Zealand*, <sup>2</sup>*Industrial Research Limited, New Zealand*, <sup>3</sup>*Stanford Synchrotron Radiation Laboratory, SLAC, United States*
- OC047** 12.00 **Self-assembly of Star-Shaped Polyphiles Investigated by SAXS and SANS**  
Liliana de Campo<sup>1</sup>, Minoog Moghaddam<sup>2</sup>, Christophe Oguey<sup>3</sup>, Jacob Kirkensgaard<sup>4</sup>, Kell Mortensen<sup>4</sup>, Trond Varslot<sup>1</sup>, Stephen Hyde<sup>1</sup>, <sup>1</sup>*ANU, Australia*, <sup>2</sup>*CSIRO, Australia*, <sup>3</sup>*Universite Cergy-Pontoise, France*, <sup>4</sup>*Copenhagen University, Denmark*

10.40am

**Ballroom 2**

**THEME 4: Nanofabrication and Microfluidics**

- OC048** 10.40 **Interfacial Structure and the Dynamic Wetting of Solid Surfaces with Ionic Liquids**  
John Ralston<sup>1</sup>, Mani Paneru<sup>1</sup>, Vera Lockett<sup>1</sup>, Rossen Sedev<sup>1</sup>, Craig Priest<sup>1</sup>, Markus Mezger<sup>2</sup>, Harald Reichert<sup>3</sup>, <sup>1</sup>*Ian Wark Research Institute, Australia*, <sup>2</sup>*Lawrence Berkeley National Laboratory, United States*, <sup>3</sup>*Max Planck Institute for Metallforschung, Germany*
- OC049** 11.00 **Capillary Driven Flows: Effects Due to Velocity Dependent Contact Angles and Chemically Patterned Walls**  
Mihail Popescu<sup>1</sup>, John Ralston<sup>1</sup>, Rossen Sedev<sup>1</sup>, Monica Marinescu<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, Australia*
- OC050** 11.20 **Capillary Absorption of Metal Nanodroplets by Carbon Nanotubes**  
Shaun Hendy<sup>1,2</sup>, Dmitri Schebarchov<sup>2</sup>, <sup>1</sup>*Industrial Research Ltd, New Zealand*, <sup>2</sup>*MacDiarmid Institute for Advanced Materials and Nanotechnology, Victoria University of Wellington, New Zealand*
- OC051** 11.40 **Capillary Models for Porous Media and Packs of Particles**  
Rossen Sedev<sup>1</sup>, Artem Borysenko<sup>1</sup>, Xun Bian<sup>1</sup>, Jan Metje<sup>1</sup>, John Ralston<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, University of South Australia, Australia*
- OC052** 12.00 **Anisotropic Slip at Janus Particle Surfaces**  
Geoff Willmott<sup>1</sup>, <sup>1</sup>*Industrial Research Limited, New Zealand*

**Ballroom 4**

**Australia-Japan Symposium (continued)**

- OC053** 10.40 **How to design a novel proton-conducting nanomembrane**  
Toyoki Kunitake<sup>1</sup>, Yoshitaka Aoki<sup>2</sup>, <sup>1</sup>*RIKEN, Japan*, <sup>2</sup>*Hokkaido University, Japan*
- OC054** 11.00 **MRI Contrast Agents based on Dispersed Cubic Phase Particles**  
Patrick Hartley<sup>1</sup>, <sup>1</sup>*CSIRO Molecular & Health Technologies, Australia*
- OC055** 11.20 **Pressure-Dependent Structural Change of 2D Colloid Crystal in Supercritical Ethanol**  
Shigeru Deguchi<sup>1</sup>, Sada-atsu Mukai<sup>1,2</sup>, Takehito Koyama<sup>1</sup>, Sayuki Ohta<sup>1,3</sup>, Makio Iwahashi<sup>3</sup>, Kaoru Tsujii<sup>4</sup>, Koki Horikoshi<sup>1</sup>, <sup>1</sup>*Japan Agency for Marine-Earth Science and Technology, Japan*, <sup>2</sup>*Kyushu University, Japan*, <sup>3</sup>*Kitasato University, Japan*, <sup>4</sup>*Hokkaido University, Japan*
- OC056** 11.40 **The Interaction Between the Hydrophilic Side of Phosphatidylcholine Monolayers at an Air-Water Interface and a Silica Probe**  
Cathy McNamee<sup>1</sup>, Michael Kappl<sup>2</sup>, Karlheinz Graf<sup>2</sup>, <sup>1</sup>*Shinshu University, Japan*, <sup>2</sup>*Max Planck Institute for Polymer Research, Germany*
- OC057** 12.00 **Supramolecular Nanoparticles Self-Assembled from Nucleotides and Lanthanide Ions in Water and their Adaptive Encapsulation Characteristics**  
Ryuhei Nishiyabu<sup>1</sup>, Nobuo Kimizuka<sup>1</sup>, <sup>1</sup>*Kyushu University, Japan*

12.20pm

**Lunch**

1.20pm

**Ballroom 1**

**THEME 3: Spectroscopy and Scattering**

- KN010** 13.20 **Fuel Cell Membranes That Become Wetter as the Surrounding Air Gets Hotter**  
Moon-Jeong Park<sup>1</sup>, Nitash Balsara<sup>1</sup>, <sup>1</sup>University of California, United States, <sup>2</sup>Lawrence Berkeley National Laboratory, United States

*Sponsored by Australian Nuclear Science and Technology Organisation*



- OC058** 14.00 **Quokka is Hopping Mad – Latest Results from the Small-Angle Neutron Scattering Instrument at ANSTO**  
Elliot Gilbert<sup>1</sup>, William Hamilton<sup>1</sup>, <sup>1</sup>ANSTO, Australia
- OC059** 14.20 **Structure of Magnetically Aligned Ferrofluid Emulsions from Small Angle Neutron Scattering**  
Connie Liu<sup>1</sup>, Gregory Warr<sup>1</sup>, Nirmesh Jain<sup>1</sup>, William Hamilton<sup>2</sup>, Brian Hawkett<sup>1</sup>, <sup>1</sup>Key Centre for Polymers and Colloids, School of Chemistry, Australia, <sup>2</sup>Bragg Institute, Australian Nuclear Science and Technology Organisation, Australia

**Ballroom 2**

**THEME 4: Nanofabrication and Microfluidics**

- KN011** 13.20 **Slip, Droplets, Complex Fluids and Other Small Things Investigated With Microfluidic Technology**  
Patrick Tabeling<sup>1</sup>, <sup>1</sup>ESPCI, France

*Sponsored by The Wark Research Institute*



- OC060** 14.00 **Nitrogen Bubble Nucleation and Transport at Oil-Water Interfaces**  
Pramith Priyananda<sup>1</sup>, Gregory Warr<sup>1</sup>, Brian Hawkett<sup>1</sup>, <sup>1</sup>Key Centre for Polymers and Colloids, School of Chemistry F11, Australia
- OC061** 14.20 **Microfluidic Solvent Extraction for Mineral Processing**  
Jingfang Zhou<sup>1</sup>, Craig Priest<sup>1</sup>, John Ralston<sup>1</sup>, Rossen Sedev<sup>1</sup>, Kazuma Mawatari<sup>2</sup>, Takehiko Kitamori<sup>2,3</sup>, <sup>1</sup>University of South Australia, Australia, <sup>2</sup>Kanagawa Academy of Science and Technology, Japan, <sup>3</sup>The University of Tokyo, Japan

1.20pm

**Ballroom 4**

**Australia-Japan Symposium (continued)**

**OC062 13.20 Spontaneous Formation of Super Water-Repellent Fractal Structures on Wax Surfaces**

Kaoru Tsujii<sup>1</sup>, <sup>1</sup>*Nanotechnology Research Center, Research Institute for Electronic Science, Hokkaido University (Retired), Japan*

**OC063 13.40 Microwires Network Assembly by Capillary Bridging Lithography**

Ivan U. Vakarelski<sup>1,2</sup>, Takashi Nonoguchi<sup>1</sup>, Derek Y.C. Chan<sup>3</sup>, Hiroyuki Shinto<sup>1</sup>, Ko Higashitani<sup>1</sup>, <sup>1</sup>*Department of Chemical Engineering, Kyoto University, Japan*, <sup>2</sup>*Institute of Chemical and Engineering Sciences, Singapore*, <sup>3</sup>*Particulate Fluids Processing Centre, University of Melbourne, Austria*

**OC064 14.00 Cooperative Clathrate Formations of Metal Organic Frameworks by Expansive Modulation**

Hirofumi Kanoh<sup>1</sup>, <sup>1</sup>*Chiba University, Japan*

**OC065 14.20 Polymerised Vesicles versus Lamellar Fragments from Amphiphilic Diblock Oligomers**

Annabelle Blom<sup>1</sup>, Jennifer O'Donnell<sup>1</sup>, Gregory Warr<sup>1</sup>, Brian Hawkett<sup>1</sup>, <sup>1</sup>*Key Centre for Polymers and Colloids, School of Chemistry F11, Australia*

2.40pm

**Afternoon Tea**

8.50am

**Ballroom 1**

**THEME 5: Soft Matter Self Assembly**

**KN012 8.50 Self-assembly of particles and functional polymers and their application in biointerface science**

Marcus Textor<sup>1</sup>, <sup>1</sup>*ETH Zurich, Department of Materials, Switzerland*

**Sponsored by CSIRO**



**OC066 9.30 Highly Ordered Mixed Protein Patterns from Assembly of Binary Colloidal Dispersions Coated with Different Proteins**

Gurvinder Singh<sup>1</sup>, Saju Pillai<sup>1</sup>, Ayyoob Arpanaei<sup>1</sup>, Peter Kingshott<sup>1</sup>, <sup>1</sup>*Aarhus University, Denmark*

**OC067 9.50 Cubic Phase Nanoparticles: Preparation and Structural Investigations.**

Durga Acharya<sup>1</sup>, Dori Pegalajar Jurado<sup>1</sup>, Ben Muir<sup>1</sup>, Anastasios Polyzos<sup>1</sup>, Patrick Hartley<sup>1</sup>, <sup>1</sup>*CSIRO Molecular and Health Technologies, Australia*

**OC068 10.10 Control of Drug Release In Vitro and In Vivo using Self Assembled Liquid Crystalline Mesophase Materials**

Wye-Khay Fong<sup>1</sup>, Kathy Lee<sup>1</sup>, Tracey Hanley<sup>2</sup>, Ben Boyd<sup>1</sup>, <sup>1</sup>*Monash Institute of Pharmaceutical Sciences, Australia*, <sup>2</sup>*Bragg Institute, ANSTO, Australia*

**Ballroom 2**

**THEME 6: Frontiers of Colloid & Interface Science**

**KN013 8.50 Biomimetic Synthesis and Nanoparticle Assembly: Towards Versatile Routes for Nanostructured Films**

Lennart Bergström<sup>1</sup>, <sup>1</sup>*Stockholm University, Sweden*

**Sponsored By Rheological Consulting Services (RCS)**



**OC069 9.30 Surface Plasmon Spectroscopy of Single Gold Nanocrystals**

Paul Mulvaney<sup>1</sup>, <sup>1</sup>*University of Melbourne, Australia*

**OC070 9.50 Superparamagnetic Nanoparticles in the Hyperthermia Treatment of Cancer and Other Medical Applications**

Nirmesh Jain<sup>1</sup>, Brian Hawke<sup>1</sup>, Yanjun Wang<sup>1</sup>, Binh Pham<sup>1</sup>, Michael Luke<sup>1</sup>, Gregory Warr<sup>1</sup>, Stephen Jones<sup>2</sup>, <sup>1</sup>*The Key Centre for Polymers and Colloids, School of Chemistry, The University of Sydney, Australia*, <sup>2</sup>*Sirtex Medical Limited, Unit F6 Parkview, 16 Mars Road, Australia*

**OC071 10.10 Non-aqueous Liquid Toners: Observation of Particle Charge via Electrophoretic Movement**

Drew Evans<sup>1</sup>, <sup>1</sup>*Research Laboratories of Australia, Australia*

**10.30am Morning Tea**

**11.00am**

**Ballroom 1 THEME 5: Soft Matter Self Assembly**

- OC072 11.00 Small Angle Scattering Study of Self Assembly in Mixed Lipid Systems**  
Divya Singh<sup>1</sup>, Lionel Porcar<sup>3,2</sup>, Gina Polimeni<sup>2</sup>, Paul Butler<sup>2</sup>, Ursula Perez-Salas<sup>4,2</sup>, Gary Lynn<sup>5</sup>, William Hamilton<sup>6,5</sup>, <sup>1</sup>*The Johns Hopkins University, United States*, <sup>2</sup>*NIST Center for Neutron Research, United States*, <sup>3</sup>*Institute Laue Langevin, France*, <sup>4</sup>*Argonne National Laboratory, United States*, <sup>5</sup>*Oak Ridge National Laboratory, United States*, <sup>6</sup>*Bragg Institute, ANSTO, Australia*
- OC073 11.20 Structure of Emulsions Stabilised by Mixtures of Particles of Different Wettability**  
Catherine Whitby<sup>1</sup>, Daniel Fornasiero<sup>1</sup>, John Ralston<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, University of South Australia, Australia*
- OC074 11.40 Hierarchical Macroporous Structures Formed by a Facile Colloidal Templating Strategy**  
Qin Li<sup>1,2</sup>, Likui Wang<sup>3</sup>, X.S. Zhao<sup>3</sup>, <sup>1</sup>*Max Planck Institute for Polymer Research, Germany*, <sup>2</sup>*Curtin University of Technology, Australia*, <sup>3</sup>*National University of Singapore, Singapore*
- OC075 12.00 The Effects of Polydispersity on the Self Assembly of Block Copolymers.**  
Patrick Fairclough<sup>1</sup>, Christine Fernyhough<sup>1</sup>, Chris Howell<sup>1</sup>, Mark Matsen<sup>2</sup>, Tom Beardsley<sup>2</sup>, Sébastien Perrier<sup>3</sup>, Vincent Ladmiral<sup>3</sup>, Jim Nobbs<sup>4</sup>, <sup>1</sup>*University of Sheffield, United Kingdom*, <sup>2</sup>*University of Reading, United Kingdom*, <sup>3</sup>*University of Sydney, Australia*, <sup>4</sup>*University of Leeds, United Kingdom*
- OC076 12.20 Capsosomes: Liposomes as Sub-Compartments in Polymer Capsules**  
Brigitte Stadler<sup>1</sup>, Rona Chandrawati<sup>1</sup>, Frank Caruso<sup>1</sup>, <sup>1</sup>*University of Melbourne, Australia*

**Ballroom 2 THEME 6: Frontiers of Colloid & Interface Science**

- OC077 11.00 Water at Hydrophobic Interfaces Explained by a New Fluctuation Force**  
James Beattie<sup>1</sup>, Angus Gray-Weale<sup>1</sup>, <sup>1</sup>*University of Sydney, Australia*
- OC078 11.20 Bubbles and Salt and Ion-specificity**  
Vincent Craig<sup>1</sup>, Christine Henry<sup>1</sup>, <sup>1</sup>*Australian National University, Australia*
- OC079 11.40 The Influence of Surface Charge on Static and Dynamic Wetting**  
LeeSan Puah<sup>1</sup>, Rossen Sedev<sup>1</sup>, Daniel Fornasiero<sup>1</sup>, John Ralston<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, Australia*
- OC080 12.00 Interfacial Layering of Ionic Liquids at Charged Interfaces from a Self-Consistent Mean-Field Perspective.**  
Yansen Lauw<sup>1,2</sup>, Bart Follink<sup>1</sup>, Mike Horne<sup>1</sup>, Theo Rodopoulos<sup>1</sup>, Frans Leermakers<sup>3</sup>, <sup>1</sup>*CSIRO Minerals, Australia*, <sup>2</sup>*ANSTO, Australia*, <sup>3</sup>*Wageningen University, Netherlands*
- OC081 12.20 Superhydrophobic Surfaces Based on Metal and Alloys**  
Jairo Garnica Rodriguez<sup>1</sup>, Rossen Sedev<sup>1</sup>, Nikolay Dimitrov<sup>2</sup>, John Ralston<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute – UniSA, Australia*, <sup>2</sup>*Binghamton University – SUNY, United States*

**12.40pm Lunch**

1.40pm

**Ballroom 1**      **THEME 5: Soft Matter Self Assembly**

- OC082** 13.40 **New Polyfunctional Molecules: Liquid Crystallinity in Star Polyphiles**  
*Stephen Hyde<sup>1</sup>, Liliana De Campo<sup>1</sup>, Christophe Oguey<sup>2</sup>, <sup>1</sup>Australian National University, Australia, <sup>2</sup>University of Cergy-Pontoise, France*
- OC083** 14.00 **Coarse-Grained Simulations of Polyphilic Molecules**  
*Jacob Kirkensgaard<sup>1</sup>, Stephen Hyde<sup>2</sup>, <sup>1</sup>Copenhagen University, Denmark, <sup>2</sup>Australian National University, Australia*
- OC084** 14.20 **Characterisation of the CMC of Amphiphiles in Protic Ionic Liquids**  
*Tamar Greaves<sup>1</sup>, Asoka Weerawardena<sup>1</sup>, Irena Krodkiewska<sup>1</sup>, Calum Drummond<sup>1,2</sup>, <sup>1</sup>CSIRO Molecular and Health Technologies, Australia, <sup>2</sup>CSIRO Materials Science and Engineering, Australia*
- OC085** 14.40 **AFM And STM Studies on the Surface Interaction of [BMP]TFSA and [Emim]TFSA Ionic Liquids with Au(111)**  
*Rob Atkin<sup>1</sup>, Robert Hayes<sup>1</sup>, Sherif Zein El Abedin<sup>2</sup>, Frank Endres<sup>2</sup>, <sup>1</sup>University of Newcastle, Australia, <sup>2</sup>Clausthal University of Technology, Germany*

**Ballroom 2**      **THEME 6: Frontiers of Colloid & Interface Science**

- OC086** 13.40 **Sonochemical Synthesis of Lysozyme Microspheres**  
*Meifang Zhou<sup>1</sup>, Mathilde Evrard<sup>2</sup>, Thomas Seak Hou Leong<sup>1</sup>, Francesca Cavaliere<sup>3</sup>, Sandra Kentish<sup>1</sup>, Muthupandian Ashokkumar<sup>1</sup>, Franz Grieser<sup>1</sup>, <sup>1</sup>Particulate Fluids Processing Centre, School of Chemistry, The University of Melbourne, Australia, <sup>2</sup>Département enie des procédés et informatique, Ecole Nationale des Ingénieurs en Arts Chimiques et Technologiques, France, <sup>3</sup>Dipartimento di Scienze e Tecnologia Chimiche, Università di Roma Tor Vergata, Italy*
- OC087** 14.00 **Modification of Structure and Functionality of Deamidated Wheat Proteins via Maillard Conjugation with Dextrans**  
*Benjamin Wong<sup>2</sup>, Donald McNaughton<sup>2</sup>, Li Day<sup>1</sup>, Maryann Augustin<sup>1</sup>, <sup>1</sup>Food Science Australia (CSIRO), Australia, <sup>2</sup>Monash University, Australia*
- OC088** 14.20 **SonophotoCatalytic Degradation of Orange G using Titanium Dioxide**  
*Madhavan Jagannathan<sup>1</sup>, Franz Grieser<sup>1</sup>, Ashokkumar Muthupandian<sup>1</sup>, <sup>1</sup>Particulate Fluids Processing Centre, School of Chemistry, University of Melbourne, Australia*
- OC089** 14.40 **Self Assembled Monolayers of Functionalised Amphiphilic PAMAM Dendrimers for pH and Metal-Ion Sensing**  
*Adrian Trinchi<sup>1</sup>, Tim Muster<sup>1</sup>, <sup>1</sup>CSIRO Materials Science and Engineering, Australia*

3.00pm

**Afternoon Tea**

3.30pm

**Ballroom 1**      **THEME 5: Soft Matter Self Assembly**

**KN014** 15.30 **Enzymatically Ordering the Nanoworld**  
Rein Ulijn<sup>1</sup>, <sup>1</sup>*University of Strathclyde, United Kingdom*

*Sponsored by CSIRO*



**OC090** 16.10 **Large Ion Aggregates in Protic Ionic Liquids observed by ESI-MS**  
Danielle Kennedy<sup>1</sup>, Calum Drummond<sup>2</sup>, <sup>1</sup>*CSIRO Molecular and Health Technologies, Australia*, <sup>2</sup>*CSIRO Materials Science and Engineering, Australia*

**OC091** 16.30 **Using Self-Assembled Copolymer Thin Films to Control the Orientation of Carbon Nanotubes**  
Tony Aitchison<sup>1</sup>, Milena Ginic Markovic<sup>1</sup>, Stephen Clarke<sup>1</sup>, <sup>1</sup>*Flinders University, Australia*

**Ballroom 2**      **THEME 6: Frontiers of Colloid & Interface Science**

**OC092** 15.30 **Colloidal Aggregation and Interaction Forces Induced by Adsorbed Dendrimers**  
Ionel Popa<sup>1</sup>, Ramon Pericet-Camara<sup>2</sup>, Georg Papastavrou<sup>1</sup>, Ger Koper<sup>3</sup>, Michal Borkovec<sup>1</sup>, <sup>1</sup>*University of Geneva, Switzerland*, <sup>2</sup>*University of Granada, Spain*, <sup>3</sup>*University of Delft, Netherlands*

**OC093** 15.50 **Direct Peptide Synthesis on a Solid Surface**  
Wade Mosse<sup>1</sup>, Merran Koppens<sup>1</sup>, Thomas Gengenbach<sup>3</sup>, Denis Scanlon<sup>2</sup>, Sally Gras<sup>1,2</sup>, William Ducker<sup>1,4</sup>, <sup>1</sup>*Department of Chemical and Biomolecular Engineering, The University of Melbourne, Australia*, <sup>2</sup>*Bio21 Institute, The University of Melbourne, Australia*, <sup>3</sup>*CSIRO Molecular and Health Technologies, Australia*, <sup>4</sup>*Virginia Tech, United States*

**OC094** 16.10 **Phoretic Motion via Self-Generated Solute Gradients: (i) Confinement Effects and (ii) Shape Dependence for Axisymmetrical Objects**  
Mihail Popescu<sup>1</sup>, Siegfried Dietrich<sup>2</sup>, Gleb Oshanin<sup>3</sup>, John Ralston<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, Australia*, <sup>2</sup>*Max-Planck-Institut for Metal Research, Germany*, <sup>3</sup>*LPTMC, Universite Paris 6, France*

**OC095** 16.30 **Electronic Tuning of the Surface Plasmon Resonances of Single Gold Nanorods**  
Carolina Novo<sup>1</sup>, Alison Funston<sup>1</sup>, <sup>1</sup>*School of Chemistry, The University of Melbourne, Australia*

**5.00pm**      **RACI Colloid & Surface Science Annual General Meeting, Ballroom 1**

**7.30pm**      **Conference Dinner & Poster Prize Presentations, Ballroom 3-5**

*Sponsored by Scientific Solutions*



9.00am

**Ballroom 1**      **THEME 7: Surface Forces and Nanotribology**

- KN015** 9.00 **Critical Casimir Forces in Colloidal Systems**  
Clemens Bechinger<sup>1</sup>, <sup>1</sup>*2. Physikalisches Institut, Germany*
- OC096** 9.40 **Measurements of the Forces Between Bubble and Particle with AFM – Effect of Surface Charge and Hydrophobicity**  
Marta Krasowska<sup>1</sup>, Raymond Dagastine<sup>2</sup>, Daniel Fornasiero<sup>1</sup>, John Ralston<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, University of South Australia, Australia*, <sup>2</sup>*Particulate Fluids Processing Centre, University of Melbourne, Australia*
- OC097** 10.00 **Superlubricity using Repulsive Van der Waals Forces**  
Adam Feiler<sup>1</sup>, Lennart Bergstrom<sup>3</sup>, Mark Rutland<sup>2</sup>, <sup>1</sup>*YKI, Institute for Surface Chemistry, Sweden*, <sup>2</sup>*KTH, Royal Institute of Technology, Sweden*, <sup>3</sup>*Stockholm University, Sweden*

**Ballroom 2**      **THEME 6: Frontiers of Colloid & Interface Science**

- KN016** 9.00 **Liquid Crystal Colloids and Emulsions: A Structured Reactive Soft Matter**  
Hiroshi Yokoyama<sup>1,2</sup>, Jun-ichi Fukuda<sup>1,2</sup>, Camilla Voeltz<sup>2</sup>, Yoji Maeda<sup>2</sup>, Makoto Yada<sup>2</sup>, Makoto Yoneya<sup>1,2</sup>, Yuka Tabe<sup>2,3</sup>, <sup>1</sup>*National Institute of Advanced Industrial Science and Technology, Japan*, <sup>2</sup>*Liquid Crystal NanoSystem Project, ERATO/SORST, JST, Japan*, <sup>3</sup>*Waseda University, Japan*
- OC098** 9.40 **Pushing the Limits of Emulsification – Creating Edible Nanoemulsions that are Inherently Stable to Ostwald Ripening**  
Tim J. Wooster<sup>1</sup>, Matt Golding<sup>1</sup>, Helen French<sup>1</sup>, Peerasak Sanguansri<sup>1</sup>, <sup>1</sup>*Food Science Australia, Australia*
- OC099** 10.00 **Electrowetting of Ionic Liquid in Solid/Liquid/Liquid Systems**  
Mani Paneru<sup>1</sup>, Rossen Sedev<sup>1</sup>, John Ralston<sup>1</sup>, <sup>1</sup>*IWRI, Australia*

10.20am      **Morning Tea**

10.50am

**Ballroom 1**      **THEME 7: Surface Forces and Nanotribology**

- KN017** 10.50 **Molecular Analysis of Liquid Adsorption at the Solid/Liquid Interfaces: Surface Forces Measurement and Surface Selective Spectroscopy**  
Masashi Mizukami<sup>1</sup>, Kazue Kurihara<sup>1</sup>, <sup>1</sup>*Tohoku University, Japan*
- OC100** 11.30 **Phase Transitions and Solvency Studied Using Surface Forces Measurements: Adsorbed Polymer Layers**  
Shannon Notley<sup>1</sup>, <sup>1</sup>*Applied Mathematics, School of Physical Sciences and Engineering, Australian National University, Australia*
- OC101** 11.50 **Influence of Adsorbed Film Viscoelasticity on the Superior Lubrication Properties of Saliva**  
Lubica Macakova<sup>1,2</sup>, Gleb Yakubov<sup>1</sup>, Damiano Rossetti<sup>1</sup>, Mark Plunkett<sup>2</sup>, Jason Stokes<sup>1</sup>, <sup>1</sup>*Unilever Corporate Research, United Kingdom*, <sup>2</sup>*YKI, Institute for Surface Chemistry AB, Sweden*
- OC102** 12.10 **Contact Angle Relaxation in Dewetting Processes**  
Renate Fetzer<sup>1</sup>, John Ralston<sup>1</sup>, <sup>1</sup>*University of South Australia, Australia*

10.50am

**Ballroom 2**      **THEME 6: Frontiers of Colloid & Interface Science**

- OC103** 10.50 **Comparative Study of the Benefits of Lignite Addition to the Flocculation of Different Types of Sludges**  
Y.R. Bhatt<sup>1</sup>, A. Salvador<sup>1</sup>, K.B. Thapa<sup>1</sup>, Y. Qi<sup>1</sup>, A.F.A. Hoadley<sup>1</sup>, <sup>1</sup>*Monash University, Australia*
- OC104** 11.10 **Acoustically-Driven Interfacial Destabilisation and Atomisation in a Microfluidic Device**  
Leslie Yeo<sup>1</sup>, Aisha Qi<sup>1</sup>, James Friend<sup>1</sup>, <sup>1</sup>*Monash University, Australia*
- OC105** 11.30 **Cleaning of Protein Coated Surfaces Using Nanobubbles: An Investigation Using a Quartz Crystal Microbalance**  
Guangming Liu<sup>1</sup>, Vincent S. J. Craig<sup>1</sup>, <sup>1</sup>*Department of Applied Mathematics, Research School of Physical Sciences and Engineering, The Australian National University, Australia*
- OC106** 11.50 **Utilising Positron Annihilation Lifetime Spectroscopy to Reveal the Functional Molecular Sieving Framework of Amorphous Silica**  
Mikel Duke<sup>1</sup>, Steven Pas<sup>2,3</sup>, Anita Hill<sup>3</sup>, Jerry Lin<sup>4</sup>, Joao C. Diniz da Costa<sup>5</sup>, <sup>1</sup>*Institute for Sustainability and Innovation, Victoria University, Australia*, <sup>2</sup>*ARC Centre of Excellence for Electromaterials Science, Department of Materials Engineering, Monash University, Australia*, <sup>3</sup>*CSIRO Materials Science and Engineering, Australia*, <sup>4</sup>*Department of Chemical Engineering, Arizona State University, United States*, <sup>5</sup>*FIMLab – Films and Inorganic Membrane Laboratory, Division of Chemical Engineering, The University of Queensland, Australia*
- OC107** 12.10 **Adsorption of Submicrometer-sized Cationic Sterically-Stabilised Polystyrene Latex at the Air-Water Interface: Foam Behavior and Contact Angle Determination by Ellipsometry**  
Erica Wanless<sup>1</sup>, Timothy Hunter<sup>1,3</sup>, Graeme Jameson<sup>1</sup>, Damien Dupin<sup>2</sup>, Steven Armes<sup>2</sup>, <sup>1</sup>*University of Newcastle, Australia*, <sup>2</sup>*University of Sheffield, United Kingdom*, <sup>3</sup>*University of Leeds, United Kingdom*

12.30pm      **Lunch**

1.30pm

**Ballroom 1**      **THEME 7: Surface Forces and Nanotribology**

- OC108** 13.30 **Dynamic Forces between Bubbles in Foams using Atomic Force Microscopy**  
Raymond Dagastine<sup>1</sup>, Ofer Manor<sup>1</sup>, Ivan Vakarelski<sup>1</sup>, Geoffery Stevens<sup>1</sup>, Franz Grieser<sup>1</sup>, Derek Chan<sup>1</sup>, <sup>1</sup>*Particulate Fluids Processing Centre, the University of Melbourne, Australia*
- OC109** 13.50 **Evaporation Models for Microdrops of Water on Hydrophobic and Hydrophilic Surfaces tested by AFM-Cantilever Measurements**  
Elmar Bonaccorso<sup>1</sup>, Dmytro S. Golovko<sup>1</sup>, Hans-Jürgen Butt<sup>1</sup>, <sup>1</sup>*Max Planck Institute for Polymer Research, Germany*
- OC110** 14.10 **Ion-specific Bubble Coalescence Inhibition: Nonaqueous Solvents**  
Christine Henry<sup>1</sup>, Vince Craig<sup>1</sup>, <sup>1</sup>*Department of Applied Maths, ANU, Australia*
- OC111** 14.30 **The Interaction Between a Very Small Rising Bubble and a Hydrophilic Titania Surface: Experiment**  
Luke Parkinson<sup>1</sup>, John Ralston<sup>1</sup>, Rogerio Manica<sup>3</sup>, Derek Chan<sup>2</sup>, <sup>1</sup>*University of South Australia, Australia*, <sup>2</sup>*The University of Melbourne, Australia*, <sup>3</sup>*Institute of High Performance Computing, Singapore*, <sup>4</sup>*National University of Singapore, Singapore*

1.30pm

**Ballroom 2**      **THEME 6: Frontiers of Colloid & Interface Science**

- OC112** 13.30 **Plasmon Interactions of Closely-Spaced Au Nanoparticles**  
Alison Funston<sup>1</sup>, Carolina Novo<sup>1</sup>, <sup>1</sup>*School of Chemistry, The University of Melbourne, Australia*
- OC113** 13.50 **Carboxymethyl Cellulose Adsorption on a Model Hydrophobic Surface Studied with QCM-D: Effect of Ionic Strength and pH on Conformation and Surface Wettability**  
Iliana Sedeva<sup>1</sup>, Daniel Fornasiero<sup>1</sup>, John Ralston<sup>1</sup>, David Beattie<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, University of South Australia, Australia*
- OC114** 14.10 **Superhydrophobic Polymer Films Based on Malonamide Dendrons with Peripheral Long Alkyl Chains**  
Ru-Jong Jeng<sup>1</sup>, Wei-Ho Ting<sup>1</sup>, Shenghong A Dai<sup>1</sup>, Chao-Chin Chen<sup>1</sup>, <sup>1</sup>*National Chung Hsing University, Taiwan*
- OC115** 14.30 **Dynamic Interactions Forces Between Particles and Droplets in Response to Perturbations of Surfactant Adsorption**  
Hemayet Uddin<sup>1,2</sup>, Geoffrey Stevens<sup>2</sup>, Derek Chan<sup>3</sup>, Franz Grieser<sup>2</sup>, Raymond Dagastine<sup>1,2</sup>, <sup>1</sup>*Particulate Fluids Processing Centre & Department of Chemical and Biomolecular Engineering, The University of Melbourne, Australia*, <sup>2</sup>*Particulate Fluids Processing Centre & School of Chemistry, The University of Melbourne, Australia*, <sup>3</sup>*Particulate Fluids Processing Centre & Department of Mathematics and Statistics, The University of Melbourne, Australia*

2.50pm      **Afternoon Tea**

3.20pm

**Ballroom 1**      **THEME 7: Surface Forces and Nanotribology**

- OC116** 15.20 **The Interaction Between a Very Small Rising Bubble and a Hydrophilic Titania Surface: Theory**  
Rogério Manica<sup>1</sup>, Luke Parkinson<sup>2</sup>, Evert Klaseboer<sup>1</sup>, John Ralston<sup>2</sup>, Derek Chan<sup>3</sup>, <sup>1</sup>*Institute of High Performance Computing, Singapore*, <sup>2</sup>*Ian Wark Research Institute, University of South Australia, Australia*, <sup>3</sup>*Particulate Fluids Processing Centre, The University of Melbourne, Australia*
- OC117** 15.40 **It's Easy To Understand Particle Dispersion In Air – Isn't It?**  
Ingrid Heinicke<sup>1</sup>, Ian Larson<sup>1</sup>, <sup>1</sup>*Monash Institute of Pharmaceutical Sciences, Australia*

**Ballroom 2**      **THEME 6: Frontiers of Colloid & Interface Science**

- OC118** 15.20 **Controlled Thiol Deposition on Hybrid Gold-Polycarbonate Membranes**  
Leonora Velleman<sup>1</sup>, Dusan Losic<sup>2</sup>, Joe Shapter<sup>1</sup>, <sup>1</sup>*Flinders University, School of Chemistry, Physics and Earth Sciences, Australia*, <sup>2</sup>*University of South Australia, Ian Wark Research Institute, Australia*
- OC119** 15.40 **Adsorption and Dipole Surface Orientational Order at Liquid Surfaces**  
Bruce Law<sup>1</sup>, Jae-Hie Cho<sup>1</sup>, John Carpenter<sup>1</sup>, Dan Smith<sup>1</sup>, <sup>1</sup>*Kansas State University, United States*

4.05pm      **Closing Remarks, **Ballroom 1****



## Poster Presentations

## Posters Presentations: Monday 2 February 2009

- PP001 Concentration Depth Profiles of Inorganic Ions at Liquid Surfaces**  
Gunther Andersson<sup>1</sup>, <sup>1</sup>*Flinders University, Faculty of Science and Engineering, Australia*
- PP002 Medicinal Plant Resources for Bioprospecting and Drug Development in Parbat District of Nepal**  
Ram Lal Shrestha<sup>1</sup>, Lekh Nath Gautam<sup>2</sup>, <sup>1</sup>*Tribhuvan University, Amrit Science Campus, Nepal*, <sup>2</sup>*Natural Product Laboratory, Nepal*
- PP003 Magneto-Responsive Hollow Capsules Prepared via Colloid Templating**  
Kiyofumi Katagiri<sup>1</sup>, Masato Nakamura<sup>1</sup>, Yuji Imai<sup>1</sup>, Kunihito Koumoto<sup>1</sup>, <sup>1</sup>*Nagoya University, Japan*
- PP004 Study on Formation Process and Structure of Polyproline SAM on Gold Surface**  
Ying Han<sup>1</sup>, Takashi Iwama<sup>1</sup>, Tatsuhiko Adachi<sup>1</sup>, Hidenori Noguchi<sup>1</sup>, Kazuyasu Sakaguchi<sup>1</sup>, Kohei Uosaki<sup>1</sup>, <sup>1</sup>*Hokkaido University, Japan*
- PP005 Adsorption Behaviour of Polyelectrolyte onto Alumina Particles and its Effect on the Particles' Dispersion State**  
Takamasa Mori<sup>1</sup>, Takafumi Hida<sup>1</sup>, Kazumasa Suzuki<sup>1</sup>, Ikue Inamine<sup>1</sup>, Takayoshi Kiguchi<sup>1</sup>, JunIchiro Tsubaki<sup>1</sup>, <sup>1</sup>*Nagoya University, Japan*
- PP006 Control of Oxygen Adsorption on Organometallic Complexes due to Magnetic Fields**  
Koichi Hashikawa<sup>1</sup>, Atom Hamasaki<sup>1</sup>, Taku Iiyama<sup>1</sup>, Sumio Ozeki<sup>1</sup>, <sup>1</sup>*Shinshu University, Japan*
- PP007 Hexagonal-Square Lattice Phase Transition in 2D Colloidal Monolayer Induced by Steric Layer Potentials: Analysis by Means of Monte Carlo Simulations**  
Masayuki Aoshima<sup>1</sup>, Akira Satoh<sup>1</sup>, Roy Chantrell<sup>2</sup>, <sup>1</sup>*Akita Prefectural University, Japan*, <sup>2</sup>*York University, United Kingdom*
- PP008 Behaviour of Aqueous Foam Stabilised by Nanosilica & Non-ionic Surfactant**  
Timothy Hunter<sup>1</sup>, Graeme Jameson<sup>1</sup>, Erica Wanless<sup>1</sup>, <sup>1</sup>*University of Newcastle, Australia*
- PP009 Self Assembly of a Polybutadiene-Poly(methacrylic acid) Copolymer in Water: Effect of pH on Morphology and Kinetics**  
Christine Fernyhough<sup>1</sup>, Giuseppe Battaglia<sup>1</sup>, Tony Ryan<sup>1</sup>, <sup>1</sup>*University of Sheffield, United Kingdom*
- PP010 Bacterial Adhesion to Poly(ethylene oxide) Polymer Brush Surfaces – Influences of Temperature and Salt Concentration.**  
Jacob Shephard<sup>1</sup>, <sup>1</sup>*University of Otago, New Zealand*
- PP011 Water Soluble Polymers For Water Purification And Vesicular Encapsulation.**  
Patrick Fairclough<sup>1</sup>, Christine Fernyhough<sup>1</sup>, Craig Fairgrieve<sup>1</sup>, Sarah Kettlewell<sup>1</sup>, <sup>1</sup>*University of Sheffield, United Kingdom*
- PP012 Reversible Coalescence in Kinetically Stabilised Emulsions**  
Nelly Bulgarelli<sup>1</sup>, Kathryn McGrath<sup>1</sup>, <sup>1</sup>*MacDiarmid Institute for Advanced Materials and Nanotechnology, School of Chemical and Physical Sciences, Victoria University of Wellington, New Zealand*
- PP013 Surface Force Measurements between Mineral Oxides: Under what conditions does DLVO Theory Apply?**  
Rick Walsh<sup>1</sup>, Vince Craig<sup>1</sup>, <sup>1</sup>*Department of Applied Mathematics, Research School of Physical Sciences and Engineering, The Australian National University, Australia*

- PP014 Core/shell structured PMMA Microspheres with Polyaniline and MWNT and their Electrorheology**  
K. Zhang<sup>1</sup>, H. J. Choi<sup>1</sup>, <sup>1</sup>*Inha University, Korea, Republic of*
- PP015 Bovine Serum Albumin Adsorption on N-Methyl-D-Glucamine Ligand Immobilized Colloidal Silica Surface**  
Jingtian Han<sup>1</sup>, Patrick Silcock<sup>1</sup>, A. James McQuillan<sup>2</sup>, Phil Bremera<sup>1</sup>, <sup>1</sup>*Department of Food Science, University of Otago, New Zealand, <sup>2</sup>Department of Chemistry, University of Otago, New Zealand*
- PP016 Marine Bioadhesives: Electron Microscopy and in situ ATR-IR Spectroscopy Characterization.**  
Luigi Petrone<sup>1</sup>, Norman L. C. Ragg<sup>2</sup>, A. Jim McQuillan<sup>1</sup>, <sup>1</sup>*Department of Chemistry, University of Otago, New Zealand, <sup>2</sup>Cawthron Institute, New Zealand*
- PP017 Polymeric Silicone-Containing Microemulsions**  
Suraj Chandra Sharma<sup>1</sup>, Koji Tsuchiya<sup>1</sup>, Kenichi Sakai<sup>1</sup>, Hideki Sakai<sup>1,2</sup>, Masahiko Abe<sup>1,2</sup>, Reiji Miyahara<sup>3</sup>, <sup>1</sup>*Department of Pure and Applied Chemistry, Faculty of Science and Technology, Tokyo University of Science, Japan, <sup>2</sup>Institute of Colloid and Interface Science, Tokyo University of Science, Japan, <sup>3</sup>Shiseido Research Center, Japan*
- PP018 AFM Bubble Colloidal Probes**  
Ivan U. Vakarelski<sup>1,2</sup>, Raymond R. Dagastine<sup>1</sup>, Ofer Manor<sup>1</sup>, Derek Y.C. Chan<sup>1</sup>, Geoffrey W. Stevens<sup>1</sup>, Franz Grieser<sup>1</sup>, <sup>1</sup>*Particulate Fluids Processing Centre, University of Melbourne, Australia, <sup>2</sup>Institute of Chemical and Engineering Sciences, Singapore*
- PP019 Anti-Fouling Surfaces Grown in Multi-Well Plates: Surface Initiated Atom Transfer Radical Polymerisation of Polymer Brushes**  
Bryan R. Coad<sup>1</sup>, Yi Lu<sup>1</sup>, Laurence Meagher<sup>1</sup>, <sup>1</sup>*CSIRO Molecular and Health Technologies, Australia*
- PP020 Study of Adsorption Kinetics Using Optical Reflectometer with Improved Sensitivity and Stability**  
Shaun Howard<sup>1</sup>, Vince Craig<sup>1</sup>, <sup>1</sup>*the Australian National University, Australia*
- PP021 Study on the surface tension of water-based adhesive on the 3-D prototype application**  
Cheng-Chien Wang<sup>2</sup>, Chuh-Yung Chen<sup>1</sup>, Yu-Cheng Kuo<sup>2</sup>, <sup>1</sup>*National Cheng-Kung University, Taiwan, <sup>2</sup>Southern-Taiwan University, Taiwan*
- PP022 Interactions of Ultrafine Particles with Bubbles**  
Sin Ying Tan<sup>1</sup>, Catherine Whitby<sup>1</sup>, John Ralston<sup>1</sup>, Daniel Fornasiero<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, University of South Australia, Australia*
- PP023 Novel Characterization of Hollow Microspheres using AFM**  
Stefanie Sham<sup>1</sup>, Raymond Dagastine<sup>1</sup>, <sup>1</sup>*Particulate Fluid Processing Centre, Department of Chemical and Biomolecular Engineering, The University of Melbourne, Australia*
- PP024 Surface Tension as a Function of Surface Structure of Ionic Liquids**  
Vera Lockett<sup>1</sup>, Rossen Sedev<sup>1</sup>, John Ralston<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute UniSA, Australia*
- PP025 Shape changes of tail-polymerizable surfactant aggregates during polymerization**  
Khwanrat Chatjaroenporn<sup>1</sup>, Paul FitzGerald<sup>1</sup>, Robert Baker<sup>1</sup>, Gregory Warr<sup>1</sup>, <sup>1</sup>*The University of Sydney, Australia*
- PP026 Adsorption and Structure of Nonionic Surfactants at the Ionic Liquid/Air Interface**  
Deborah Wakeham<sup>1</sup>, Petru Niga<sup>2</sup>, Mark Rutland<sup>2</sup>, Gregory Warr<sup>3</sup>, Rob Atkin<sup>1</sup>, <sup>1</sup>*University of Newcastle, Australia, <sup>2</sup>Royal Institute of Technology, Sweden, <sup>3</sup>University of Sydney, Australia*

- PP027 Conformal Nanometric Surface Patterning Using Polymer Film Dewetting**  
Andrew Michael Telford<sup>1</sup>, Chiara Neto<sup>1</sup>, Laurence Meagher<sup>2</sup>, <sup>1</sup>*University of Sydney, Australia*, <sup>2</sup>*CSIRO, Australia*
- PP028 Synthesis and Characterisation of Self-Assembled Monolayers of N-[3-(Trimethoxysilyl) propyl] diethylenetriamine on Silica Particles**  
Chiu Ping Chan<sup>1</sup>, Peter Majewski<sup>1</sup>, Namita Choudhury<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, Australia*
- PP029 Synthesis of Mesoporous Titanium Dioxide from Protic Ionic Liquids**  
Zhengfei Chen<sup>1,3</sup>, Tamar Greaves<sup>1</sup>, Rachel Caruso<sup>3</sup>, Calum Drummond<sup>2</sup>, <sup>1</sup>*CSIRO Molecular and Health Technologies (CMHT), Australia*, <sup>2</sup>*CSIRO Materials Science and Engineering (CMSE), Australia*, <sup>3</sup>*School of Chemistry, The University of Melbourne, Australia*
- PP030 Fabrication of Nanoporous Anodic Alumina Oxide membranes with tailored chemical functionalities**  
Md Jani Abdul Mutalib<sup>1</sup>, Losic Dusan<sup>2</sup>, G. Shapter Joe<sup>1</sup>, H. Voelcker Nicolas<sup>1</sup>, <sup>1</sup>*Flinders University, Australia*, <sup>2</sup>*University of South Australia, Australia*
- PP031 Gel Spinning of Atactic Poly(vinyl alcohol)/Sodium Alginate Blend Solution**  
Dong Gyu Park<sup>1</sup>, Won Seok Lyoo<sup>1</sup>, Eun Joo Shin<sup>2</sup>, Yong Sik Chung<sup>3</sup>, Tae Hwan Oh<sup>1</sup>, Sung Soo Han<sup>1</sup>, <sup>1</sup>*Division of Advanced Organic Materials, School of Textiles, Korea, Republic of*, <sup>2</sup>*Polymer Gel Research Cluster Center, Yeungnam University, Korea, Republic of*, <sup>3</sup>*Department of Textile Engineering, Chunbuk National University, Korea, Republic of*
- PP032 Leaching Mechanism and Kinetic Behaviour of an Aluminosilicate Clay Mineral**  
Terry Dermis<sup>1</sup>, William Skinner<sup>1</sup>, Jonas Addai-Mensah<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute (University of South Australia), Australia*
- PP033 Preparation and Characterization of High Molecular Weight Atactic Poly(vinyl alcohol)/Sodium Alginate/Silver Nanocomposite by Electrospinning**  
Won Seok Lyoo<sup>1</sup>, Young Jae Lee<sup>1</sup>, Kyeong Il Oh<sup>1</sup>, Han Yong Jeon<sup>2</sup>, <sup>1</sup>*Division of Advanced Organic Materials, School of Textiles, Yeungnam University, Korea, Republic of*, <sup>2</sup>*Division of Nano-Systems Engineering, Inha University, Korea, Republic of*
- PP034 Preparation of Syndiotactic Poly(vinyl alcohol) Gel Microspheres by Heterogeneous Surface Saponification of Poly(vinyl pivalate/vinyl acetate) under Various Saponification Conditions**  
Young Jae Lee<sup>1</sup>, Won Seok Lyoo<sup>1</sup>, Kun Young Kwak<sup>1</sup>, Jin Wook Cha<sup>1</sup>, Hae Giu Lee<sup>2</sup>, Kyong Min Shin<sup>3</sup>, Han Gon Choi<sup>4</sup>, Seok Kyun Noh<sup>5</sup>, <sup>1</sup>*Division of Advanced Organic Materials, School of Textiles, Yeungnam University, Korea, Republic of*, <sup>2</sup>*Medical College, The Catholic University, Korea, Republic of*, <sup>3</sup>*Taewong-Medical Co., Ltd., Korea, Republic of*, <sup>4</sup>*College of Pharmacy, Yeungnam University, Korea, Republic of*, <sup>5</sup>*School of Display and Chemical Engineering, Yeungnam University, Korea, Republic of*
- PP035 NanofabricationSA**  
Dennis Palms<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, Australia*
- PP036 Development of a High Performance Continuous Cake-less Filtration System**  
Junlchiro Tsubaki<sup>1</sup>, Hiroshi Satone<sup>1</sup>, Takahisa Katsuoka<sup>1</sup>, Takayuki Hirata<sup>1</sup>, Takamasa Mori<sup>1</sup>, <sup>1</sup>*Nagoya University, Japan*
- PP037 Correlation between Interfacial and Dermal Delivery Characteristics of Nanoparticle-coated O/W Emulsions**  
Nasrin Ghouchi Eskandar<sup>1</sup>, Spomenka Simovic<sup>1</sup>, Clive A. Prestidge<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, Australia*
- PP038 The Effects of Polydispersity on the Self Assembly of Nanostructures**  
Chris Howell<sup>1</sup>, Christine Fernyhough<sup>1</sup>, Patrick Fairclough<sup>1</sup>, <sup>1</sup>*University of Sheffield, United Kingdom*

- PP039 Environmental Marine Bacteria Interactions with Poly(Ethylene Terephthalate) Polymer Surfaces**  
Hayden Webb<sup>1</sup>, Russell Crawford<sup>1</sup>, Tomoo Sawabe<sup>2</sup>, Elena Ivanova<sup>1</sup>, <sup>1</sup>*Swinburne University of Technology, Australia*, <sup>2</sup>*Laboratory of Microbiology, Faculty of Fisheries Sciences, Hokkaido University, Japan*
- PP040 Dynamic Forces between Bubbles and Surfaces and Hydrodynamic Boundary Conditions**  
Ofer Manor<sup>1</sup>, Ivan Vakarelski<sup>1,4</sup>, Geoffrey Stevens<sup>1</sup>, Franz Grieser<sup>1</sup>, Raymond Dagastine<sup>1</sup>, Derek Chan<sup>1,2</sup>, <sup>1</sup>*Particulate Fluids Processing Centre, University of Melbourne, Australia*, <sup>2</sup>*Mathematics, National University of Singapore, Singapore*, <sup>3</sup>*Institute of High Performance Computing, Singapore*, <sup>4</sup>*Institute of Chemical and Engineering Sciences, Singapore*
- PP041 Preparation of Poly(vinyl pivalate)/Gold Nanocomposite Microspheres using Suspension Polymerization of Vinyl Pivalate**  
Sun Gil Kim<sup>1</sup>, Won Seok Lyoo<sup>1</sup>, Won Wook Jeong<sup>1</sup>, Seong Cheol Kim<sup>1</sup>, Yeong Soon Gal<sup>2</sup>, Seok Soon Noh<sup>1</sup>, <sup>1</sup>*Division of Advanced Organic Materials, School of Textiles, Yeungnam University, Korea, Republic of*, <sup>2</sup>*Polymer Chemistry Laboratory, College of Engineering, Kyungil University, Korea, Republic of*
- PP042 Continuous Flow Polymer Adsorption on Monodisperse Droplets for Microcapsule Synthesis in a Microfluidic Chip**  
Craig Priest<sup>1</sup>, Anthony Quinn<sup>2</sup>, Almar Postma<sup>2</sup>, Alexander Zelikin<sup>2</sup>, John Ralston<sup>1</sup>, Frank Caruso<sup>2</sup>, <sup>1</sup>*University of South Australia, Australia*, <sup>2</sup>*The University of Melbourne, Australia*
- PP043 Biomolecular surface interactions and cell adhesion studied using QCM-D**  
Olivia Lavén<sup>1</sup>, <sup>1</sup>*Q-Sense, Sweden*
- PP044 Surface Dilational Viscosity of Nonionic Polypropylene Glycol Surfactants and their influence on Foam Behaviour**  
Su Nee Tan<sup>1</sup>, Anzhen Jiang<sup>1</sup>, Jin Jau Liau<sup>1</sup>, Roger Horn<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, Australia*
- PP045 Surface Chemical Modification of Porous Silicon to Control Molecular interactions and Adsorption**  
Karyn Jarvis<sup>1</sup>, Timothy Barnes<sup>1</sup>, Clive Prestidge<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, University of South Australia, Australia*
- PP046 The Influence of Shear Responsive Polyethylene Oxide Adsorption behaviour on the Dewatering Behaviour of Talc**  
Kai Ying Yeap<sup>1</sup>, Jonas Addai-Mensah<sup>1</sup>, David Beattie<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, University of South Australia, Australia*
- PP047 Synchrotron XPS Study of Fractured, Solution Exposed Heterogeneous Chalcopyrite Surfaces**  
Robert Acres<sup>1</sup>, Sarah Harmer<sup>1</sup>, David Beattie<sup>1</sup>, <sup>1</sup>*Ian Wark Research Institute, University of South Australia, Australia*
- PP048 Enzyme Assisted Self Assembly**  
Richard Williams<sup>1</sup>, Rein Ulijn<sup>2</sup>, <sup>1</sup>*CSIRO Molecular and Health Technologies, Australia*, <sup>2</sup>*The University of Strathclyde, United Kingdom*
- PP049 Phospholipid-based cubic Phases for Improved Drug Delivery Applications**  
Hsin-Hui Shen<sup>1</sup>, Florian Huber<sup>1</sup>, Guoliang Zhen<sup>1</sup>, Durga Acharya<sup>1</sup>, Simon Saubern<sup>1</sup>, Patrick Hartley<sup>1</sup>, Keith McLean<sup>1</sup>, <sup>1</sup>*CSIRO, CMHT, Australia*
- PP050 Analysis of Osteoblast Cell Behaviour on Nanostructured Porous Silicon Functionalised with Chemical Gradients of Plasma Polymerised Films**  
Endre Szili<sup>1</sup>, David Steele<sup>1</sup>, Andrew Michelmores<sup>1</sup>, Robert Short<sup>1</sup>, Nicolas Voelcker<sup>2</sup>, <sup>1</sup>*Mawson Institute, University of South Australia, Australia*, <sup>2</sup>*School of Chemistry, Physics and Earth Sciences, Flinders University, Australia*

- PP051 Lamellar to Cubic Phase Transitions Intermediates in Colloidal Dispersions of Self-Assembled Systems.**  
Xavier Mulet<sup>1</sup>, Calum J. Drummond<sup>1</sup>, Xiaojuan Gong<sup>2</sup>, Lynne J. Waddington<sup>3</sup>, <sup>1</sup>*CSIRO Molecular and Health Technologies, Australia*, <sup>2</sup>*CSIRO Molecular and Health Technologies, Australia*, <sup>3</sup>*CSIRO Molecular and Health Technologies, Australia*
- PP052 The Effect of Architecture on the Crystallization of Oxyethylene/Oxybutylene Block Copolymers from Micelles in n-Octane**  
Shaomin Mai<sup>1</sup>, Anthony J. Ryan<sup>1</sup>, <sup>1</sup>*University of Sheffield, United Kingdom*
- PP053 Forces between alpha-AI203 probe and air bubble measured by AFM**  
Li Jiang<sup>1</sup>, Marta Krasowska<sup>1</sup>, Daniel Fornasiero<sup>1</sup>, John Ralston<sup>1</sup>, <sup>1</sup>*University of South Australia, Australia*
- PP054 Characterization of amino functional groups on the surface of silica colloids**  
Khoa Pham<sup>1</sup>, Damian Fullston<sup>1</sup>, Kwesi Sagoe-Crentsil<sup>1</sup>, <sup>1</sup>*CSIRO, Australia*
- PP055 Gelation kinetics of silica colloids in the presence of Ca<sup>2+</sup> ion**  
Khoa Pham<sup>1</sup>, Damian Fullston<sup>1</sup>, Kwesi Sagoe-Crentsil<sup>1</sup>, <sup>1</sup>*CSIRO, Australia*

# ABSTRACTS



## Plenary Abstracts

PL001

## RACI Colloid Division Plenary Lecture

### **Networking polymers and the forces they generate**

Martien A. Cohen Stuart

*Wageningen University, Netherlands*

Physical gels are an intriguing and relevant class of Soft Matter. Numerous food systems can be considered as (highly complex) physical gels in which proteins and/or polysaccharides play the structural roles, but in many other products such as paints, lubricants, cosmetics and detergents physical gelation is a characteristic feature. In terms of structure, a physical gel is an open network filled with solvent; hence, the network-forming component(s) (often of macromolecular type) must be able to build such a network under the appropriate conditions. A well known class of network formers are the *telechelic polymers* belonging to the general class of S-C-S triblocks (S = sticker, C = connector); these so-called associative thickeners display very interesting static and dynamic behavior. Three examples of telechelics; two of them have polyethylene oxide as the connector, and the third is a polymer consisting of hydrophilic amino acids will be discussed. As 'stickers', we have considered (1) hydrophobic alkyl groups, (2) charged groups undergoing complexation, and (3) collagen-inspired polypeptide chains that can form triple helices. All these systems form small association structures (mostly micelles) at low concentrations, and networks at higher concentrations. The networks have very different relaxation times, depending on the sticker type, so that sometimes they behave like viscous fluids, whereas in other cases they can be considered as elastic, self-healing solids. Under shear, they always flow; for suitable combinations of shear rate and relaxation time the flow acquires surprising instabilities (shear banding) which lead to chaotic stress fluctuations with the same statistics as earthquakes. At interfaces, some of these molecules can lead to very unusual adsorption patterns, as well as capillary condensation, leading to weak long range attraction between hydrophobic surfaces.

PL002

## **Alexander Lecture**

*Sponsored by The University of Sydney*

### **How ultrasound and bubbles interact to give rise to “exotic” chemical reactions**

Franz Grieser

*ARC Particulate Fluids Processing Centre, School of Chemistry, University of Melbourne, Melbourne, Australia*

The interaction between ultrasound waves and micro-bubbles in a fluid leads to a phenomenon referred to as acoustic cavitation. The action of a fluctuating pressure field (sound) as it moves through a fluid causes adventitious micro-bubbles present in the liquid to grow and eventually collapse violently, leading to near adiabatic compression of the gases within the bubble- usually the vapour of the liquid and any gases that are dissolved in the liquid. The process leads to the creation of extreme temperatures and pressures within the bubble, producing ions, radicals and excited state species. Theoretical estimates of peak temperatures puts them above 100,000 K and pressures above 500 atmospheres. Chemical methods for determining the mean temperatures during collapse are more modest with temperatures measured as high as 5000 K and pressures of the order of 200 atmospheres. The creation of these mini “hot spots” leads to a number of interesting chemical reactions. The talk will discuss how the extreme condition generated in a collapsing bubble can be utilised to produce metal nano-particles and polymer lattices; degrade organic pollutants, and create electronically excited species. All of these systems rely on how the solutes used affect the bubbles that undergo activation by the ultrasonic field. Interfacial chemistry plays a major role in the eventual chemistry that ensues from a sonicated system. Collectively there are many steps involved in sonochemical processes and the talk will reveal the enormous complexity behind the way sound waves produce the chemistry that is produced.

Ashokkumar, M.; Grieser, F. *The effect of surface active solutes on bubbles in an acoustic field*, Phys.Chem.Chem.Phys. **2007**, 9, 1-13.



## Keynote Abstracts

**KN001**

## **Novel Inks for Direct-Write Assembly of Functional Materials**

Jennifer Lewis

*Frederick Seitz Materials Research Laboratory, University of Illinois, Urbana, IL, United States*

The ability to pattern functional materials in planar and three-dimensional forms is of critical importance for several technological applications, including flexible electronics, photonics, sensors, and tissue engineering scaffolds. Direct ink writing enables one to rapidly design and fabricate materials in arbitrary shapes without the need for expensive tooling, dies, or lithographic masks. Recent advances in the design of concentrated inks composed of colloidal, polyelectrolyte, and organometallic building blocks with tailored rheological properties will be highlighted with an emphasis on patterning 3D structures at the microscale.

KN002

## Dynamic Surfaces that Modulate Cell Interactions

April Kloxin<sup>1</sup>, Julie Benton<sup>1</sup>, Kristi Anseth<sup>1,2</sup>

<sup>1</sup>University of Colorado, Boulder, Colorado, United States, <sup>2</sup>Howard Hughes Medical Institute, Boulder, Colorado, United States

Many studies have shown the importance of a substrate's chemical functionality and physical properties on cellular functions<sup>1</sup> such as adhesion, proliferation, migration, and differentiation. An underlying theme to this research is to better understand how cells receive information from their external microenvironment, and oftentimes, sophisticated control of the cell-material interface is required to answer the complex questions about this dynamic relationship. Here, we present an approach to varying the presentation of physical and chemical cues to cells cultured on hydrogel surfaces in a manner that can be controlled both spatially and temporally, as well as in a continuum manner, via the use of light. Specifically, two photodegradable macromolecular monomers were synthesized by incorporating a nitrobenzyl ether derived moiety, which was selected for its photolytic efficiency and previous use in live cell culture and imaging<sup>2</sup>. A multifunctional photodegradable monomer was synthesized by acrylation of the photolabile moiety *via* a pendant hydroxyl group. This was subsequently attached *via* a pendant carboxylic acid to poly(ethylene glycol)-*bis*-amine to create a photocleavable crosslinking macromer from which degradable gels were synthesized. These gels were subsequently degraded using a light exposure gradient and confining the light to the top 50 microns to create a material with a continuously varying surface stiffness. The stiffness of these materials with light exposure was characterized via photorheology and AFM. The initial gel stiffness was  $13.6 \pm 1.0$  kPa, and upon exposure to  $10 \text{ mW/cm}^2$  of 365 nm light,  $G'$  decreased to 79% of its original value with 2.5 mins of exposure, 26% with 5 mins, and 3% with 10 mins. Valvular interstitial cells (VICs), which are known to respond to substrate stiffness, were seeded on these gels and their response to the stiffness gradient was evaluated by examining cell morphology, proliferation, migration and alpha smooth muscle actin ( $\alpha$ SMA) production. VIC activation (i.e.,  $\alpha$ SMA production) decreased in response to decreasing substrate stiffness, along with increased migration along the stiffness gradient. These properties are important towards understanding and manipulating disease progression in heart valves. To control the chemical functionality of the gel, we developed a strategy for coupling the photodegradable monomer through its pendant carboxylic acid to biomolecules containing a pendant primary amine or hydroxyl group. This approach yields an asymmetric biofunctional acrylic monomer that is tethered to the gel and is released upon light exposure. To demonstrate its utility in regulating the chemical functionality of surfaces, we fabricated gels with the RGD functionality, which is an epitope found in fibronectin, an important protein for cell adhesion. Human mesenchymal stem cells (hMSCs) were cultured on these gels, and the surface chemistry was temporally tuned to direct hMSC chondrogenic differentiation by externally-triggering the photorelease of the RGD functionality.

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2. Y. R. Zhao *et al.*, JACS, **2004**, 126, 4653.

KN003

## Interfacial Molecular Structure at Solid/Liquid Interfaces by SFG Spectroscopy

Kohei Uosaki, Hidenori Noguchi, Satoshi Nihonyanagi, Rie Yamamoto, Hiroshi Minowa, Jian Ping Gong, Yoshihito Osada

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Many important processes take place at solid surfaces in aqueous solution. To clarify the reaction mechanism of these reactions, it is essential to determine the structure of molecules at the interfaces including water. One needs to use surface specific techniques for this purpose because there is much larger number of molecules in solution. Sum frequency generation (SFG) spectroscopy is an interface-selective probe and has been applied to determine the interfacial molecular structure in many systems, including solid/liquid interfaces. Furthermore, time-resolved surface vibrational spectroscopy to investigate the mechanism of chemical reactions at solid/liquid interfaces based on SFG is possible because short pulse laser is used. We have already reported the results of SFG investigations on molecular structures at a wide variety of interfaces including aqueous solution/quartz modified by self-assembled monolayer (SAM) interfaces<sup>(1,2)</sup> and aqueous solution/metal electrode interfaces.<sup>(3,4)</sup>

Here we describe the molecular structure of PVA gel/solid interface and polymer brush surfaces studied by SFG.

We used two SFG systems, one based on a ps Nd:YAG laser and the other based on a Ti:sapphire regenerative amplifier system.

Hydropolymer gel such as PVA has been considered to be a possible candidate for an artificial articular cartilage in artificial joints because it exhibits very low friction when it is in contact with a solid. The origin of such a low friction is considered to be associated with the water absorbed in the gel, some of which is squeezed out from the gel under the load and serves as a lubricant layer between the gel and solid surface, resulting in a hydrodynamic lubrication. SFG spectrum at quartz/aqueous solution interface shows two broad peaks of almost equal intensity in the OH stretching region at 3200 and 3400  $\text{cm}^{-1}$ , corresponding to the symmetric OH stretching of tetrahedrally coordinated, *i.e.*, strongly hydrogen bonded “ice-like” water, and the asymmetric OH stretching of water in a more random arrangement, *i.e.*, weakly hydrogen bonded “liquid-like” water.<sup>(1)</sup> The “liquid-like” water became dominant when the PVA gel was pressed against the quartz surface, suggesting “liquid-like”, *i.e.*, weakly hydrogen bonded, water acts as a lubricant at the PVA gel/fused quartz interface.

We carried out an SFG study on a poly(4-vinyl-N-n-alkylpyridinium)bromide (alkyl = ethyl, hexyl and dodecyl) polyelectrolyte brush, which exhibits an antibacterial function, in dry nitrogen, water vapour, and liquid water. The conformational order of alkyl chains was very strongly affected by environment. Alkyl chains are in relatively high conformational order under dry nitrogen, gauche defects are introduced to alkyl chains upon contact with water vapour and, alkyl chains became disorder in liquid water. The structure of interfacial water was also measured.

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**KN004**

## **Frothers and Flotation**

James Finch

*McGill University, Montreal, Quebec, Canada*

Frothers are almost universally used in flotation to reduce bubble size and initiate froth formation. In this presentation some properties of frothers related to both functions are discussed.

The action of frothers is often ascribed to prevention of coalescence. This is illustrated first by observing bubble formation at a capillary. The tedious task of following the process visually (requiring inspection of large number of image sequences) is overcome by a novel approach: listening to the process. Bubbles as they form and coalesce produce a characteristic sound signal that is easily identified. Closer to the flotation case, in the second method, single-sized bubbles were released into an impeller and the subsequent daughter bubble size distribution monitored. Both these studies support that frother retards coalescence and a mechanism is offered.

Bubble motion (rise velocity) and shape are also controlled by frother. This is illustrated with video footage and measurements tracking bubbles in swarms to following the rise of single bubbles. The effects are dependent of frother type; it is shown that frothers equally capable of producing small bubbles nevertheless differ widely in their effect on rise velocity and shape. The results reveal that bubble velocity and shape are related: as the bubble becomes more spherical the velocity decreases. The mechanism and possible significance in flotation are discussed.

These aspects refer to processes in the pulp phase. To finish, recent work tracking frother distribution between pulp and froth is described which may help identify a mechanism of water recovery.

**KN005**

**Programming lateral interactions in quasi two-dimensional lipid bilayer membranes**

Jay Groves

*HHMI, UC Berkeley, Berkeley, CA, United States*

A number of chemically distinct genetically-encoded lipid modifications link soluble protein domains to cell membranes in vivo. It is widely speculated that these provide targeting mechanisms that direct protein organization in the membrane. Here, we use fluorescence cross correlation spectroscopy to probe interactions among all combinatorial pairs of four common lipid anchoring motifs expressed in live primary T cells as fluorescent protein fusions. New results hint at precisely programmed interaction potentials that lead to complex organization in the membrane liquid phase. Experimental data and modeling results will be discussed.

KN006

## **Making silicon water friendly: an easy approach to producing stable oxide free silicon for biophotonic and bioelectrochemical applications**

J. Justin Gooding<sup>1</sup>, Kris Kilian<sup>1</sup>, Till Boecking<sup>1</sup>, Simone Ciampi<sup>1</sup>, Guillaume Le Saux<sup>1</sup>, Jarred Shein<sup>1</sup>, Leo Lai<sup>1</sup>, Michael James<sup>2</sup>, Jason Harper<sup>1</sup>

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The compatibility of silicon with microfabrication makes it an ideal material for biophotonics, bioelectrochemistry and many other purposes. However, for many applications involving aqueous solution, the oxidation of the silicon surface limits the use of this material and alternatives must be found. Self-assembled monolayer (SAM) modification of hydrogen-terminated silicon via hydrosilylation of alkenes is one strategy to make silicon devices water friendly. However, to modify silicon for these purposes without significant silicon oxide requires great skill and care and even then the silicon still oxidises with repeated use. Recently, however, we have observed that the modification of silicon with 1,8-nonadiyne produces silicon surfaces that are both more resistant to oxidation both during modification and afterwards.<sup>1</sup> Upon hydrosilylation of 1,9-nonadiyne the surface is rendered with a distal alkyne such that the surface can be further modified via 'click' chemistry with an azide species.<sup>2</sup>

This presentation will focus on the modification of flat and porous silicon surface via both hydrosilylation of alkenes and alkynes for biophotonic and bioelectrochemical applications. Initially the application of porous silicon (PSi) photonic crystals for the capture of mammalian cells followed by the monitoring of the release of proteins from these cells will be discussed. Crucial to this work is the stabilisation of the PSi using alkenes to show how a PSi, which would normally completely degrade within a couple of days in biological media, is stable for up to 2 months.<sup>3</sup> This chemistry is further extended to enable the modification of the exterior and interior surfaces of these mesoporous photonic crystals with completely different surface chemistry to enable the capture of cells and detection of cellular material.<sup>4</sup> The second topic will be the modification of flat silicon for applications in electrochemistry using a passivating self-assembled monolayer derived from an alkene. The electrochemistry of these silicon electrodes are 'switched on' by the attachment of gold nanoparticles to the distal end of the SAM. This nanoparticle-SAM modified silicon surfaces provides a unique strategy for fabricating nanoelectrode arrays where electrochemistry and antifouling properties can be conferred on the same electrode. Finally, the modification of silicon electrodes with dialkynes followed by the subsequent modification by redox active species using click chemistry will be discussed. Electrodes fabricated are shown to be highly stable and resistant to oxidation. The application of these electrodes to producing electrochemically switchable surfaces are demonstrated.

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KN007

## The Structure of Isolated Monomolecular Films of Proteins at the Air-water interface

John White, Jinminh Lin

*Australian National University, ACT, Australia*

We have recently<sup>(1)</sup> demonstrated that isolated mono-molecular protein films can be prepared at the air-water interface and their reactions studied by x-ray reflectometry.

The method consists of establishing a monomolecular protein film using the correct concentration of a protein solution in water and then very gently 'washing out' the film forming substrate with pure water. After several exchanges of substrate in this way, a durable films of b lactoglobulin, b casein and k casein have been prepared. This technique shows how durable both globular and non globular protein films can be and allows the protein chemistry to be studied independently of exchange reactions with the forming solution.

The work complements that on monomolecular surface films of proteins in **equilibrium with** the forming solutions which show the response to denaturants, such as urea or guanadinium hydrochloride (added to the protein solution before investigation by x-ray and neutron reflectivity). Here the surface monomolecular films studied in this way present a clear signatures as denaturation progresses and that sometimes an intermediate state can be observed<sup>(2,3)</sup>. Using the film thickness as an order parameter the thermodynamic free energy of denaturation of the film forming process is determined.

The "wash-out" method has shown that the response to denaturant of isolated monomolecular b lactoglobulin films is quite different from the denaturation process in solution. The lateral interactions in the film inhibit denaturation and other reactions.

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KN008

## ***Scanning probes: from imaging to fabrication***

Michelle Simmons

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One driving force behind the microelectronics industry is the ability to pack ever more features onto a silicon chip, by continually miniaturising the individual components. However, there is no known technological route to reduce device sizes below 10nm. In this talk we outline a complete, directed self-assembly fabrication strategy towards atomic-scale device fabrication in silicon using scanning probe lithography and high purity silicon crystal growth.

A key aspect of being able to build single atom devices is the ability to distinguish single atoms on and in the silicon surface. We demonstrate a detailed understanding of the surface chemistry to identify and control the position of individual dopant atoms using gaseous dopant sources [1]. We demonstrate that we can place individual dopant atoms in silicon at precise locations [2] and encapsulate them in epitaxial silicon with minimal diffusion and segregation of the dopants [3].

Detailed studies have confirmed the range of electrical transport characteristics that can be achieved using highly doped, planar dopants from gaseous sources [4]. We demonstrate that we can pattern this dopant layer using STM lithography and relate the electrical device characteristics at low temperatures to the presence of the lithographic patterning [5].

Using this process we have fabricated conducting nanoscale wires with widths down to ~2nm, tunnel junctions, in plane gated single electron transistors and arrays of quantum dots in silicon [6]. We will present an overview of the devices that have been made with this technology and highlight some of the challenges to achieving truly atomically precise devices in all three spatial dimensions.

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**KN009**

## **Nanoparticles and Photocatalysis: Enabling technologies for Plugging into the Sun**

Max Lu, *FTSE Federation Fellow*

*The University of Queensland, Brisbane, Australia*

Nanoparticles and nanocrystals of semiconducting oxides constructed from nanoscale building blocks often possess unique and much improved properties. Such materials are promising in enabling innovative technologies for conversion and storage of renewable energies for the future. With current challenges in climate change and sustainable development, nanotechnology is especially exciting because it provides great opportunities for technological advances in areas of solar power, solar hydrogen production and storage.

This paper highlights the latest developments in nanomaterials as photocatalysts. Materials such as titania and associated semiconducting materials are photoactive and photocatalytic materials promising cheap and efficient solar cells, hydrogen production from water splitting and solar detoxification of water and air. Latest advances in anatase single crystals and layered titanates will be introduced. We have developed powdered as well thin film coatings of such materials as photocatalysts with high visible light photocatalytic activity.

**KN010**

## **Fuel cell membranes that become wetter as the surrounding air gets hotter**

Moon-Jeong Park, Nitash Balsara

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We establish a new systematic methodology for controlling the water retention of polymer electrolyte membranes (PEMs). Block copolymer membranes comprising hydrophilic phases with widths ranging from 2 to 5 nm become wetter as the temperature of the surrounding air is increased at constant relative humidity. Simple calculations suggest that capillary condensation is important at these length scales. The widths of the moist hydrophilic phases were measured by cryogenic electron microscopy experiments performed on humid membranes and in-situ small angle neutron scattering. The connection between moisture content and proton conductivity is demonstrated. The talk will begin with a discussion of the thermodynamic properties of hydrated PEMs before discussing transport properties. We show that the thermodynamic properties of hydrated PEMs are not in agreement with standard theories of polymer/solvent mixtures.

KN011

## **Slip, droplets, complex fluids and other small things investigated with microfluidic technology**

Patrick Tabeling

*ESPCI, Paris, France*

Microfluidics is about flows of liquids and gases in miniaturized systems fabricated by MEMS (i.e. Micro ElectroMechanical Systems) technology, using hard (silicon or glass) or soft (polymers) materials. The domain is fostered by exciting applications representing important industrial challenges. It also embraces a number of fundamental issues interesting in their own right. The talk will concentrate on some of them through a presentation of a number of experiments we have been carrying out at ESPCI over the last three years.

The first topic is about slip phenomena in liquids which benefit from the excellent flow control provided by the microfluidic environment.

Measurements of flow velocities down to 30 nm from the wall, with and without applied electric fields, over smooth and superhydrophobic surfaces reveal spectacular effects induced by the existence of slippage however small the related slip lengths can be.

The second topic is about droplets. Controlling interface dynamics in immiscible fluids is a general challenge that microfluidic technology is facing. Experiments repeatedly recall that even in the simplest situations, droplets may develop complex dynamical behaviors .

Nonetheless, low Reynolds number conditions and the complete control of the flow geometry offers the possibility to produce complex structures under outstanding control, such as multiple emulsions and capsules, opening the route towards the synthesis of new particles.

The third topic is about rheology of complex fluids. Operating in miniaturized formats allows both large shear rates and low Reynolds numbers. Experiments carried out in straight microchannels show how this possibility can be exploited to resolve for the first time the rheology of surfactant solutions at high shear rates along with analyzing non newtonian flow instabilities.

**KN012**

## **Self-assembly of Particles and Functional Polymers and their Application in Biointerface Science**

Marcus Textor

*ETH Zurich, Zurich, Switzerland*

Self assembly of functional polymers, micro/nanoparticles and their combination offers a great potential for the design and fabrication of surfaces that exhibit well-controlled presentation of (bio)chemical functionalities, both in terms of spatial organisation and surface density. In the field of biointerface science, interactions of biological molecules and species such as proteins, carbohydrates, eukaryotic cells and bacteria with surfaces are often highly sensitive to conformation, orientation and density of immobilized ligands, and therefore of great relevance to applications in the life sciences including biosensors, cell-based screening platforms, tissue engineering scaffolds/regenerative medicine, and (targeted) drug delivery.

I will discuss a number of topics including:

An introduction into self-assembly of functional polymers on surfaces with the aim of reducing undesirable non-specific interactions with biological media and directing specific biological response to proteins, cells and bacteria.

An overview of techniques for the patterning of surfaces at the micron and nanoscale using top-down fabrication and bottom-up (self-assembly) processes and their combination, including lithography in combination with self-assembly of polymers and colloids, and their application to studies of cell-surface interaction and cell function.

Surface modification of particles with functional molecules using novel attachment strategies derived from nature (mussel-adhesive proteins, ion chelators used by cyanobacteria) to provide long-term adhesion and colloidal stability in aqueous solutions and biological media. Applications include drug delivery systems and contrast agents for medical imaging.

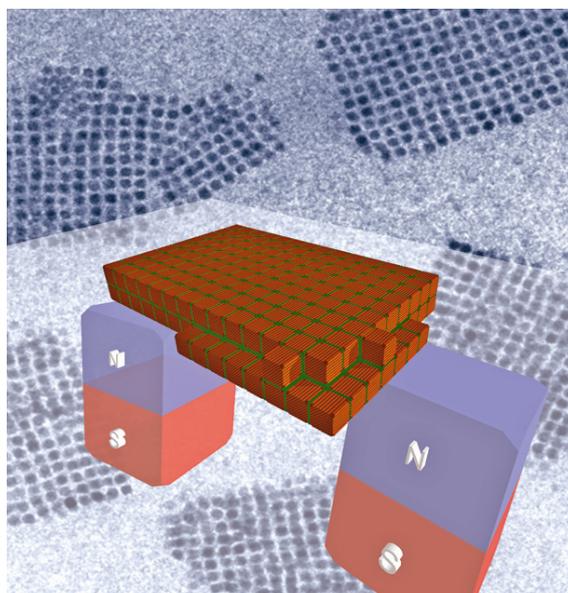
KN013

## Biomimetic Synthesis and Nanoparticle Assembly: Towards Versatile Routes for Nanostructured Films

Lennart Bergström

*Stockholm University, Stockholm, Sweden*

Self-assembly processes commonly scan a rich energy landscape with many metastable states that can be kinetically arrested. Similarly, biomimetic synthesis routes are also characterized by complex, multi-step reactions where the kinetics of the formation and dissolution of the intermediate phases often play a crucial role. This talk will give an overview of recent research on the self-assembly of inorganic particles with a focus on ordered arrays of nanocrystal, and deposition of nanostructured oxide films on substrates by a biomimetic process. Evaporation of dilute dispersions on various substrates yields colloidal arrays and it will be demonstrated how the coverage and short-range order of the deposited nanoparticles can be controlled. We will discuss how the characteristic dimensions of the superlattice are controlled by the particle concentration as well as by introducing a weak magnetic field (1). In addition, we will describe recent work on controlled deposition of inorganic, crystalline ZnO films directly from solution. The thermally activated mineralization of ZnO in a methanol solution will be analysed in detail and it will be shown that it is the regulation of the concentration of reactive species through the formation, and subsequent dissolution, of the intermediate amorphous phase in solution that controls the formation of smooth and textured films (2).



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**KN014**

## **Enzymatically Ordering the Nanoworld**

Rein Ulijn

*University of Strathclyde, Glasgow, United Kingdom*

Self-assembly (SA) as an approach to produce functional molecular architectures is commonplace in biology. Despite significant advances it is still a major challenge to achieve similar control and complexity in the laboratory. Self-assembled structures that are reproducible and virtually defect-free are of interest for applications in 3D cell culture, templating, biosensing and supramolecular electronics. In this talk we will discuss the use of fully reversible enzyme catalysed reactions to drive SA.(1,2,3) In this approach, molecular SA of aromatic short peptide derivatives (4,5) provides a thermodynamic driving force that enables a protease to produce building blocks in a reversible and spatially confined manner. We demonstrate that this system uniquely combines three features: (i) self-correction: fully reversible SA under thermodynamic control, (ii) component-selection: the ability to amplify the most stable molecular SA structures in dynamic combinatorial libraries, (iii) spatiotemporal confinement of nucleation and structure growth. Enzyme-assisted SA therefore provides unprecedented control in bottom-up fabrication of nanomaterials, ultimately paving the way to functional nanostructures with enhanced complexities and fewer defects. Applications in biomedicine and nanotechnology will be discussed.(4,5-8)

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**KN015**

## **Critical Casimir Forces in Colloidal Systems**

Clemens Bechinger

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Similar to electromagnetic vacuum fluctuations which can induce long-ranged interactions between uncharged, conducting surfaces, a rather similar effect was predicted almost 30 years ago to occur in confined binary mixtures close to their critical point. This so-called critical Casimir effect has attracted considerable attention because it can strongly modify the interaction potential of colloidal particles immersed in a binary fluid.

We present a direct measurement of such critical Casimir forces between a colloidal particle and a flat surface in a water – 2,6-lutidine mixture. With total internal reflection microscopy (TIRM) which is capable to resolve forces down to 5fN, we obtain distance resolved particle-wall interaction profiles. Upon approaching the critical point we observe long-ranged interactions which are attractive or repulsive depending on the specific boundary conditions of the walls. This behavior is in good agreement with recent theoretical predictions. In addition, we demonstrate, how critical Casimir forces can be used for the assembly of ordered colloidal monolayers on chemically patterned substrates.

KN016

## Liquid Crystal Colloids and Emulsions: A Structured Reactive Soft Matter

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<sup>3</sup>Waseda University, Tokyo, Japan

Colloids and emulsions using liquid crystal as their hosts have been attracting considerable attention in recent years as a new avenue to innovative reactive soft matter. What makes them particularly unique is the emergence of elastically mediated inter-particle forces generated by the molecular orientational order of liquid crystals. This anisotropic inter-particle force often overwhelms the classical electrostatic and van der Waals forces, thereby making dramatically different colloidal behaviours possible, including the intriguing polymorphic self-assembly in two and three dimension ordered structures. The liquid crystal-mediated inter-particle forces are essentially anisotropic and change their strength and symmetry depending on the size and surface anchoring conditions of the particles. Although the elementary properties of liquid crystal colloids are now known, thanks to the extensive theoretical and experimental studies in the past decade, much of the intricacies and scientific and engineering opportunities of the liquid crystal colloids still remains to be explored. We introduced gas bubbles as particulate inclusions in liquid crystals. We can vary the size of bubbles over a wide range from hundreds of microns down to the sub-micrometer scale or even the vanishing size by applying hydrostatic pressure. By careful balance of the pressure and the rate of absorption of gas into the liquid crystal, we can let the bubbles shrink or grow so that the size-related properties of the liquid crystal colloids can be seamlessly studied. By this technique, we succeeded, for the first time, in demonstrating the theoretically predicted topological transition in molecular configuration around a particle between the so-called hedgehog (dipolar) and the Saturn-ring (quadrupolar) configurations. Furthermore, by using the smectics (layered liquid crystals) in combination with inflating bubbles, we obtain a stable foam structure consisting of thin molecular walls.

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KN017

## Molecular Analysis of Liquid Adsorption at the Solid/Liquid Interfaces: Surface Forces Measurement and Surface Selective Spectroscopy

Masashi Mizukami, Kazue Kurihara

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A molecular level of understanding of adsorption at the solid/liquid interface has become increasingly important in advanced materials science and technology which require downsizing, fine designing, and low environmental loads, e.g., micro/nano-machines, microchip devices, lubrication. One of interesting adsorption systems is liquid adsorption onto solid surfaces from binary liquids. However, previous studies have been limited mainly to adsorption isotherm measurement and its model analysis.

We have been studying liquid adsorption onto silica surface from binary liquids of polar and non-polar liquids such as alcohols (carboxylic acids, amides)–cyclohexane. Colloidal probe atomic microscope (AFM), ATR–FTIR spectroscopy and adsorption excess isotherm measurement were employed. We found that alcohols, carboxylic acids and amides adsorbed on the silica surface form ordered structures extending to several tens of nanometer through hydrogen bonding (we call them “surface molecular macrocluster”).<sup>1–9</sup>

The characteristics of the surface molecular macroclusters are summarized as follows.

(1) The molecular macrocluster formation occurs even in completely miscible binary liquids, indicating that it is not related to the bulk phase separation and is caused by chemical interaction of adsorbed molecules with the silica surface.<sup>1–3, 5–8</sup>

(2) The structure of the molecular macrocluster depends on the structure and chemical properties of the adsorbate molecule.<sup>1–9</sup> Phenol macrocluster has sparse packing structure and its density was closed to half of the bulk density of phenol.<sup>8</sup>

(3) The contact of the molecular macrocluster adsorption layers brings about long range attraction. The interfacial energy between methanol adsorption layer and the bulk was ca. 10 times of the bulk L/L(methanol/cyclohexane binary liquid in phase separation) interfacial energy.<sup>7</sup> The attraction decreases with increasing concentration of adsorbate, indicating the decrease in the interfacial energy.

(4) Polymer nano-film such as poly(acrylic acid) and poly(NIPAAm) film can be prepared by in-situ photo-polymerization of monomer macrocluster adsorption layers on silica surfaces.<sup>3, 9</sup>

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## Oral Abstracts

## The Quest for a Versatile Process Route for Macroporous Ceramics - Exploring Expandable Spheres

Linnéa Andersson<sup>1</sup>, Mark A. Knackstedt<sup>2</sup>, Lennart Bergström<sup>1</sup>

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We have developed a process route for macroporous alumina that offers a flexible and easy way to tailor and change the porosity, pore size distribution and connectivity.

Expandable microspheres were successfully incorporated in a gel-casting suspension to form macroporous alumina (Andersson et al., 2008). The pores were created by the imprint of the expandable microspheres, which were burned out later in the process. The commercially available expandable microspheres consist of a gas-filled copolymer shell which may increase up to 40 times in volume as the temperature is increased.

With this novel process we have achieved macroporous ceramic bodies with porosities up to 86 vol%. The choice of microspheres governed the pore sizes which ranged mainly between 5 and 130  $\mu\text{m}$  in presintered alumina. We also observed that the number and size of cell windows, i.e. the connectivity increased with increasing pore size and porosity.

In an attempt to tailor the connectivity, the surface of the spheres was manipulated by a layer-by-layer process where sub-micron alumina particles were deposited on the expandable spheres. These spheres were then incorporated in an alumina gel-casting suspension to create porous alumina; as a result, as seen in Figure 1, the number and size of the cell windows decreased.

X-ray micro-computed tomography, which is a non-destructive technique used to generate three dimensional images of a structure, was applied to characterise the macroporous alumina.

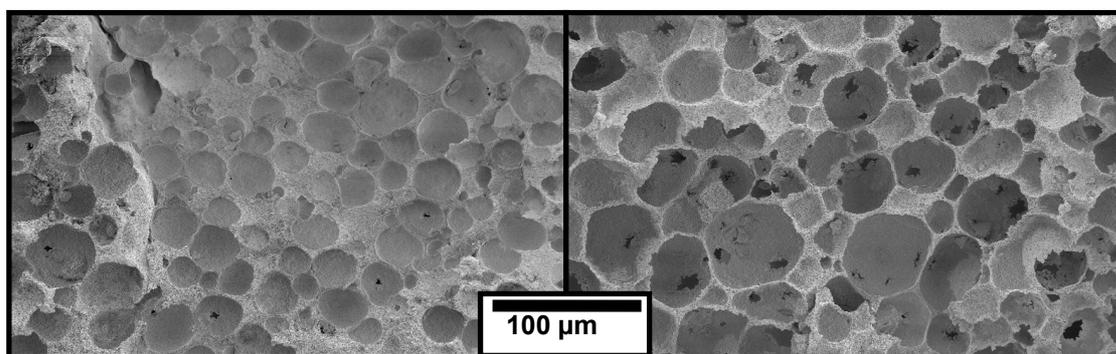


Figure 1: SEM images of the microstructure of macroporous presintered alumina. To the left the number and size of cell windows is decreased as a result of adding a layer of sub-micron alumina to the expandable spheres.

Andersson, L., Bergström, L. Gas-filled microspheres as an expandable sacrificial template for direct casting of complex-shaped macroporous ceramics. *J. Eur. Ceram. Soc.*, **2008**, 28, 2815-2821

OC002

## Particle-Stabilised Foams

Diana Tran, Catherine Whitby, Daniel Fornasiero, John Ralston

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Fine particle separation is important in the mineral and mining industries. With conventional separation methods, such as flotation, the capture of fine particles (< 10  $\mu\text{m}$ ) by bubbles is inefficient due to the low mass and momentum of these particles.

The aim of this project is to control the selective attachment of fine particles at the air-water interface by avoiding the inefficient collision step through direct contact of the particles to the bubbles. We exploited differences in particle wettability to separate a mixture of hydrophobic graphite and hydrophilic quartz particles in a foam. Foams were prepared by vigorously aerating the particle suspensions [1] with a non-ionic surfactant, such as poly(ethylene oxide)-poly(propylene oxide)-poly(ethylene oxide) triblock copolymers. Foams prepared in the presence of quartz were more stable to bubble coalescence than foams prepared in the presence of graphite. The foam evolution (after mixing) could be subdivided into four stages [2]. We found the selectivity was unexpected, as the quartz particles were recovered and not the graphite in the foams. The relationship between the foam stability, liquid drainage and bubble size provided some insight as to the interaction of particles at the air-water interface.

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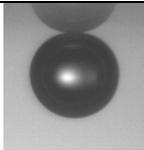
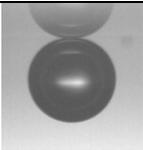
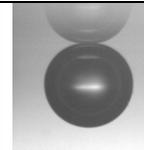
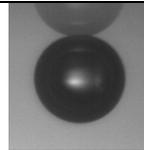
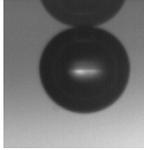
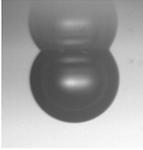
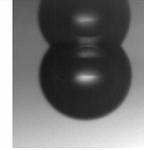
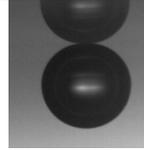
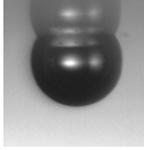
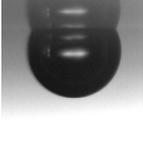
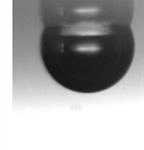
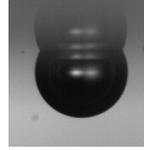
## Influence of Surface Charge and Hydrophobicity on Stability of a Thin Liquid Film during Bubble Collision with a TiO<sub>2</sub> Surface

Marta Krasowska<sup>1</sup>, Anna Niecikowska<sup>2</sup>, John Ralston<sup>1</sup>, Kazimierz Malysa<sup>2</sup>

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<sup>2</sup>*Institute of Catalysis and Surface Chemistry Polish Academy of Sciences, Krakow, Poland*

When a bubble collides with a liquid/solid interface, then depending on forces interacting within the film, either a stable wetting film or three phase contact line can be formed. The influence of solution pH and modification of the hydrophilic/hydrophobic properties of smooth titania surface on the stability of the wetting film, formed by the colliding bubble, was studied using a high speed camera. Since the point of zero charge of titania is at pH=4.5, therefore, the titania electrical charge can be reversed by changing the solution pH. As the bubbles bear a negative charge from very low pH (pH~2) the importance of the electrostatic interaction between similarly and oppositely charged interfaces could be investigated, simultaneously with the influence of the titania hydrophobicity modification. We found that for the hydrophilic titania surface the wetting film was stable within the pH range (1.7-7) studied, i.e. independent of electrical surface charge of the interacting interfaces (Fig.1–top row). However, on increasing the titania surface hydrophobicity we observed that attractive electrostatic interaction started to be factor affecting the film stability. For “intermediate hydrophobicity” at pH=1.7 (both interfaces positively charged) and 7 (both negatively charged) the film did not rupture due to electrostatic repulsion. The film ruptured and the TPC was formed at pH 3.5 and 4, i.e. when the titania/solution interface was positively and the bubble surface negatively charged (Fig.1 – middle row). Further increase in titania surface hydrophobicity (“large hydrophobicity”) caused the wetting film to rupture within the entire pH range, i.e. the stability was not pH-sensitive (Fig.1 – bottom row). These data indicate that surface electrical charge can be an important factor for three phase contact formation in the case of weakly hydrophobic solids.

	pH = 1.7	pH = 3.5	pH = 4.0	pH = 7.0
Hydrophilic TiO <sub>2</sub>				
TiO <sub>2</sub> /OTHS (intermediate hydrophobicity)				
TiO <sub>2</sub> /OTHS (large hydrophobicity)				

## Integration of Plasmonic Nanoparticles into Hybrid Multifunctional Colloidal Nanostructures

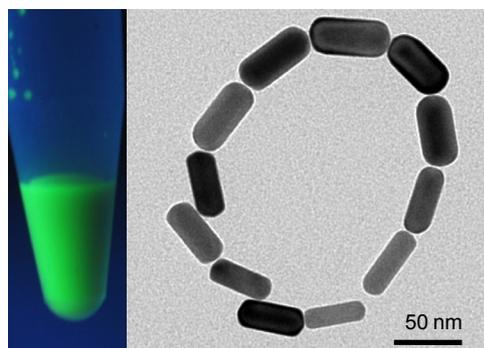
Benjamin Thierry, Jane Phui Mun Ng

*Ian Wark Research Institute, Adelaide, SA, Australia*

Plasmonic nanoparticles and nanorods, made of noble metals such as gold and silver, are arguably among the most promising nanomaterials due to their surface plasmon resonance (SPR) enhanced light scattering and adsorption<sup>1,2</sup>. Gold nanorods are of particular interest as their plasmonic resonance can be easily tuned from the visible to the near-infrared (NIR) by changing their aspect ratio. The intrinsic optical properties of gold nanorods have been exploited to design various novel in vitro and in vivo diagnostic and therapeutic strategies based on light scattering, two-photon fluorescence, photoacoustic effect, optical coherence tomography, and photothermal effect. A critical requirement towards their successful integration into functional nanodevices is the need for optimal surface functionalization procedures.

Towards the design of a robust and universal gold nanorods functionalization procedure, we report here the use of an intermediate polymeric layer that acts as a steric stabilization agent during ligand exchange procedures. To demonstrate the versatility of this novel approach, gold nanorods have been functionalized with various  $\omega$ -substituted alkanethiols such as 11-mercaptoundecaonic acid (MUA), 3-amino-5-mercapto-1,2,4-triazole, dodecanethiol and 3-mercaptopropyl-trimethoxysilane (MPTS). Partial functionalization at the gold nanorods ends with alkanethiol molecules such as MUA is usually observed due to preferential binding of thiols to the Au{111} surface due to the lower coverage of hexadecyltrimethylammonium bromide (CTAB). Taking advantage of the steric protection provided by a polyethyleneglycol layer, complete removal of the CTAB bilayer could be obtained in this work without impacting on the colloidal stability of the gold nanorods as shown by X-ray photoelectron spectroscopy, transmission electron microscopy and UV-vis measurements.

The creation of well-defined functionalized interfaces enabled the manipulation, self-assembly and integration of the gold nanorods into complex multifunctional nanostructures. MPTS functionalization afforded vitreophilic nanorods that could be easily encapsulated within a silica shell and further loaded with fluorescent and Raman dyes (Fig. 1). Hydrophobized nanorods displayed typical self-assembly features (Fig. 1) and have been integrated into hybrid plasmonic-micellar nanostructures that could be further loaded with chemotherapeutics such as paclitaxel.



**Figure 1.** Dye-loaded silica shell@nanorod core and self-assembled hydrophobized rods

In summary, the integration of gold nanorods into hybrid colloidal nanostructures is described towards the design of novel plasmonic diagnostic and therapeutic strategies.

(1) Stewart, M. E.; Anderton, C. R.; Thompson, L. B.; Maria, J.; Gray, S. K.; Rogers, J. A.; Nuzzo, R. G. *Chem Rev* 2008, 108, 494-521.

(2) Jain, P. K.; Huang, X.; El-Sayed, I. H.; El-Sayed, M. A. *Acc Chem Res* 2008.

OC005

## Surface Initiated Polymer Coatings for the Control of Cell-Surface Interactions

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Interest in surface initiated polymerization (SIP) to generate surface coatings for application in biomaterials has increased rapidly in the last few years, particularly those coatings generated using “living” free radical polymerization since they result in coatings with very well defined properties and architectures.<sup>1</sup> Biomaterials applications have been in the control of cell attachment by varying the type of monomer used (e.g. neutral, hydrophilic coatings can be used to reduce protein adsorption and cell attachment).

In this study, we present an approach to preparing such coatings which relies on the covalent attachment of a polymer containing controlled free radical initiators onto amine surfaces.<sup>2</sup> This approach allows for maximum flexibility with respect to the substrate (unlike those using self assembled monolayers). Whilst earlier studies have relied on passive coatings, we have included biological signals by building activated functional groups into the coatings as well as drugs and molecules for the specific binding of proteins. These coatings therefore have the potential to interact with biological systems in a much more dynamic manner. XPS and colloid probe AFM were used for coating characterisation. Cell culture studies (24 hours) were carried out with either HeLa, bovine corneal epithelial or L929 fibroblast cells using standard techniques. Protein adsorption was quantified using time resolved fluorescence and proteins labeled with an Eu chelate.

Examples presented in this study are the use of iniferters, ATRP initiators and RAFT agents to form SIP coatings with well defined properties. For example, dense polymer brushes which have low or high cell attachment depending on the type and amount of protein adsorption. In addition, the incorporation of cell attachment peptides into coatings via reaction with activated NHS esters will be discussed. Furthermore, the use of click chemistry to conjugate biological signals into coatings formed using our approach will be presented as well as the incorporation of molecules which allow for specific protein binding (e.g. polymerisable biotin) will be discussed in the form of application to ELISAs.

1. Edmond, S., Osborne, V.L. and Huck, W.T.S. *Chemical Society Reviews*, 33, 14, 2004.

2. Meagher, L., Thissen, H., Pasic, P., Evans, R.A., Johnson, G., *Polymeric coatings and methods for forming them*, WO2008019450-A1, 21 Feb 2008.

## **Biolubrication of Mucin studied with Quartz Crystal Microbalance (QCM-D) and AFM Friction Force Microscopy**

Adam Feiler<sup>1</sup>, Anna Sahlholm<sup>2</sup>, Tomas Sandberg<sup>2</sup>, Karin Caldwell<sup>2</sup>

<sup>1</sup>YKI, Institute for Surface Chemistry, Stockholm, Sweden, <sup>2</sup>Uppsala University, Uppsala, Sweden

The adsorption kinetics and viscoelastic properties of mucin (Bovine Submaxillary Gland Mucin, BSM) and Bovine Serum Albumin (BSA), adsorbing to polystyrene surfaces has been studied using Quartz Crystal Microbalance (QCM-D). The lubricating properties of the adsorbed protein layers were studied using a friction force AFM colloid probe technique. A significant difference in the adsorption properties of the different proteins was detected; with the BSA adsorbing in a flat rigid layer whilst the mucin adsorbed in a diffuse, highly viscoelastic layer. Subsequent addition of BSA to the preadsorbed mucin layer resulted in significant stiffening of the protein layer which was attributed to complexation of the mucin by BSA. Mixtures of mucin and BSA showed intermediate properties between that of the individual protein species and this varied systematically with the protein ratios allowing one to tune the properties of the adsorbed layer. Purified mucin actually provided poor lubrication whilst BSA gave better lubrication. Superior lubricity was evident in the complexed layer formed after BSA adsorption to the mucin layer. This provides valuable insight into the synergistic effects of complexation of lower molecular weight biomolecular species with mucin

It has been shown previously that a mucin-rich surface coating reduces protein and bacterial adsorption to plastic and polymer surfaces. This work indicates that mucins may be suitable for incorporation as a responsive biomaterial coating which can specifically adsorb soluble proteins from solution.

Feiler, A. A.; Sahlholm, A.; Sandberg, T.; Caldwell, K. D.; *J Colloid Inter. Sci.* (2007), 315(2), 475-481.

Valle-Delgado, J. J.; Molina-Bolivar, J. A.; Galisteo-Gonzalez, F.; Galvez-Ruiz, M. J.; Feiler, A.; Rutland, M. W. *Langmuir* (2006), 22(11), 5108-5114.

Valle-Delgado, Juan J.; Molina-Bolivar, Jose A.; Galisteo-Gonzalez, Francisco; Galvez-Ruiz, Maria J.; Feiler, Adam; Rutland, Mark W. *Journal of Physical Chemistry B* (2004), 108(17)

OC007

## Surface Modification of Microfluidics for Protein Assays and Separation

Malinda Salim<sup>1</sup>, Gautam Mishra<sup>2</sup>, Simon Forster<sup>2</sup>, Greg Fowler<sup>2</sup>, Ana Pereira<sup>1</sup>, Phillip Wright<sup>1</sup>, Sally McArthur<sup>3</sup>,

<sup>1</sup>*The University of Sheffield, Department of Chemical and Process Engineering, United Kingdom,* <sup>2</sup>*The University of Sheffield, Department of Engineering Materials, United Kingdom,* <sup>3</sup>*Swinburne University of Technology, Faculty of Engineering and Industrial Sciences, Australia*

The emerging proteomics field has triggered the development of many bioanalytical tools and technologies. Since biological samples are usually present in small quantities and volume, there is a high priority for the analytical tools to be able to process these minute samples creating opportunities for microfluidic devices and assay to be developed. There are significant limitations inherent in the current technologies used in protein extraction and separation for proteomes larger than 3,000 as this represents the upper limit of protein separation using conventional 2D gels. The project aims to investigate novel micro-channel processing schemes that will enable spatio-temporal separation of both soluble and membrane-related proteins that can subsequently be interfaced with mass spectrometry analysis. The ability to control interactions between biomolecules and micro-channel surfaces is an integral component of this project. Plasma polymerisation has been shown to be an attractive method for coating microchannel surfaces with a wide variety of different chemistries (acids, glymes, anhydrides, amines and epoxies). A major advantage in the use of the plasma polymers is that they can be translated to a variety of substrate materials commonly used for microfluidic devices including glass and PDMS. By utilising photolithographic patterning, arrays of different chemistries can be created within channels. This approach has enabled us to both immobilise functional biomolecules (antibodies and trypsin) in specific regions of the devices, as well as establish protein separation techniques (ion metal affinity (IMA) and isoelectric focussing (IEF)). In order to understand how the surface properties of a material influence the organization of biomolecules surface analytical techniques such as X-ray photoelectron spectroscopy (XPS), static secondary ion mass spectrometry (SSIMS), zeta potential measurement, AFM and biological assays have all been utilised to provide a complementary approach for characterizing these complex devices.

OC008

## Monodispersed ITO Nanoparticles Precisely Controlled in Size and Shape

Atsushi Muramatsu, Takafumi Sasaki, Yosuke Endo, Kiyoshi Kanie

*Tohoku University, Sendai, Japan*

Indium tin oxide (ITO) has been widely utilized as transparent conductive materials, in particular, as a film-type for flat panel displays. However, indium is a rare metal so that the world-wide deficiency in supply is as a serious problem in the near future. From this point of view, Japan National Project, the Alternative Metal Resources – Reduction of Indium, was started last year, and then a research group was organized in charge of the development of a highly efficient system of ITO nano-film coated with ITO nano-ink in a non-sputter technique. We have investigated the novel synthesis of monodispersed nanoparticles, precisely controlled in size and shape with large productivity as an industrial level. We have started this ITO project from the shape control of ITO particles by various methods, such as the Gel-Sol method, which has been developed originally, and the polyol method in non-aqueous medium. In the present work, we focused our attention on the development of a novel synthesis method of ITO fine particles, controlled in size and shape precisely, in highly condensed aqueous systems by the Gel-Sol method, which is not the Sol-Gel method. For the Gel-Sol method, the co-existence of a precursory solid phase and solution leads to the regulation of the concentration of metal ions, and the highly viscous gel works as an inhibitor against the aggregation of the growing particles by stabilizing them in the gel-network. Namely, the strict separation of the nucleation and the particle growth as well as the complete inhibition of the aggregation of the particles results in the formation of monodispersed particles, since monodispersed particles grow not by the aggregation mechanism of primary particles but by the direct deposition of the precursor solute to the particle. In the present study, initially, the precursor gel was prepared by aging mixtures of In/Sn salts with NaOH at 100 C for 24 h. Then, the resulting gel was further aged at 250 C for 3 h to obtain Sn-containing  $\text{In}(\text{OH})_3$  particles. The particles were sintered at 300 C for 1 h to convert to ITO fine particles. The morphology and the size of  $\text{In}(\text{OH})_3$  which were synthesized by hydrothermal treatment depended on the pH of the initial highly viscous solution. The size was large (1 micron  $\sim$ ) when synthesized at low pH ( $\sim$  near neutral) and the size was small ( $\sim$  100 nm) when synthesized at high pH (9  $\sim$ ). The morphology of Indium hydroxide was a rectangular solid at all ranges of pH except when the initial pH was nearly 12. By physically mixing the Sn source to  $\text{In}(\text{OH})_3$  and calcination, ITO was successfully formed. Thus, TEM and SEM observation revealed that the cubic-shaped  $\text{In}(\text{OH})_3$  particles were transformed into ITO particles without any change in morphology. In addition, the resulting ITO particles will be placed on some substrate with regular arrangement by controlling the surface potential, followed by the low-temperature thermal treatment to give an ITO nano-film, which will be also discussed.

## Bacterial Interactions with Nano-Smooth Surfaces

Elena Ivanova, Russell Crawford

*Swinburne University of Technology, Melbourne, Victoria, Australia*

The formation of unwanted biofilms costs billions of dollars every year across a wide range of industries. On ship hulls, it has been estimated that a biofilm of just a few hundred of microns yields an average 20% increase in fuel consumption, which corresponds to an additional cost of approximately US\$ 400/hour. The food industry performs extensive system decontamination processes using harsh chemicals, which results in both environmental and financial costs, while bacterial infection of biomedical devices causes complications with a number of medical interventions (e.g. dental plaque and wound infection). Despite recent advances in creating antifouling surfaces, many fundamental aspects of bacterial attachment, especially related to the initial stages of biofilm formation, remain unresolved. Once aggregated, the biofilm structures and triggers very efficient 'self-protection' mechanisms that shield the cells from the outer environment. The interaction of bacterial cells (in particular the attachment of single cells) is the critical first step in the chain of events leading to the formation of biofilms. A number of preliminary studies have shown that nanotopography can affect the initial stages of bacterial cell-surface interactions followed by attachment.

This study used nano-structured titanium surfaces, with surfaces roughness varying between 10 nm to 2000 nm, to probe the mechanism of bacterial cell attachment and address the question whether nanoscale surface roughness and topography can control bacterial adhesion. Model metallic surfaces employed for these experiments included: standard titanium alloys that are extensively used as implant materials in orthopaedics and dentistry, equal channel angular pressing (ECAP) of titanium of extreme grain refinement, and sputtered titanium of commercial purity (CP2). The increase in extent of bacterial attachment ECAP titanium surfaces was associated with morphologic and metabolic changes (Fig. 1). The results obtained suggest that nano-scale surface roughness might strongly influence bacterial attachment. The results suggest that bacterial interactions with metallic surfaces were significantly influenced by nanoscale changes in the surface roughness and topography. These factors may be far more important than was previously believed, and should therefore be considered as a parameter of primary interest alongside other well-recognized factors.

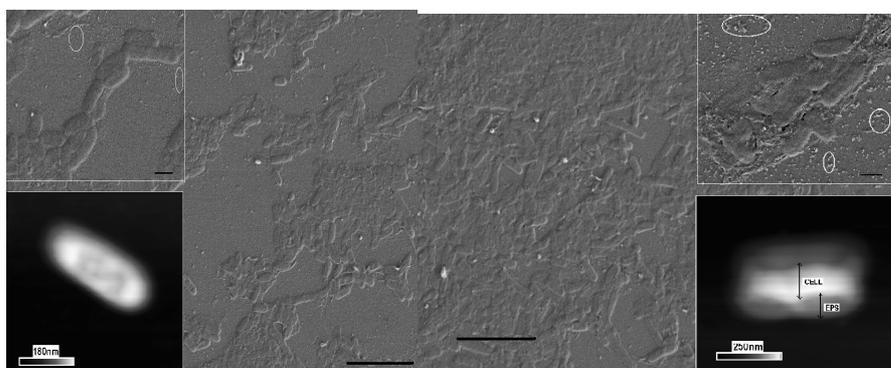


Figure 1. Typical SEM images showing *P. aeruginosa* cells interacting with titanium surfaces after 18 h incubation. An increase in cell numbers and the formation of extracellular polymeric materials (EPS) were observed on ECAP titanium surfaces (right).

## Effect of Dispersant Functional Groups on the Interaction with Mineral Oxide Particles

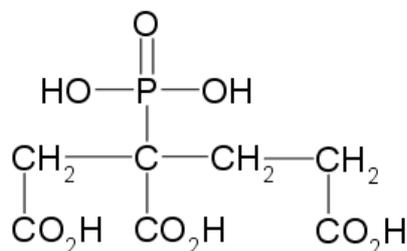
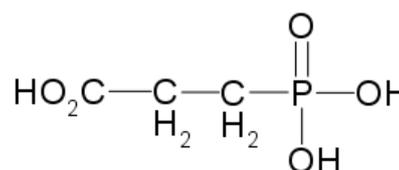
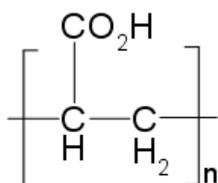
Marlene Cran<sup>1</sup>, Gayle Morris<sup>1</sup>, Leanne Brichter<sup>2</sup>

<sup>1</sup>Institute for Sustainability and Innovation, Victoria University, Werribee, VIC, Australia, <sup>2</sup>Ian Wark Research Institute, University of South Australia, Mawson Lakes, SA, Australia

Effective dispersion of titania pigments is essential to prevent aggregation of pigment particles during processing. The resulting inorganic coatings should also remain stable and well dispersed during storage and subsequent application. Sodium polyphosphates are common industrial additives that are used to facilitate the effective dispersion of titania particles during processing [1]. Elevated temperatures and high alkalinity during processing, however, can reduce the stability of sodium polyphosphates which can reduce the stability of the pigment dispersion [2]. Alternative dispersing additives that remain stable over a range of processing conditions would therefore be advantageous.

This study explores the dispersive properties of carboxylate- and phosphate-based additives on several mineral oxide suspensions. Experiments were conducted at pH values above and below the isoelectric point of the mineral oxides. Adsorption of the dispersants onto the mineral oxide surfaces was studied using adsorption isotherms, infrared spectroscopy, rheological and zeta potential experiments. The interaction of the dispersing agents with the oxide surface was investigated using these techniques in order to explore the influence of dispersant group composition on the resulting suspensions.

Dispersants used in the study:



poly(acrylic acid)  
phosphonobutane tricarboxy acid

phosphonopropionic acid

[1] Rashchi, F.; Finch, J. A., *Miner. Eng.* **2000**, *13*, 1019-1035.

[2] Van Wazer, J. R., *Phosphorous and its Compounds*. Interscience Publishers: New York, **1958**; Vol. 1.

OC011

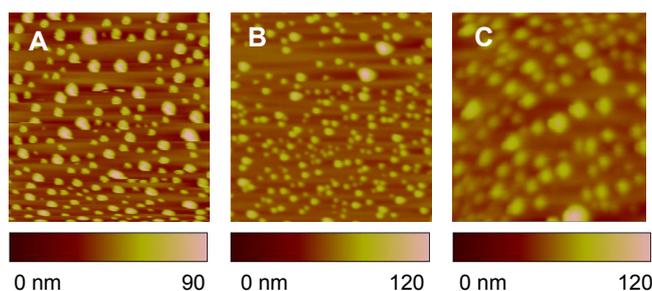
## Investigation of Dextrin Adsorbed on Hydrophobic Mineral Surfaces

Audrey Beaussart, Agnieszka Mierczynska-Vasilev, David Beattie

*Ian Wark Research Institute, UniSA, Adelaide, South Australia, Australia*

Due to its ability to alter the wettability of minerals, Dextrin has been extensively studied as a flotation depressant, to help achieve a selective separation between different mineral phases present in an ore. In this study, the adsorption of a maize Dextrin (Dextrin TYM) has been compared across 3 naturally hydrophobic minerals: talc, molybdenite and graphite. The fundamental interest of this comparison resides in the similarities of the mineral structure and surface properties. They are also represented in many metal sulphide flotation circuits around the world.

Adsorption isotherms and *in-situ* tapping mode atomic force microscope (TMAFM) imaging has enabled polymer adsorbed amount and properties of the adsorbed layer (in terms of layer thickness and coverage) to be determined. The mismatch between the volumes of adsorbed material obtained via these 2 methods has enabled the determination of the amount of hydration water in the structure of the adsorbed layer. The effect of the depressant on the mineral contact angles, measured by a captive bubble method, has revealed clear correlations between the hydrophobicity reduction of the minerals, the adsorbed amount and the surface coverage of the adsorbed polymer. Predictions of the flotation recovery of the treated mineral phases have been confirmed by performing batch flotation experiments. The direct impact of the adsorbed layer coverage and thickness on the recovery has highlighted the importance of these parameters in the predictions of depressant efficiency. The role of the initial hydrophobicity of the underlying minerals on flotation response is also discussed.



*5x5 μm AFM height images of adsorbed Dextrin TYM onto hydrophobic surfaces: A) talc, B) molybdenite, and C) graphite taken in-situ. The polymer adsorbed from a solution at 50 ppm in 10<sup>-2</sup>M KCl background electrolyte at pH 9.*

OC012

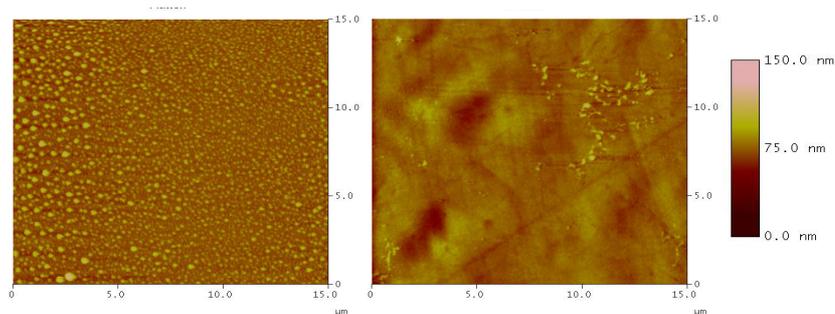
## In Situ Atomic Force Microscopy of Carboxymethyl Cellulose Adsorption on Talc and Chalcopryrite: Correlation Between Adsorbed Layer Properties and Flotation Performance.

Agnieszka Mierczynska-Vasilev, David Beattie

*Ian Wark Research Institute University of South Australia, Adelaide, South Australia, Australia*

Talc is a readily floatable sheet silicate mineral. Unless treated with polymeric depressants, talc will report to the concentrate during the flotation of sulphides, and interfere with subsequent metallurgical treatment. Many factors have been identified as important for the performance of polymeric depressants for talc, including: the degree of substitution; type of substituent; the backbone chemistry of the polymer; and the presence of other reagents and ions in solution. Although the existing knowledge of the effect of bulk polymer chemistry on talc depression has allowed tailored polymers to be produced, further improvements in the depression of talc, i.e. increased power and selectivity for talc depression, will rely on studying the properties of the adsorbed polymer layer on target value and gangue minerals in conjunction with altering the bulk polymer chemistry.

In this work we have used *in situ* tapping mode atomic force microscopy (TMAFM) to image adsorbed polymers on mineral surfaces [1]. This methodology was chosen to ensure the images reflected the true nature of the polymer layer when adsorbed on a mineral surface in an aqueous suspension. The polymers are a selection of carboxymethyl celluloses (CMC) with varying bulk chemistry but similar molecular weight. The AFM images have been supplemented by adsorption isotherm determinations and packed particle bed contact angle measurements to quantify the influence of the polymers on the surface wettability. The measurements include the adsorbed layer characteristics on both gangue (talc) and valuable (chalcopryrite) mineral phases, to see if depressant power and depressant selectivity can be predicted. Correlations are drawn between the morphology (roughness, thickness, coverage) with the ability of the polymers to reduce the hydrophobicity and flotation recovery of talc. These correlations are discussed within the overall framework of the bubble-particle attachment process, in an attempt to clarify exactly how a polymeric depressant can prevent mineral recovery. AFM height images of adsorbed CMC onto Talc (left) and Clinocllore (right) taken *in situ* (25 ppm, pH 9,  $10^{-3}$ M)



[1] Mierczynska-Vasilev, A.; Ralston, J.; Beattie, D. A. *Langmuir*, **2008**, *24*, 6121-6127.

## Nanostructured Porous Silicon: A Novel Delivery System for Poorly Soluble Drugs

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<sup>1</sup>Ian Wark Research Institute, University of South Australia, Mawson Lakes, SA, Australia, <sup>2</sup>Sansom Institute, University of South Australia, Adelaide, SA, Australia

Porous silicon (pSi) has received considerable attention in recent years for use in applications ranging from biosensing through to drug delivery.<sup>1</sup> Radioactive <sup>32</sup>P doped pSi (Brachysil<sup>TM</sup>) is currently undergoing Phase II clinical trials for inoperable primary liver cancer.<sup>2</sup> Thermally oxidised and carbonised pSi have previously been shown to increase the release of poorly soluble drugs.<sup>3</sup> However, considerable work remains to optimise pSi for routine use as a drug delivery system. Here we report a range of physicochemical and biophysical investigations on poorly soluble drug loaded pSi, to gain insight into loading mechanism and biopharmaceutical action.

In this study, using thermal oxidation to control pSi surface chemistry,<sup>4</sup> we have investigated the loading and release of model poorly soluble drugs including celecoxib and indomethacin. In particular, we consider the influence of loading methodology on the crystallinity of the loaded poorly soluble drug, we characterise the poorly soluble drug-loaded pSi and quantify their release *in-vitro*. Finally, the *in-vivo* performance of the poorly soluble drug loaded pSi is investigated using a rat model.

<sup>1</sup> Prestidge, C. A.; Barnes, T. J.; Lau, C.-H.; Barnett, C.; Loni, A.; Canham, L., *Expert Opin. Drug Deliv.* **2007**, *4*, 101-110.

<sup>2</sup> Press releases at the home page of pSivida Ltd <http://www.psivida.com>.

<sup>3</sup> Salonen, J.; Laitinen, L.; Kaukonen, A. M.; Tuura, J.; Bjorkqvist, M.; Heikkila, T.; Vaha-Heikkila, K.; Hirvonen, J.; Lehto, V. P., *J. Control. Rel.* **2005**, *108*, 362-374.

<sup>4</sup> Jarvis, K. L.; Barnes, T. J.; Badalyan, A.; Pendleton, P.; Prestidge, C. A. *J. Phys. Chem. C* **2008**, *112*, 9717-9722.

OC014

## Targeted Drug Delivery Using Bioinspired Nanoengineered Capsules

Angus Johnston, Lillian Lee, Christina Cortez, Frank Caruso

*The University of Melbourne, Melbourne, Victoria, Australia*

Targeted delivery of drugs to specific cells in the body has the potential to improve the treatment of many illnesses, including cancer and HIV. An emerging technique to deliver drugs is by immobilising the drug inside a nanocapsule, whereby the body is protected from potentially harmful side effects of the drug, while also preventing the drug from being degraded by the body.

One way to prepare these capsules is by the layer-by-layer deposition of interacting polymers onto a sacrificial template particle. This technique allows for fine control over the properties of the capsule by altering the number of layers deposited, the material deposited at each layer, and also by controlling the assembly conditions. However, assembly of structures on the nanoscale requires fine control of the assembly process. DNA provides an ideal building block for such films, as it is biocompatible and the complementary base pairing can be used to facilitate assembly of the film as well as induce structures into the film on a nanoscale. We show that stable, responsive DNA capsules can be synthesised and the properties of the film can be controlled using different DNA sequences.

We also show that nanocapsules can be targeted specifically to colorectal cancer cells by modifying the surface of the capsule with the A33 antibody. The A33 antigen is found on almost all colorectal cancer cells and is currently undergoing clinical trials for cancer therapy. Using imaging flow cytometry, we show that A33 functionalised capsules are internalised into cancer cells, while uptake by healthy cells is limited. The high throughput nature of imaging flow cytometry allows internalisation analysis to be performed on tens of thousands of cells compared with confocal microscopy where the number of cells analysed is limited.

## Dimers are forever: The importance of the membrane in ion pump function

Ronald Clarke

*University of Sydney, Sydney, Australia*

Ion pumps belonging to the P-Type ATPase enzyme class such as the Na<sup>+</sup>,K<sup>+</sup>-ATPase, the Ca<sup>2+</sup>-ATPase and the H<sup>+</sup>,K<sup>+</sup>-ATPase carry out critical functions in a broad range of physiological processes, e.g. nerve impulse transmission, muscle contraction and relaxation, nutrient reabsorption in the kidney and digestion. Over the last 8 years crystal structures of a number of these enzymes have been solved by x-ray crystallography<sup>1,2</sup>. Although the structural data is very useful, it does not lead to a complete understanding of the ion pumping mechanism of these enzymes. Crystallisation of membrane proteins always requires the use of detergents to replace the native lipids and solubilise the proteins. This destroys all lipid-protein and protein-protein interactions which may be present in the native membrane environment.

From stopped-flow kinetic studies of the Na<sup>+</sup>,K<sup>+</sup>-ATPase in native membrane fragments, we have found that protein-protein interactions within the membrane play a critical role in the enzyme's mechanism<sup>3,4</sup>. It has been known for many years that ATP plays an allosteric role in the mechanism of the Na<sup>+</sup>,K<sup>+</sup>-ATPase by accelerating the rate of the rate-determining conformational change of unphosphorylated enzyme. The crystal structure of an isolated Na<sup>+</sup>,K<sup>+</sup>-ATPase molecule provides no clue to the origin of this allosteric effect. Our kinetic investigations, on the other hand, indicate that the ATP allosteric effect is mediated by a change in protein-protein interactions within the native membrane. In many tissues the Na<sup>+</sup>,K<sup>+</sup>-ATPase is packed at a very high density within the membrane (10<sup>3</sup>-10<sup>4</sup> molecules per μm<sup>2</sup>). The close proximity of individual Na<sup>+</sup>,K<sup>+</sup>-ATPase molecules to each other could easily lead to steric hindrance, inhibiting the rate of ion pumping. The binding of ATP leads to a closing of the cytoplasmic domains of the protein, resulting in a compact conformation. This could, thus, relieve steric hindrance and enhance the rate of ion pumping. We believe, therefore, that a consideration of the native membrane environment of these enzymes is crucial to a full understanding of their mechanism.

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## Simultaneous Anomalous Reflection and Quartz-Crystal Microbalance Measurements of Biomolecule Bindings on a Gold Surface

Yoshio Okahata, Takayoshi Kawasaki

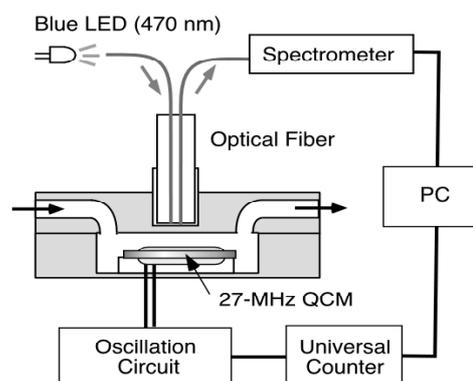
Tokyo Institute of Technology, Yokohama, Japan

Viscoelastic and hydration properties of proteins have generated much interest, because these properties result in the structure and function of proteins such as stability, folding, structural changes, molecular recognition, and enzymatic activity. A piezoelectric quartz-crystal microbalance (QCM) is a very sensitive mass measuring device and has been used as a mass-sensor in aqueous solutions. In many cases, when solid and hydrophobic materials are immobilized on the QCM plate, they behave as elastic membranes, and the resonance frequency ( $\Delta F$ ) decreases linearly with increasing mass ( $\Delta m$ ) on the QCM plate; the phenomenon has been described by the Sauerbrey equation. However, in the liquid system, frequency shifts ( $\Delta F_{\text{water}}$ ) correlate not only a mass but also a viscosity of the liquid as known as Kanazawa-Gordon equation. Therefore, when hydrated and viscoelastic proteins are immobilized,  $\Delta F_{\text{water}}$  decreases with a different slope or deviates from the linear slope and quantification becomes difficult. If substances on the QCM are highly hydrated, a larger  $-\Delta F_{\text{water}}$  value than expected is obtained due to the hydration.

In order to solve this complexity of the QCM, the combination with an optical sensing method such as a surface plasmon resonance (SPR) measurement has been studied, because SPR is supposed to simply reflect surface mass changes without the effects of water. Simultaneous detections with QCM and SPR have been studied by two different methods; a dual probed device with one gold surface, in which SPR signals can be obtained from a corrugated grating prepared on the gold surface of a QCM plate, and a parallel measurement device using a single cell with different gold surfaces for SPR and QCM, respectively. In the simultaneous detection method, however, it is still difficult to detect SPR signals on the vibrating QCM gold plate, because the grating of the QCM gold surface affects the vibration of the QCM in water.

In this paper, we propose a new simultaneous sensing device using an optical fiber sensor based on anomalous reflection (AR) of gold surface of the QCM electrode (Fig. 1). We have measured protein bindings to the surface, DNA hybridization, and DNA polymerase reactions on a DNA-immobilized AR-QCM.

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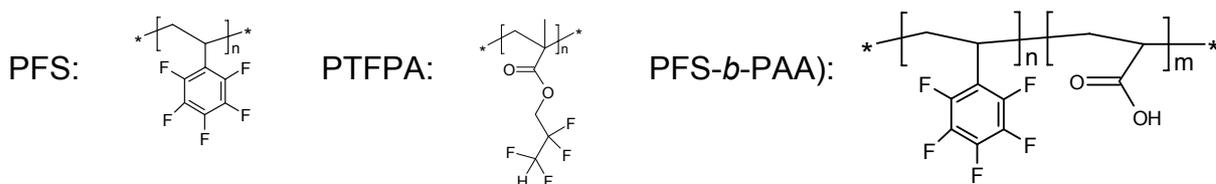
**Fig. 1** A schematic illustration of a simultaneous detection of protein bindings to a gold surface of 27-MHz quartz-crystal microbalance (QCM) and an optical fiber sensor based on an anomalous reflection (AR) of gold.

## Adsorption of Well-Defined Fluorine-Containing Polymers onto PTFE

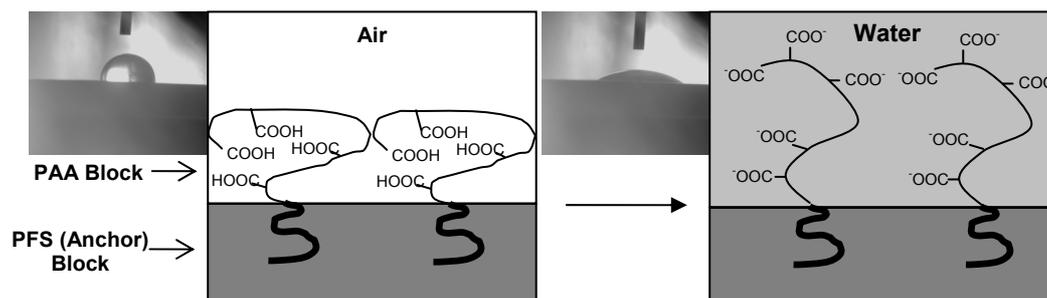
Lisbeth Grondahl<sup>1</sup>, Shuko Suzuki<sup>1,2</sup>, Michael Whittaker<sup>1</sup>, Michael Monteiro<sup>1</sup>, Edeline Wentrup-Byrne<sup>2</sup>

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Adsorption of well-defined fluorinated polymers onto clinically relevant polytetrafluoroethylene (PTFE) substrates offers an attractive method of modifying the surface properties of chemically inert PTFE. Reversible addition fragmentation chain transfer (RAFT) was used to synthesis of the polymers in this study: the homopolymers poly(2,3,4,5,6-pentafluorostyrene) (PFS), poly(2,2,3,3-tetrafluoropropyl acrylate) (PTFPA), and poly(2,2,3,3-tetrafluoropropyl methacrylate) (PTFPMA) as well as their block copolymers with tert-butyl acrylate (tBA). Water soluble blocks were synthesized through the hydrolysis of the t-butyl side groups of P(tBA) to the corresponding carboxylic acid.



Adsorption of selected polymers onto PTFE from a series of solvents (methyl ethyl ketone (MEK), dimethyl formamide (DMF), fluorobenzene (FB), dichloromethane (DCM)) was investigated using x-ray photoelectron spectroscopy (XPS) and sessile water drop measurements. The three homopolymers studied all adsorbed irreversibly (i.e. were not removed by washing) from organic solvents at ambient temperature. PFS displayed the highest adsorption and this was attributed to strong hydrophobic interactions. From angle resolved XPS it was concluded that PFS became impregnated into the PTFE substrate down to depths of 100 Å when using FB as a solvent. The carboxylic acid-containing block copolymers adsorbed more effectively from DMF (a good solvent for the PAA block) compared to MEK. The resulting modified PTFE substrates displayed high stability with respect to desorption in aqueous solution, yet conformational changes of the adsorbed polymer resulted in a switchable hydrophobic-hydrophilic surface (in air or water respectively). These results highlight the success of a facile and simple approach to irreversibly adsorb functional polymers to a non-functional fluorinated surface.



OC018

## Magnetic Field Control of Structures and Functions of Colloidal Assemblies

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Although the magnetic energy of a weak magnetic molecule in magnetic fields is much less than thermal energy, molecular assemblies, organometallic complexes, and macromolecules having high molecular weight and magnetic anisotropy would have energy enough to form oriented and ordered structures under high magnetic fields. Therefore, a magnetic field is one of the attractive energies for structural control of weak magnetic materials such as, e.g., orientation of hydrocarbon chains and ordering organic-inorganic hybrids. Also, magnetic fields may control directly the properties and functions of such materials as well as indirectly through magnetic deformation of their structures.

The structure and size of vesicles of lipids and a crown-surfactant via the magnetofusion and magnetodivision, the crystal parameters and orientation of the hexagonal mesophase of block-copolymer/silicate hybrids (SBA15 hybrids), and the volume of volume phase-transition gels (*N*-isopropylacrylamide gels) were drastically changed by steady magnetic fields. Moreover, the granular organometallic microcrystals of CPL-1 ( $\text{Cu}_2(\text{pzdc})_2(\text{pyz}) \cdot 2\text{H}_2\text{O}$ ) were converted to needle-like microcrystals ( $\text{Cu}(\text{pzdc})(\text{pyz}) \cdot \text{ClO}_4$ ) when prepared under a 6T magnetic field.

Magnetic fields also can control the membrane potential of black lipid membranes of DPPC and electron tunneling reaction through a SAM of (ferrocenylmethyl)dodecyldimethylammonium bromide on a gold electrode.

We present several examples for magnetic field control of structures and functions of organized colloids comprising weak magnetic substances.

Acknowledgement: This work was supported by Grand-In-Aid of Scientific Research for Priority Area (Area 767, No. 15085205) and No. 16655004, 20350003, and 20655002 from MEXT Japan. The experiment of high magnetic fields up to 30T was performed at Tsukuba Magnet Laboratory.

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OC019

## **Sulphide Mineral Surfaces in the Presence and Absence of Microorganisms Studied by Imaging Electrochemistry**

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Bioleaching, the use of micro-organisms to recover precious and base metals from mineral ores and concentrates, has developed into a successful and expanding area of biotechnology. The bioleaching of sulphide minerals involves electrochemical and chemical reactions of mineral with the leaching solution and the extra-cellular polysaccharide layers on the microorganisms. The microorganisms derive energy by oxidising the sulphur moiety and ferrous iron, which can be interpreted by electrochemistry and surface chemistry.

Scanning Electrochemistry Microscopy (SECM) is a useful technique for imaging electrochemical reactivity of a surface immersed in solution. It has been employed to reveal localized electrochemistry at submicrometer to micrometer level domains and has been used in surface studies in the fields of bioelectrochemistry and materials science.

As a first step in exploring the influence of different mineral surfaces on bioleaching, our initial investigations involve bacteria attached to model substrates prepared for example by sol-gel methods. We have also prepared patterned substrates to study relative preference of bacteria for different material surfaces, and to study the effects of heterogeneity such as found with real mineral surfaces. With these substrates we have used imaging electrochemical techniques such as SECM and Electrochemical Atomic Force Microscopy (EC-AFM) to investigate the dissolution kinetics of well-controlled metal sulphide surfaces in the presence and absence of bioleaching microorganisms.

**OC020**

## **Wetting Characterisation in Porous Media**

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Direct measurement of the contact angle of liquid on powder particles or porous media is difficult although knowledge of the wetting properties of those surfaces play a very important role in industrial practice. Wettability of drug powders in the pharmaceutical industry, wettability of mineral particles in the flotation process, and liquid penetration in porous media like textiles or paper, and in oil recovery are some examples of applications. However, precise wettability studies of powders have always been challenging in terms of precision, reproducibility, and the absolute value obtained.

The Capillary rise method can be used for contact angle determination of such powder particles and porous media. This method is based on two different experimental approaches, height or weight gain measurement in a packed bed, and the contact angle can be calculated from Washburn's equation. We have developed the apparatus, based on the weight gain measurement approach, to characterise the wettability of ballotini particles. Contact angles of narrowly sized fractions of spherical and crushed ballotini under a controlled environment were measured to elucidate the impact of the particle shape and particle size on wettability. Penetration kinetics of liquid into a packed bed of ballotini was also investigated. Flotation tests in a modified Denver cell using ballotini were also conducted to relate the floatability to the surface's wettability.

OC021

## Effects of Clay-Organics in Structure and Rheology of Mature Fine Oilsands Tailings

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Mature fine tailings (MFT) from Canada's oilsands extraction processes occur in tailings ponds occupying vast amounts of land space. The recovery of clean water from these ponds is important for use in the extraction of bitumen and for reducing the demands on fresh water and the consequent environmental impacts. MFT is made up of largely colloidal clays (kaolinite and illite), water, sand and bitumen emulsions. The MFT was separated into four layers by centrifugation. The top layers of oil and water were removed. The middle clay-organic complexes (M) and bottom layer of sand and clay (B) with less bound organics were removed and freeze dried and later reconstituted in the process water<sup>1</sup>. The elastic moduli  $G'$ , relative viscosities, and Bingham yield stresses of the M, B and admixtures of both M+B were studied at various volume fractions in process water. It was found that the aggregation and flow behavior of the clays from the MFT, under imposed external stresses and strains, depended on their physicochemical properties, and volume fractions. Both M clay slurry and total MFT showed viscoelastic behaviours. Using power laws,  $G' = k \Phi^n$  and  $\tau_b = k' \Phi^{n'}$  the index for aggregation was determined for each system. The M clays had a higher index ( $n=6.1$ , and  $n'=6.1$ ) than B clays ( $n=3.6$ ,  $n'=3.2$ ). The flow curves of reconstituted MFT ( $R_c$ ) ( $n=4.5$  and  $n'=4.5$ ) were similar. As a result, the clay-organic complexes were deemed mainly responsible for forming structures that trapped the large volumes of water in the viscoelastic MFT.

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OC022

## Smart Polymers for Improved Mineral Processing

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Temperature sensitive polymers which display hydrophilic/hydrophobic transitions in response to changes in temperature such as Poly (*N*-isopropyl acrylamide) (PNIPAM) have been found to be useful as multiple function reagents. The polymer can cause the mineral particle surfaces to be hydrophilic at room temperature and hydrophobic at temperature above about 32°C. Therefore, both particle surface wettability and inter-particle interaction forces are reversibly controllable. When the surface is hydrophilic, particle dispersion is achieved by repulsive inter-particle forces. When the surface is hydrophobic, particle aggregation is induced by inter-particle hydrophobic attractive forces. The resulting aggregation produces fast sedimentation so that rapid solid/liquid separation is achieved. Additional consolidation of the settled solids occurs when the temperature is then reduced to induce repulsion between particles. In addition, the hydrophobic surface condition allows for the attachment of particles to bubbles. Homopolymers and charged copolymers have been synthesised. Their adsorption onto a range of substrates has been studied as a function of temperature. Sedimentation, consolidation and flotation tests have been conducted on silica, alumina, hematite and clay. Surface force measurements with the colloid probe have been used to measure the change from repulsion to attraction as the temperature is increased. Contact angle measurements confirm the change in surface wettability. The results indicate that PNIPAM can be used to induce a transition between hydrophilic and hydrophobic surface character at temperature lower or higher than its critical solution temperature (32°C). Thus, effective suspension dispersion, hydrophobic aggregation and flotation have been demonstrated. The approach has the potential to reduce the amount and types of reagents required for mineral processing while improving flotation recovery and recovering more water from tailings.

OC023

## Control of Aggregate Structure, Settling and Dewatering in Mineral Tailings Processing

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Globally there are more than 10 billion tonnes tailings with a high percentage of water produced every year. These mineral tailings (gangue) are the reject materials from mineral processing operation. Tailings represent a significant capital and operating cost that continues long after the mine closes, due to the low solid concentration from industrial thickener under flow.

The solid-liquid separation and consolidation in thickener by polymer flocculation generally experiences (R.Hogg 2000):

- the free settling zone, where the flocs initiate and grow when solid particles collide with polymers,
- the hindered settling zone, where larger flocs and extended chains contact each other forming a loose network
- the compression zone, where the self-weight of the sediment overcomes the yield stress to compact the network.

Cryovitrification sampling and imaging by cryo-SEM techniques were used to study kaolinite aggregate and floc micro-structures changes in a flocculated kaolinite suspension, and a plastic cylinder (diameter of 85mm) with a rectangular rake (6cm width× 25.5 cm length).

By sampling the floc structure in the different settling zones and examining with Cryo-SEM, this study shows the flocs will grow during the free settling zone along the edge chain, when the flocs settle to the hindered settling zone, a “honeycomb” will form to resist compression, the settled structure traps both inter-aggregate and intra-aggregate water with relatively low bed density. This loose network structure needs to be destroyed so the trapped water can be released. Raking can dramatically release the trapped water by breaking down the honeycomb network. The results also show that raking in the thickener not only assists releasing the trapped water, but also re-arranges the aggregates structure from edge-edge (E-E) to much denser face-face (F-F), hence a dramatically increase in bed density is achieved.

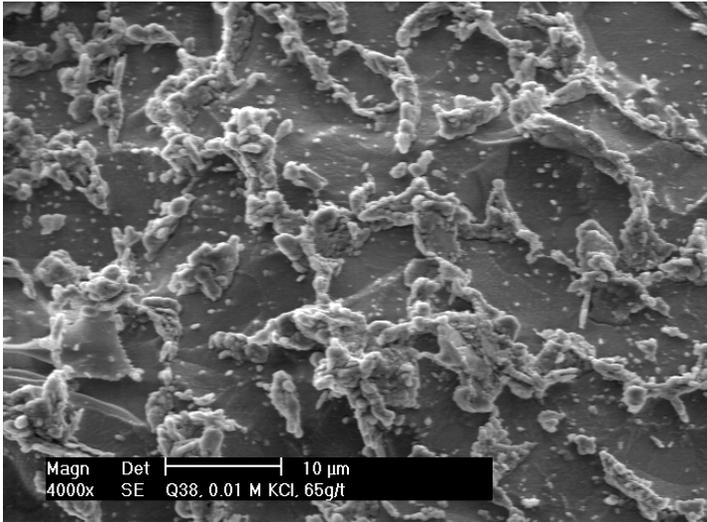


Figure 1 Cryo-SEM images shows that kaolinites form a loose network structure during flocculation in the hindered settling zone.

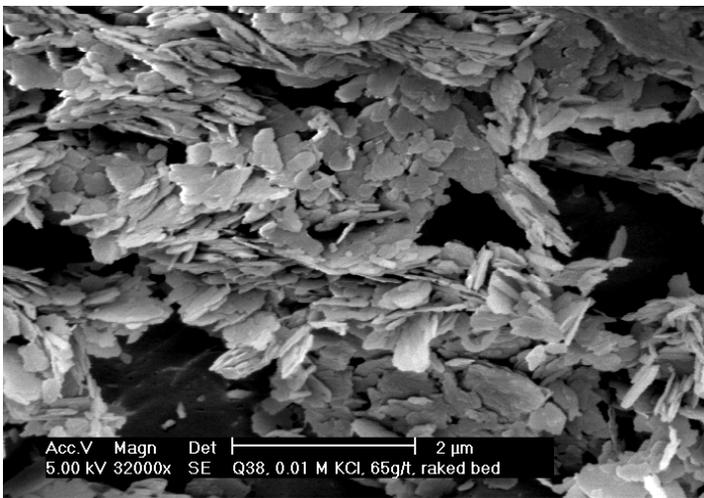


Figure 2 Kaolinite platelets restructured from E-E to mainly F-F structure by raking in the consolidation zone.

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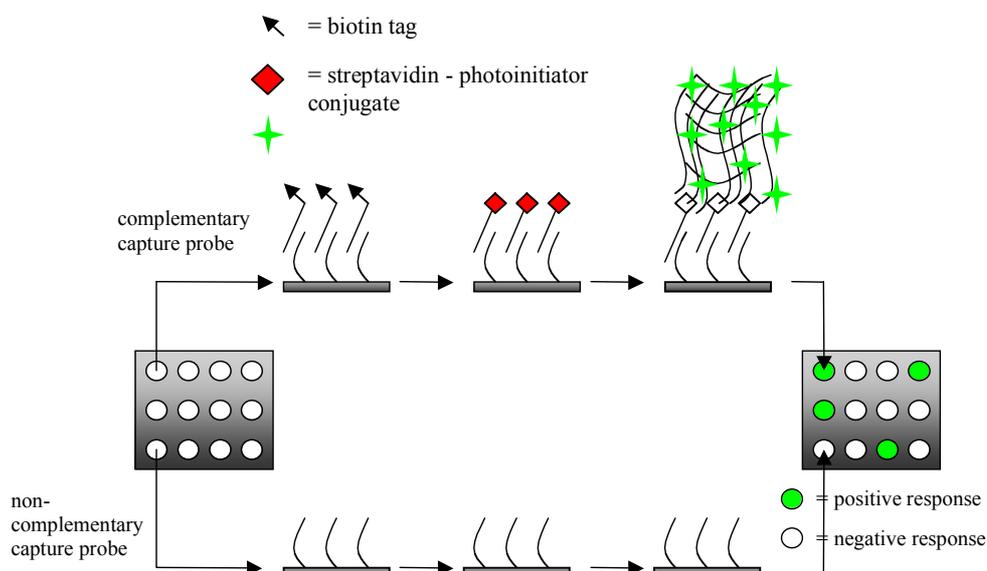
## Polymerization-Based Signal Amplification for Detection of Molecular Recognition

Christopher Bowman, Ryan Hansen, Leah Johnson, Heather Avens, Raveesh Shenoy

*University of Colorado, Boulder, CO, United States*

The methods of disease diagnosis and treatment may benefit from characterizing biomarkers because of the potential for identifying subcellular aberrations before the onset of an advanced disease. However, a primary challenge in such molecular diagnostics involves both identifying and quantifying minute amounts of biological targets from a patient sample, thus requiring sensitive and specific detection methodologies amenable to clinical implementation or bed side testing.

The overall focus of our work is to apply free radical photopolymerizations in the detection of clinically relevant biological targets. The detection occurs by coupling photoinitiators to molecular recognition sites on array-based biochips. Following a surface initiated photopolymerization using monomer and surface irradiation, the formation of a visible, high-molecular weight polymer film signals the presence of the target (shown below in the case of DNA detection). The resultant films permit sensitive, rapid, and direct visualization of the target. Coupling fluorescent or absorbing moieties to the polymer film growth allows large and quantifiable signal gains, enabling evaluations of target concentrations using robust and inexpensive optical detection instrumentation. Considering the robust and rapid characteristics of this signal amplification approach, this method holds significant potential for eventual use in point-of-care molecular diagnostic applications.



OC025

## Particle-Based Biosensors for Cancer and Infectious Disease Detection

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Despite the vast improvements in medical therapeutics over the past 50 years, the mortality rate associated with cancer has remained constant<sup>1</sup>. This is in contrast to other diseases such as heart disease, influenza and cerebrovascular diseases which have seen a marked decrease in mortality rate over the same period. The ability to detect cancer early gives the patient a significantly better chance of survival (90% 5 year survival rate) compared with late detection where the patient may only have a survival rate of less than 20%<sup>2</sup>. Similarly, early detection of infectious disease gives the patient the best chance of a cure. There is a great need to develop clinical diagnostic tests for detection of cancer and infectious disease on the molecular level, that is, before the appearance or reappearance of a tumour or when symptoms of infectious disease first appear.

In order to fulfill this requirement, we are developing new particle-based biosensors which are focused on early detection of cancer and infectious disease<sup>3</sup>. The biosensors consist of fluorescently-encoded, functionalized silica particles which have biological probes (eg DNA, peptides, antibodies, antibody fragments, proteins) attached. Libraries of these probe-bound particles are used to interrogate biological fluids and extracts from cancer tumour tissue (eg DNA) in a process known as *multiplexing*. A high-throughput instrument such as a flow cytometer can rapidly detect the positive interactions between the probe-bound particles and moieties in the target sample (eg proteins, DNA, etc). We have demonstrated the use of particle-based biosensors for a variety of diseases (e.g. breast, ovarian and cervical cancer, West Nile Virus, Dengue Fever) using genomic, proteomic as well as epigenetic-based assays.

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OC026

## Tethered Bilayer Lipid Membranes as Versatile Model Membrane Systems

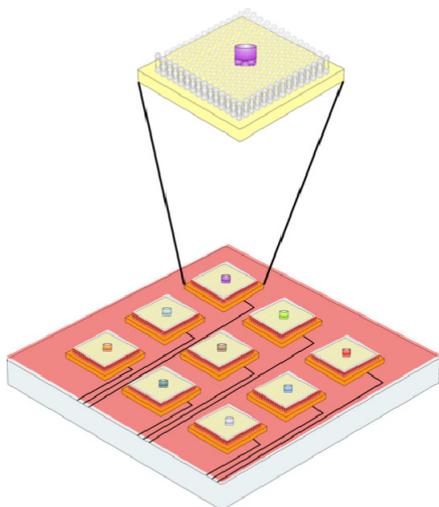
Ingo Köper

*Max Planck Institute for Polymer Research, Mainz, Germany*

Tethered bilayer lipid membranes (tBLMs) are solid supported model membrane architectures, where the inner leaflet of a lipid bilayer is covalently attached to a solid support via an oligomeric spacer. These architectures have been shown to provide very high electrical sealing properties, which make them an ideal system to study the functional incorporation of membrane proteins, especially ion channels [1,2].

We have developed a molecular tool kit, which allows tuning the membrane properties in terms of its structure and electrical properties with respect to a certain membrane protein [3]. Structural properties have been investigated by neutron reflectivity and surface plasmon spectroscopy, and a clear structure-function relationship could be established. Electrical properties are mainly characterized using impedance spectroscopy where the functional incorporation of ion channel proteins has been followed; this process has also been visualized using AFM [4].

We will present an overview on recent progress and focus on the use of tBLMs in a biosensing concept. Novel polymerizable lipids and structured substrates as important steps towards the construction of a “membrane-chip” (see Figure) will be shown.



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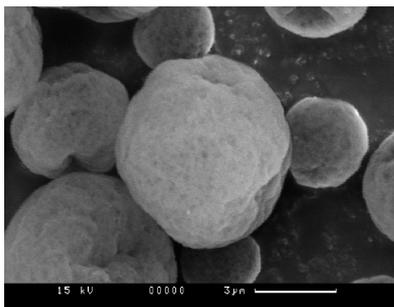
OC027

## Hybrid Microcapsules Engineered from Submicron Lipid Droplets and Silica Nanoparticles – Applications in Pharmaceutical Delivery

Spomenka Simovic, Clive Prestidge

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The fabrication and properties of hybrid microcapsules composed of silica nanoparticles and lipids are reported. Capsule formation is facilitated by the spray drying of emulsions containing silica nanoparticles and is critically dependent on the interfacial structure of the nanoparticle containing emulsion, which is in turn controlled by the surfactant charge and the nanoparticle-to-lipid ratio. Capsules can be prepared with 10 times less silica nanoparticles when stable colloidosomes are employed, i.e. when a droplet-nanoparticle charge neutralizing mechanism is operative. The capsules have a specific internal porous matrix structure (pore sizes in the range 25-100 nm), which facilitates high molecular loading and stabilisation of molecules in lipid solutions. Furthermore, the capsule surfaces have dual hydrophilic-lipophilic characteristics, enabling them to be used as effective particulate emulsifiers.



These dry hybrid lipid capsules offer a number of attractive properties for applications in pharmaceutical encapsulation and delivery, including solid state storage stability, re-dispersion in simulated gastric and intestinal conditions, high loading capacity and improved orally dosed bioavailability for poorly soluble drugs in comparison to pure lipid emulsions.

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## Binary Colloidal Crystals as Templates for Simple Generation of Highly Ordered Chemical Patterns used for Controlled Location of Proteins

Gurvinder Singh, Saju Pillai, Vijay Gothri, Morten Foss, Peter Kingshott

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Nanopatterning of biomolecules such as proteins, DNA, and polysaccharides are of great interest in cell culture dishes, biosensors, medical implants and tissue engineering. These so-called nanoarrays require attachment of biomolecules at specific locations on solid substrates with precisely controlled chemistry, but to function fully the non-specific adsorption in surrounding regions must be prevented. Currently, the most widely used techniques for patterning are photolithography, soft lithography and electron beam lithography, all of which involve multi-step surface modification directly onto substrates, and are time consuming and expensive<sup>1-3</sup>. We have shown recently that highly ordered binary colloid patterns can be generated from simple self-assembly onto surfaces, where single layers of large particles are surrounded by crystals of smaller particles<sup>4</sup>. Here, we report on a new method for generating chemical patterns by sputtering of gold through the colloid crystal layer followed by lift-off of the particles. The crystal regions of the binary pattern, composed of the smaller particles, facilitate transport of the Au sputter beam to the substrate. After particle lift-off only the regions where the small particles have been in contact with the silicon substrate are coated with Au. The large particles act as a mask and remain uncoated, and the thickness of the surrounding Au layer is controlled by the sputter time. The highly ordered chemical patterns are generated where the size of the features are tuned by appropriate choice of particle sizes (50 nm to 3  $\mu$ m diameters) and ratios. In another approach, binary patterns made from 2  $\mu$ m silica and 200 nm amine polystyrene particles are heated at 100 °C (above glass transition temperature of polystyrene) followed by etching with HF to remove the silica particles. The surfaces are then sputtered coated with Au generating gold patterns with silicon as a background after removal of polystyrene particles by dissolving them in toluene. The thickness of gold features can be controlled by the sputtering time. We demonstrate that the resultant Au layer can be coated with a protein resistant mercapto-oligo(ethylene glycol) layer ((1-mercapto-11-undecyl)-tri(ethylene glycol)) that allows selective adsorption of fluorescently labelled proteins, such as FITC-labelled antibodies or rhodamine-labelled albumin, only onto the Si regions of the pattern. The Au patterns and subsequent protein adsorption are characterized by AFM, SEM and fluorescent microscopy. XPS and ToF-SIMS are used to characterise the chemical modification steps of the patterning.

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## New Surface Forces Apparatus Using Two-beam Interferometry

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When two solid surfaces are immersed in a liquid, quite diverse forces operate between the surfaces depending on the surface properties such as the charge density and the chemical composition. Various surface force apparatuses (SFAs) have been developed to understand the origins of the forces. The conventional SFA uses multiple beam interferometry of white light employing fringes of equal chromatic order (FECO) to measure the distance between macroscopic surfaces.<sup>1,2</sup> It allows one to monitor the surface forces with a high resolution in the forces (10 nN) and the distance (0.1 nm).<sup>1-3</sup> For FECO, the substrate needs to be transparent. Atomically smooth mica surfaces are commonly used as the transparent substrate. The liquids between the surfaces also need to be transparent. These restrictions lead an unfavorable situation for understanding and controlling the interaction of many materials and liquids which are not transparent. An alternative method is necessary for studying nontransparent samples.

We designed a new surface forces apparatus for measuring the interactions between two nontransparent substrates and/or in nontransparent liquids.<sup>4</sup> The small displacement of a surface, was measured by the two-beam (twin path) interferometry technique using the phase difference between the laser light reflected by a fixed mirror and that by a mirror on the back of the bottom surface unit. It is possible to determine the distance with a resolution of 1 nm in the working range of 5  $\mu\text{m}$ . This apparatus was successfully applied to measure the forces between mica surfaces in pure water and aqueous KBr solutions.

This technique does not require transparent substrates liquids; therefore, it is applicable to any surfaces including metals, ceramics, polymers, and their composites. The system is stable and easy to handle. Computer control and data acquisition are also possible. We believe that this apparatus will extend the scope of the surface forces measurement.

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OC030

## Factors Affecting the Stability of Surfactant-Free Liquid Films

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We present results of our late colleague Vassili Yaminsky's investigations into freestanding films of pure water in water-saturated air, or water with low levels of electrolyte and no added surfactant. Measurements were made in a thin film balance with control of capillary pressure. The set-up also allowed dynamic investigations of two air/water menisci approaching each other at a controlled rate.

The main results are:

1. Pure water films are stable but electrolyte films are not.

For films that are thinned slowly, giving a quasi-static approach of the two air/water surfaces, it was found that films of pure water are stable for periods of hours or days. Measuring the film thickness using optical interferometry shows that capillary pressures of some tens of Pa result in film thicknesses of a few hundred nm. The thickness change on varying pressure is reversible, with increasing pressure resulting in a thinner film. This is consistent with film stabilisation by a double-layer disjoining pressure between surfaces bearing a charge of  $0.3 \text{ mC/m}^2$  (or a surface potential of  $\sim 60 \text{ mV}$ ) and a Debye length of 150 nm. Adding even a small amount of electrolyte ( $8 \times 10^{-4} \text{ mol/L NaCl}$ ) reduces the Debye length without substantially increasing the surface charge. This reduces the maximum disjoining pressure to less than the applied capillary pressure, and the film is destabilised by van der Waals forces which cause the film to collapse when its thickness is about 50 nm.

2. Approach in electrolyte solutions is hindered by thin film drainage, indicating that the air/electrolyte interface is not fully mobile.

Lateral surface stress due to a surface tension gradient can act to oppose hydrodynamic stress and thus resist the lateral flow of liquid out of the thin film (Marangoni effect). An order of magnitude calculation shows that only a tiny surface tension difference – which could be attributed to ionic adsorption – is sufficient to produce this effect. When it occurs the thin film drainage is as slow as if no-slip boundary conditions were acting.

3. Rapid approach of air bubbles in pure water is not resisted by hydrodynamic drag.

Surface tension gradients are limited in magnitude, and so they can counteract hydrodynamic stress only up to a certain flow rate. We observe a critical approach rate of the two air/water menisci that bound the thin film, above which the Marangoni effect is inoperative and the air/water interfaces remain fully mobile. In that case there is negligible hydrodynamic resistance to approach, and the two menisci collide ballistically and coalesce immediately. The critical approach speed is  $\sim 200 \text{ } \mu\text{m/s}$  for meniscus radii of 0.5 mm.

## Cations on Silica Surface Act as “Abrasive Ions”?

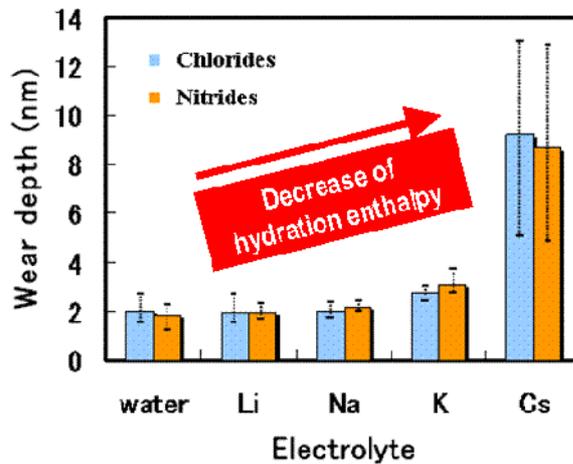
Ivan Vakarelski, Naofumi Teramoto, Cathy McNamee, Ko Higashitani

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We conducted a series of AFM measurements of the friction and wear of fully-hydrophilic silica plates by using  $\text{Si}_3\text{N}_4$  cantilever tips in various electrolyte solutions of various pH's. The following features are found.

- (1) The characteristics of friction and wear of silica surface correspond very well.
- (2) The friction force and wear depth increase with electrolyte concentration.
- (3) The friction force and wear depth increase with decreasing hydration enthalpy of cations, and especially, in the case of Cs ions, the wear depth becomes very large as shown in the figure.
- (4) The adsorption strength of cations on a silica plate plays a vital role in the wear of silica surfaces.
- (5) Counter ions do not affect the wear in the case of monovalent cations, but do in the case of divalent cations.

It is extremely curious to know that cations adsorbed on silica surface act as if cations, especially Cs ions, are “abrasive ions”, although it is hardly imagined. Hence, other mechanisms are examined and discussed.



**OC032**

## **Lubrication forces on colloidal particles**

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We have measured the hydrodynamic force between a particle ( $R \sim 10 \mu\text{m}$ ) and a smooth, flat plate using Atomic Force Microscopy for Newtonian, concentrated sucrose–water solutions for both hydrophilic solids (hydroxyl-terminated silica) and hydrophobic solids (methyl-terminated silica or graphite). For all cases, the measured force is consistent with Reynolds Lubrication theory with the no-slip boundary condition and a constant viscosity. Our error in determining the slip length varies according to the particular experiment, but is about 2 nm. We have restricted our analysis to conditions where Reynolds lubrication is valid, i.e. films that are much greater than the molecular diameter of the fluid. Our experimental method contains two significant improvements over earlier work: the use of much stiffer cantilever springs, and the use of evanescent wave scattering as an independent check of the zero of separation. Our results are consistent with molecular dynamics simulations for thinner films and greater shear rates.

OC033

## Surfactant-assisted Formation of Whisker and Rod-shaped Nanoparticles of Hydroxyapatite (HAp)

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Formation of hydroxyapatite (HAp) particles were carried out by a surfactant-assisted synthesis using AOT (sodium bis(2-ethylhexyl) sulfosuccinate) as an anionic surfactant. Amorphous particles were formed by mixing aqueous  $\text{Ca}(\text{NO}_3)_2$  and  $(\text{NH}_4)_2\text{HPO}_4$  solutions at pH 10 and 20 °C. Then the particles were dispersed in an aqueous AOT solution and heated at a given temperature for 24 hours to form the HAp particles. It was found that whisker-shaped HAp particles having 100 nm length and 10 nm width are formed at more than 30 °C and the particles turn to be rod-shaped at more than 60 °C. Another anionic surfactant SDS (Dodecyl sulfate sodium salt), a cationic surfactant DTAB (dodecyltrimethylammonium bromide), a nonionic surfactant  $\text{C}^{12}\text{E}^4$  (tetraethylene glycol monododecyl ether) were also used in the same procedure. As a result, formation of the whisker and rod-shaped HAp particles is characteristic of the anionic surfactants.

## The Effect of Crystal Habit on the Surface Speciation and Reactivity of Pyrite Fracture Surfaces

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The preparation of ores for industrial beneficiation and extraction processes such as flotation and leaching often involves grinding them to specific size fractions. The result is the production of fractured and cleaved surfaces that often have dissimilar properties than the bulk of the material. Understanding the surface chemistry of these minerals provides insight into their reactivity and reaction mechanisms, and ultimately opens a route to controlled manipulation of their surface properties for custom applications in metal extraction. Sulfide ores from different sources can behave in extremely different ways. Impurities, grain size and crystal structures have all been shown to effect minerals processing. While indepth studies of pure sulphides and ores have been carried out under various conditions including: pristine fracture[1]; direct leaching[2;3]; collectorless flotation[4] and electrochemical dissolution[5]; no systematic study of the effect of impurity phases on these processes has been carried out.

Three crystal habits of pyrite were chosen for their variation in physical characteristics for this study. High purity samples of cubic; fine pyritohedral; and a nodular disc were collected from the Adelaide and Melbourne Museum collections. Each sample was analysed using Synchrotron radiation excited X-ray photoelectron spectroscopy (SR-XPS) and conventional XPS: upon *insitu* fracture; exposure to air; and oxidised at pH 9. Additionally, parallel, abinitio, quantum mechanical simulations of bulk and fracture-surface electronic DOS and electron population of pure pyrite will be discussed. The outcomes of these studies provide links between crystal structure, electronic structure and surface speciation resulting from fracture and oxidation.

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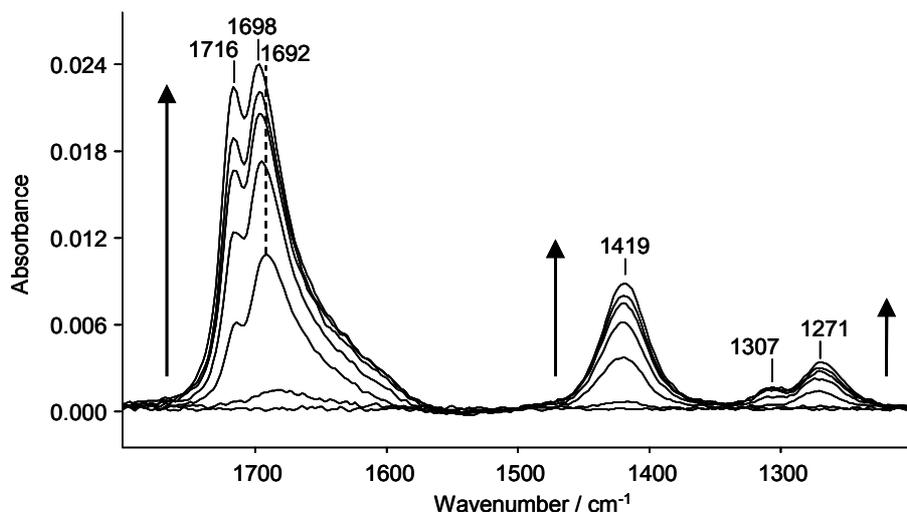
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## Adsorption/desorption kinetics from ATR-IR spectra of oxalate on anatase TiO<sub>2</sub> particle films – an alternative route to adsorption equilibrium constants?

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The measurement of adsorption isotherm data provides information about adsorption affinity which is often given in the form of equilibrium constants based on the Langmuir adsorption isotherm. While the Langmuir adsorption isotherm is the simplest adsorption model, and real situations are not expected to conform closely to this model, the resultant adsorption (affinity) constants are useful for comparing adsorption affinities of a series of adsorbates on a single substrate. For strongly adsorbing species which reach monolayer coverage at low adsorbate concentrations the rate of approach to equilibrium is slow and the measurement of equilibrium data points for adsorption isotherms takes a long time. In principle, adsorption equilibrium constants are obtainable on a shorter timescale from measurements of adsorption and desorption rate constants.



The adsorption of oxalate on TiO<sub>2</sub> was one of the first systems studied by the deposited particle film attenuated total reflection infrared (ATR-IR) spectroscopic method [1]. While the spectra contain relatively few absorption bands, there is evidence in the adsorption kinetics (above) for the presence of more than one adsorbed species having different adsorption affinity. Thus the time dependence of absorbance for individual bands may reflect the adsorption kinetics of more than one type of adsorbate. It will be shown that the desorption kinetics is more useful in distinguishing different adsorbate types through their different desorption rate constants than the adsorption kinetics and that the derivation of adsorption equilibrium constants is not facile via this approach.

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## On the Structure of Foams: Structure factor of foams and synchrotron scattering from nanofoams

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Results of the first experiments simulating scattering from 100% dry random foams (at any scale) is reported here. One major result is that the simulations yield, an effective structure factor for any dry foam. The usefulness of this is demonstrated by prediction of the average foam cell size in a monodisperse nanofoam from its scattering curve ( $I(q)$  vs  $q$ ), the cell sizes independently verified by nitrogen sorption and TEM imaging. The findings are expected to be generally useful for understanding a range of foam-structured materials at various length scales.

Statistical data pertaining to the real space structure of high-volume fraction colloids such as biliquid foams, nanoemulsions and liquid-air foams are difficult to obtain due to extremely limited experimental examples and/or probe techniques<sup>1</sup>. To date in disordered systems, knowledge of the structure of nanometer scale colloids jammed beyond their random close packed limit have been exclusively restricted to simulations when volume fractions exceed around 70-80%<sup>2</sup>. Silica nanofoams with polyhedral space filling approaching 100% can offer a viable alternative for studying the structure and formatin of high volume fraction colloids close to the dry limit, and are interesting structures in their own right.

The simulated and experimental synchrotron scattering strongly supports a recent model<sup>3</sup> for the prediction of nanofoam cell sizes from x-ray scattering data.

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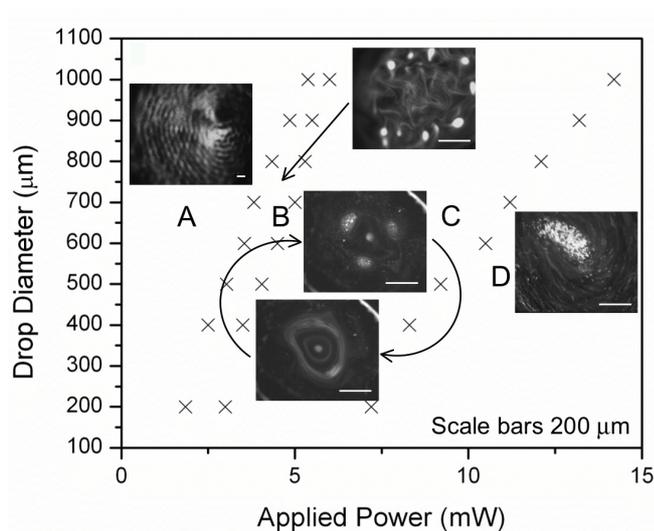
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## Vibration-Induced Microfluidic Colloidal Island Self-Assembly and Erasure

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Microfluidics offers the potential for facilitating the self-assembly of sub-micron colloidal particles for the patterning of nanostructured materials or for cell sorting [1]. Here, we demonstrate a peculiar phenomenon of rich and complex interfacial pattern formation arising from the nonlinear dynamics associated with the standing wave vibrations induced on the free surface of a drop containing a suspension of 500 nm colloidal particles by 20 MHz surface acoustic waves that propagate on the

piezoelectric substrate on which the drop is placed [2]. At low input powers, the colloidal particles assemble into linear concentric rings that resemble fingerprint-like patterns (Regime A) through a particle drift mechanism [3] that arises as a consequence of the capillary force acting on the particles in concert with the interfacial acceleration of the low amplitude 20 MHz standing wave vibrations induced at the free surface of the drop by the 20 MHz surface acoustic wave travelling beneath it. Upon increasing the input power, the colloidal particles in the linear ring-like assemblies then cluster to form point-wise colloidal islands (Regime B). The number and position of the colloidal island assemblies is seen to be dependent on the drop size. Further increases in the input power leads to the onset of significant fluid streaming within the drop (Regime C). When streaming commences, the particles disperse and the colloidal island assemblies are destroyed. After a short transient, however, the streaming ceases and the colloidal islands are observed to reform until the streaming recommences and erases them again. This cyclic phenomenon occurs aperiodically and the streaming direction (clockwise/anticlockwise) appears to be random, suggesting that this is a transient metastable state triggered by a peculiar instability arising from the highly nonlinear coupling between the acoustic, hydrodynamic and capillary forces. As the input power is increased (Regime D) the streaming becomes stronger and more consistent, leading to permanent dispersion of the particles.

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OC038

## **Surface Patterning and Structuring through Self-Assembly of Nanowires**

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Advances in microfluidics technology has the potential to revolutionize many research fields, such as molecular biology, bio-sensing, DNA analysis, and proteomics. In microfluidics minute amounts of liquids are made to flow through micro-capillaries and react in micro-vessels. Minimising interfacial drag and simplifying pattern preparation are still outstanding challenges. We have synthesised metal nanowires through a template, and have developed two potential applications. In the first we have produced interesting metal “nanocarpet”, which, once treated, have superhydrophobic properties, and could act as surface coatings to reduce fouling and interfacial drag. In the second application, the nanowires are magnetic, and, once released from the template, can be aligned on a surface to induce patterns of controlled geometry in unstable thin polymer films. Both these applications have the potential to benefit the design of microfluidic devices.

OC039

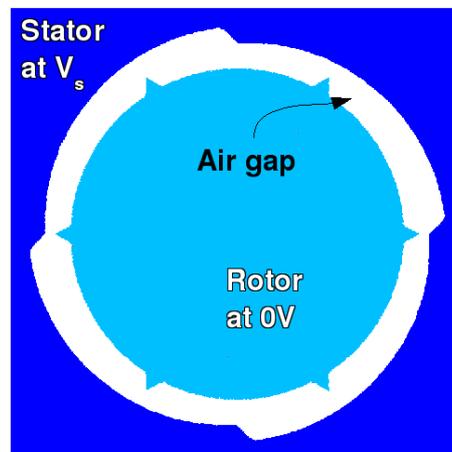
## Torque Generation via Boundary Shaping in an Electrodynamic Brownian Rotor

Jiufu Lim, John Sader, Paul Mulvaney

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A new model for the transduction of mechanical energy into a micro-mechanical rotary system is presented [1]. At small length scales on the order of microns, the otherwise dominant effect of inertia becomes negligible and objects are subject to substantial and inescapable Brownian motion due to interactions with the thermal bath of the surrounding fluid. A novel aspect of the design of the rotary motor is the employment of Brownian ratcheting, a mechanism that has been well documented and also experimentally demonstrated [2].

Unlike molecular designs that rely on charge distributions to provide energy landscapes [3], the stator-rotor system is built on the premise of torque generation via boundary shaping of their equipotential surfaces. As well as describing such a design, which enables the steady state production of an angular force, a novel outcome will be shown that deals with the protrusion pattern of the rotary motor. Stochastic simulations will be presented that also show how the rotor performs energetically against an external torque. The results demonstrate that the Brownian



ratchet rotor is feasible.

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## Nafion®-Protected Pt Monometallic and Au-Pt Bimetallic Nanoparticles for Fuel Cells

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It is well known that metal nanoparticles are controlled in size, shape, composition, structure and dispersibility by making use of polymeric protecting agents and additives in organic and aqueous solutions. These nanoparticles have attracted much attention in the fundamental research and applications<sup>1</sup>. Polymeric protecting agents, however, sometimes inhibit chemical reactions on the nanoparticle surface due to a strong interaction. So, additional procedures to remove the agents are required for the nanoparticles before application to electrocatalysis. If a functional polymer having proton conductivity, gas permeability, chemical stability and non-inhibition to the reaction can be used as the protecting agent directly, the coordination of the functional polymer to all atoms of the nanoparticle surface should improve the utility of the catalyst surface<sup>2</sup>. In this study, we have prepared Pt monometallic and Au-Pt bimetallic nanoparticles protected with Nafion® in an aqueous solution and characterize its structure and electrocatalytic activities.

The Pt monometallic and Au-Pt bimetallic nanoparticles were prepared by a NaBH<sub>4</sub> reduction method in the aqueous solution containing Nafion®. A colloidal solution was concentrated to 5 wt% of Pt to optimize the solid content for an electrochemical measurement. TEM images of Pt monometallic and Au-Pt (Au/Pt=1/4) bimetallic nanoparticles showed the primary particles of average diameter ca. 5 nm form nanowires and a nano-network. The same nanoparticles without the concentration were well dispersed and did not form the nano-network. The EDS line analysis of a single particle of Au-Pt bimetallic nanoparticles showed Pt and Au localized near the surface and centre, respectively, i.e., Nafion® protected Au-Pt bimetallic nanoparticles had a core-shell structure with a nano-network.

Electrocatalytic activity for oxygen reduction was investigated by a rotating disk electrode. Pt monometallic and Au-Pt bimetallic nanoparticles with the nano-network dried on the electrode surface was more porous than that of non-concentrated ones. The structure of the dried catalyst layer seems to reflect the nano-network of particles. Pt mass activity for oxygen reduction reaction of Au-Pt bimetallic nanoparticles showed 27% better performance than that of a commercially available Pt/Ketjen catalyst.

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OC041

## The Yielding of Concentrated Coagulated Particulate Suspensions

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The rheology of concentrated coagulated suspensions is strongly influenced by the interplay of forces between particles and with the suspending media. The rheology of these complex materials is important to the optimisation of a range of practical processes. A good understanding of inter-particle forces and the way these forces affect the overall rheology and structure of concentrated coagulated suspensions is thus critical to enhance particulate suspension processibility.

An important rheological property that is used in characterising the strength of concentrated coagulated particulate suspensions is the yield stress. However, the yield stress is a poorly defined rheological property that has led to much debate of its existence within the scientific community. Despite this, it is widely accepted that the yield stress is an engineering reality and remains as a necessary and important rheological property required in both the understanding and characterisation of complex particulate fluids in industrial processes. It is commonly accepted that yield stress suspensions behave as a rigid solid at applied stresses less than the yield stress and flow at stresses greater than the yield stress. Although a simple definition, the transition to flow of concentrated suspensions is often difficult to define, especially when movement as a result of an applied stress may be elastic in nature. Therefore, it is possible in some systems that a range of yield stresses could be reported for a material, depending on the mode of measurement.

A detailed analysis of the transition to flow of a concentrated coagulated suspension of ceramic grade alumina has been performed using a range of yield stress measurement techniques. The data provides a clear indication of the true value of the yield stress of a particulate suspension and interesting insights as to the role of inter-particle forces in controlling the rheology of these suspensions. The data also provides, in some instances, a clear indication of when a yield stress does not exist.

## Structure of Nonionic Surfactant Micelles in Organic Solvents: A SAXS Study

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The structure of mono- and diglycerol fatty acid ester ( $C_mG_1$  and  $C_mG_2$ ) nonionic surfactant micelles in different organic solvents has been investigated by the small-angle X-ray scattering (SAXS) technique. The SAXS data of reverse micelles were analyzed by a *generalized indirect Fourier transformation* (GIFT) method and supported by theoretical model calculations. The GIFT analysis of the SAXS data gives pair-distance distribution functions (PDDFs), which provide a quantitative estimation of the reverse micellar structure (shape and size). Generally, reverse micelles exhibit less variety of structures as they are often spherical in shape. Despite this anticipation, we present a variety of reverse micellar structures (spherical, cylindrical and planar like) in  $C_mG_1$  and  $C_mG_2$ /oil systems without water addition.

A symmetrical bell shaped PDDF curve observed in the 5wt%  $C_{14}G_2$ /cyclohexane system at 50°C is a signature of spherical micelles. An asymmetry in the shape of the PDDF curve is developed, when octane replaces cyclohexane, indicating a prolate ellipsoid type of micelle. Upon increasing chain length of the oil (octane, ( $C_8$ ) to tetradecane, ( $C_{14}$ )), a pronounced peak in the low- $r$  regime with an extended tail to the high- $r$  side of the PDDF curve is observed, which is a typical feature of a cylindrical micelle. The inflection point after the maximum in the PDDF curve semi-quantitatively measures the cross section diameter of the hydrophilic core. A clear picture of one dimensional micellar growth is seen with increasing surfactant concentration. Increasing temperature induces a cylinder-to-sphere type transition, which is possibly due to penetration of oil to the lipophilic chain of surfactant. The reverse micelle swells with water, which in turn results a drastic elongation in the micellar structure. The hydrophilic size of the surfactant plays a crucial role in the reverse micellar structure. The present data have shown that tuning solvent properties, surfactant concentration, temperature, water addition, and hydrophilic size of the surfactant could flexibly control the structure of nonionic surfactant reverse micelles.

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OC043

## **In Situ ATR-FTIR Studies of SO<sub>4</sub> Adsorption on Goethite in the Presence of Copper Ions**

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Despite the existence of many single ion sorption studies on iron and aluminium oxides, fewer studies have been reported that describe co-sorption reactions. In this work, we present an in situ ATR FTIR spectroscopic study of synergistic adsorption of sulfate (SO<sub>4</sub>) and copper (Cu) on goethite. This system is representative of the minerals and ions present in mine wastes, acid sulfate soils, and other industrial and agricultural settings. Sulfate adsorption was studied as a function of varying pH, and as a function of increasing concentration in the absence and presence of Cu. The presence of Cu ions in solution was seen to have a complex effect on the ability of SO<sub>4</sub> ions to be retained on the goethite surface with increasing pH, with complete desorption occurring at around pH 7 in the absence of Cu and at around pH 9 in the presence of Cu. In addition, Cu ions altered the balance of inner vs. outer sphere adsorbed SO<sub>4</sub>. The solid phase partitioning of SO<sub>4</sub> at pH 3 and pH 5 was elevated by the presence of Cu; in both cases Cu increased the affinity of SO<sub>4</sub> for the goethite surface. Complementary ex situ sorption edge studies of Cu on goethite in the absence and presence of SO<sub>4</sub> revealed that the Cu adsorption edge shifted to lower pH (6.3 → 5.6) in the presence of SO<sub>4</sub>, consistent with a decrease of the electrostatic repulsion between the goethite surface and adsorbing Cu. Based on the ATR FTIR and bulk adsorption data we surmise that the co-sorption products of SO<sub>4</sub> and Cu at the goethite-water interface were not in the nature of ternary complexes under the conditions studied here. This information is critical for the evaluation of the onset of surface precipitates of copper-hydroxy sulfates as a function of pH and solution concentration.

## A combined in-situ ATR-IR/Surface Photovoltage Spectroscopy study of TiO<sub>2</sub> thin films in an aqueous environment.

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The sampling geometry of attenuated total reflection IR spectroscopy (ATR-IR) has proved to be especially well suited to in situ monitoring of adsorption on polycrystalline films. A flow cell mounted above a polycrystalline film deposited on the surface of an ATR prism allows species to be adsorbed on to the film and the process monitored using an evanescent wave penetrating a few microns from the ATR prism surface. This leads to minimal spectral interference from solution species and has proved successful using a wide range of adsorbates<sup>[1-4]</sup>. However, the data obtained in this manner mainly relates to the adsorbate and rarely provides information regarding changes in the substrate.

Surface photovoltage spectroscopy (SPS) is a well established contactless technique that has been used to study surface, bulk and interfacial properties of a wide range of semiconductors and semiconductor devices<sup>[5]</sup>. The commonest method is the Kelvin probe technique, where the difference between the work functions (contact potential difference, CPD) of a vibrating metal reference electrode and the semiconductor are measured. These measurements are usually carried out either under an ambient gas or vacuum. There have been very few studies involving CPD measurements in a liquid/aqueous environment<sup>[6]</sup>.

We have recently reported an apparent conductor type reversal in polycrystalline films formed from small anatase particles.<sup>[7]</sup> This apparent type conversion appeared to be related to adsorbed surface water. As an extension of that work, we report here the behaviour of TiO<sub>2</sub> polycrystalline films in an aqueous environment using a combination of in situ ATR-IR and SPS measurements. The latter being achieved using a flow cell similar to that used in the ATR-IR data collection. Details of this flow cell and its potential use in monitoring films in aqueous environments will be discussed.

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## Tunable light emission using Quantum dot coated Upconverters

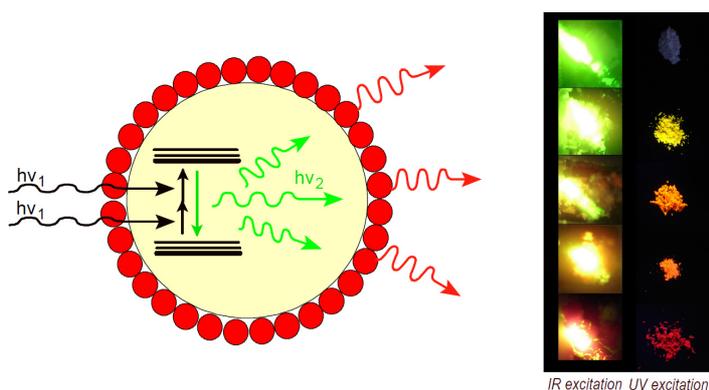
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Fluorescent upconverting crystals (UCs) typically consist of metal oxides doped with lanthanide ions. When excited in the near infrared (NIR), the ions upconvert either through a non-linear 2-photon absorption process or by sequential absorption of photons via the formation of a long lived intermediate state. Such upconverters have a variety of potential uses in solar energy conversion and optical labelling,<sup>1-3</sup> however they are currently limited by the narrow range of emission wavelengths available. One solution to this problem is to use semiconducting nanocrystals or quantum dots (QDs) to tailor the UC emission characteristics.

Quantum dots are well known for their size tunable emission properties. In principle the combination of strong up-converter absorption with tunable down-conversion from semiconducting QDs provides a method for creating tunable upconverters. We demonstrate a simple method for encapsulating NIR upconverters such that they can emit at any tunable visible wavelength with a high emission quantum efficiency. By coating conventional NIR upconverters with multilayers of QDs, the upconverted emission is absorbed by the QD coating (i.e. radiative energy transfer) which then re-emits at its design (visible) wavelength, a feature that is not available with current lanthanide based upconverters.

The resulting tunable fluorophores are extremely photostable and can be transferred into glassy or polymer matrices. This process cannot generally be exploited with molecular species such as dyes because of their smaller absorption cross-sections. Importantly, the absorption cross-section of the QDs is high enough that just a few monolayers on the UC surface are sufficient to ensure both a high yield of radiative energy transfer and emission efficiency.



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## Probing monolayer/subphase interactions and real time crystallisation using synchrotron radiation

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The structure and properties of Langmuir monolayers have been investigated experimentally and theoretically in the first instance for almost a century. For the most part the equilibrium behaviour of neutral monolayers in all their complexity is well established. Introduction of a significant charge on the monolayer, however enhances significantly the role of the subphase. This opens the possibility of achieving considerable manipulation of monolayer structure and properties, through alteration of not only the ionic strength of the subphase but most importantly chemical identity of the subphase counter and coions. Moreover when these systems are used as chemical reactors, such as crystallisation at the monolayer/subphase interface (purportedly one of the key steps in biomineralisation) dynamics begin to dominate as the system is thrown into non-equilibrium. Neither of these aspects have received the attention of their neutral equilibrium counterparts. However they are believed to be crucial in driving the face selective nucleation almost exclusively achieved by nature in the production of biominerals.

In order to probe crystallisation at the monolayer in real time, the dynamics and response of the monolayer to subphase chemistry and crystallisation, and to investigate the structure of the subphase close to the monolayer, techniques capable of rapid response and sensitive only to the upper most few molecular layers must be used. Here we present a synchrotron-based investigation of monolayer structure and dynamics based on  $\alpha$ -hydroxyteric acid (HSA). Grazing incidence X-ray diffraction (GIXD) and X-ray reflectivity (XRR) have been used in conjunction with four subphases: ultrapure water, calcium chloride, sodium bicarbonate and calcium carbonate. The subphases were chosen to represent in a stepwise manner each of the components present in the calcium carbonate crystallisation system. HSA was selected due to the known enhanced chelating characteristics of a carboxylic acid with an alpha hydroxyl group.

We have probed 1) the extent of control of electrostatics vs hydrogen bonding in defining monolayer structure, 2) the manipulation of Hofmeister effects and a coions ability to hydrogen bond, and 3) the formation of a linear counterion/coion network in the Stern layer extending out towards the double layer. Additionally for the first time nucleation and crystal growth in real time has been followed, with direct evidence for the formation of a transient amorphous phase prior to crystallisation.

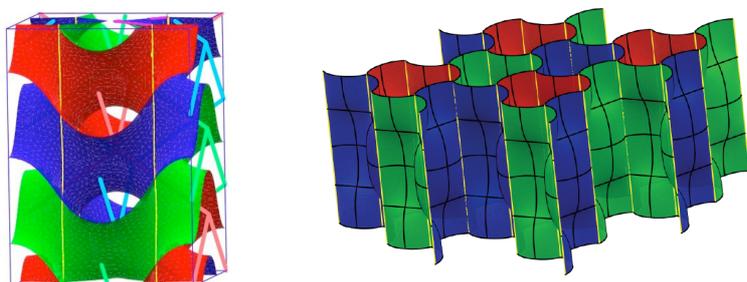
OC047

## Self-assembly of Star-Shaped Polyphiles Investigated by SAXS and SANS

Liliana de Campo<sup>1</sup>, Mino Moghaddam<sup>2</sup>, Christophe Oguey<sup>3</sup>, Jacob Kirkensgaard<sup>4</sup>, Kell Mortensen<sup>4</sup>, Trond Varslot<sup>1</sup>, Stephen Hyde<sup>1</sup>

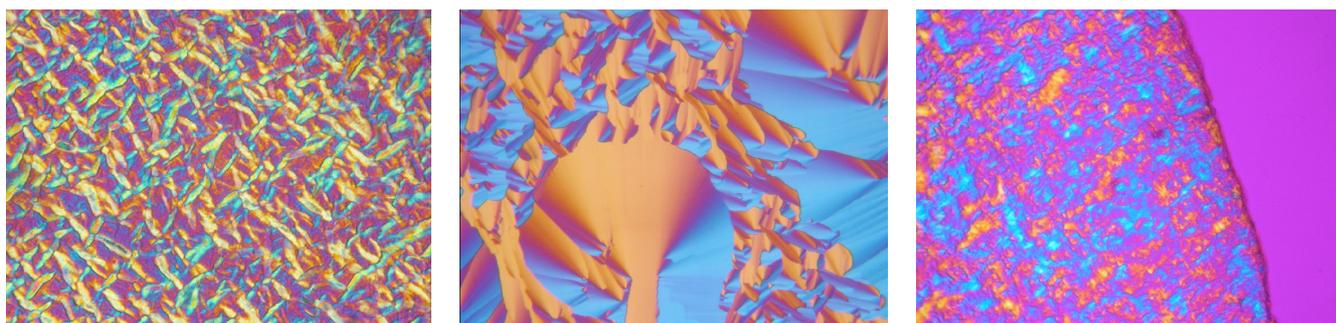
<sup>1</sup>ANU, Australia, <sup>2</sup>CSIRO, Australia, <sup>3</sup>Universite Cergy-Pontoise, France, <sup>4</sup>Copenhagen University, Denmark

Star-Polyphiles are novel star-shaped analogues of amphiphiles: while amphiphilic molecules contain two immiscible domains, usually a hydrophilic and a hydrophobic domain, polyphilic molecules bear three (or more) immiscible domains in a star shaped geometry. As a consequence, polyphiles can only self-assemble along one-dimensional lines, and not along surfaces, which opens the path to a wealth of possible novel nanostructures [1]. Two examples are shown here:



We have synthesized a range of polyphiles bearing a central aromatic core, onto which we attached a polyethyleneglycol (hydrophilic), a hydrocarbon (oleophilic), and a fluorocarbon (fluorophilic) chain of various lengths.

Here we demonstrate that these molecules self-assemble to a variety of liquid crystalline nanostructures as determined by polarizing microscopy and SAXS, dependent on temperature and the mix of (up to) three distinct solvents: water, hydrocarbon oil and fluorocarbon oil.



Polarizing Microscopy Images

A crucial concept for the understanding of self-assembly within these novel phases is the potential segregation of the three arms into three distinct domains, which we have investigated by a systematic contrast variation study using SANS.

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OC048

## **Interfacial Structure and the Dynamic Wetting of Solid Surfaces with Ionic Liquids**

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<sup>1</sup>*Ian Wark Research Institute, Adelaide, South Australia, Australia,* <sup>2</sup>*Lawrence Berkeley National Laboratory, Berkeley, California, United States,* <sup>3</sup>*Max Planck Institute for Metallforschung, Stuttgart, Germany*

Solid surfaces may be encouraged to alter wettability when stimulated by electric potential in the presence of ionic liquids. Precise chemical control of the solid surface is required to effect these changes in wetting behaviour. Dynamic wetting and dewetting can be controlled in a predictable fashion. The molecular kinetic theory provides an adequate description of the dynamic events taking place, enabling the surface friction coefficient to be obtained and for clear physical insights of the mechanisms involved. There is a strong link between solid liquid interactions and dynamic wetting/dewetting, supported by X-ray reflectivity and spectroscopic examination of the interfaces in question. The outcomes of this research are of great relevance to systems where flow through porous materials, capillaries and micro- and nanofluidic circuits is concerned.

## Capillary Driven Flows: Effects Due to Velocity Dependent Contact Angles and Chemically Patterned Walls

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Capillary driven flow, an ubiquitous natural phenomena, represents the basis for a wide variety of technological applications such as oil extraction through porous rocks or ink-jet printing [1]. The classic description of the capillary rise dynamics of liquid into homogeneous narrow tubes is given by Washburn's equation [2]. In the field of micro- and nano-fluidics, the combination of using minute quantities of fluids, extreme geometrical confinement, and accurate imprinting of topological and/or chemical patterns on the walls of the channels have led to a number of new questions on the interplay between the chemistry of the surface and/or topography and the flow properties. We address two such questions, namely, the capillary rise in the case where: (i) the contact angle is dependent on the velocity of the moving three-phase contact line [3] and (ii) the capillary tube has chemically patterned walls with alternating stripes made of two different materials.

For a number of proposed expressions for the velocity dependence of the dynamic contact angle, we analyse the resulting dependence of the contact angle and of the time of rise, respectively, on the height of the capillary rise, and discuss the theoretical predictions for the particular cases of high viscosity silicone oils and water in glass capillaries, respectively. Our results show that strong similarities arise between the various approaches and the classic theory, which explains the lack of consistent experimental evidence for deviations in the rate of capillary rise from the Washburn equation, unless there is a very strong velocity dependence of the contact angle in the low-velocity range, as in the case of the rise of water in glass capillaries [3].

As an example of capillary rise in a tube with chemically patterned walls we consider the case of a periodic pattern of alternating rings with different liquid-solid surface tension (chemistry). We evidence a significantly different dynamics, with a number of new qualitative features occurring; e.g., a stick-slip like behaviour, the existence of several (stable or unstable) solutions for the maximum rise and of imbibition/drainage hysteresis, and discuss the dependence of these features on the characteristic length scales (size and spacing) introduced by the chemical patterning. Finally, we discuss the (technologically relevant) case of droplet imbibition and encapsulation [4] in such chemically patterned channels.

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OC050

## Capillary Absorption of Metal Nanodroplets by Carbon Nanotubes

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We present a simple model that demonstrates the possibility of capillary absorption of non-wetting liquid nanoparticles by carbon nanotubes assisted by the action of the Laplace pressure due to the droplet surface tension [1]. We test this model with molecular dynamics simulation and find excellent agreement with the theory, which shows that for a given nanotube radius, there is a critical size below which a metal droplet will be absorbed. We then consider the dynamics of capillary absorption using a steady-state flow model, which is based on the Lucas-Washburn model with the addition of a driving force due to the Laplace pressure of the droplet. We find an exact solution to this evolution equation for the height of the absorbed liquid column as a function of time, and show that this reproduces the dynamics observed in the simulations well. The simulations show that the flow of the metal exhibits a large degree of slippage at the tube walls, with slip lengths of up to 10 nm depending on the wettability of the nanotube. These findings have implications for our understanding of the growth of CNTs from metal catalyst particles, and suggests new methods for fabricating composite metal-CNT materials. The results also support the use of the Lucas-Washburn approach for modelling capillary absorption at the nanoscale, and explain the recent observations of capillary absorption of non-wetting Cu nanodroplets by carbon nanotubes.

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OC051

## Capillary Models for Porous Media and Packs of Particles

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The distribution and movement of fluids in porous media are crucial in a variety of natural and industrial processes, e.g., oil recovery, water migration in soils, filtration and separation processes, etc. The pore geometry is usually complex and difficult to account for in a quantitative manner. We consider simplified models of the porous medium and their ability to describe adequately capillary pressure and capillary flow. The models are applied to experimental results obtained with packed beds of particles. Pressure and flow measurements were performed with advancing as well as receding liquids. The interpretation is given in terms of an equivalent capillary radius or a hydraulic radius. A strategy for the estimation of advancing and receding contact angles in porous media is outlined. The inclusion of a porous element on a microfluidic chip is suggested.

OC052

## Anisotropic Slip at Janus Particle Surfaces

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Fabrication of dual-hemispherical Janus particles has become increasingly common in micro- and nanofluidics laboratories. It is thought that such particles could be useful for nanoscale self-assembly processes and for various biotechnological and medical applications. Janus particles are usually spherical, minimising surface energy, and often the two faces are of opposite polarity.

Recent experimental studies of surface slip have confirmed that, for smooth surfaces, slip lengths are only non-zero if there is a hydrophobic surface interaction. It is also well known that hydrophobic textured patterns can produce large slip lengths. It is therefore likely that Janus particles with anisotropic surface slip are being (or could be) fabricated.

Navier's slip boundary condition, which is near-universally used in slip measurement work, implies that anisotropic slip would result in unbalanced viscous forces acting on the particle surface. This work will present calculated dynamics of an anisotropic sphere in laminar flow of a Newtonian fluid [1]. The secondary fluid velocity field (Fig. 1) gives rise to force and torque applied to the sphere. These dynamics indicate that Janus particles should be lubricated relative to the flow, and that their orientation can simply be controlled using flow direction.

Preliminary experimental work, ideas and limitations caused by thermal motion will be introduced. Orientation control would be a promising result for possible in vivo applications. Experiments could reveal important information about the hydrophobic interaction, and molecular-scale mechanisms of slip at a curved surface.

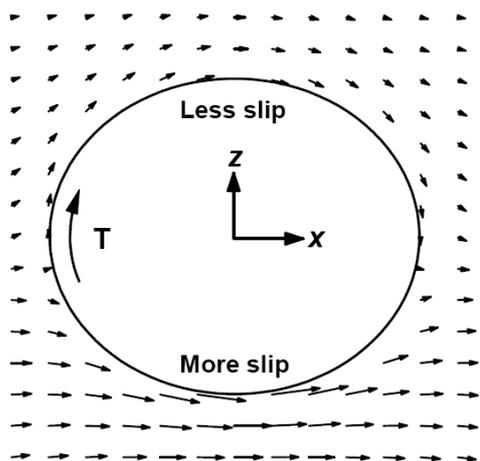


Figure: Secondary flow field in the  $y = 0$  plane for a Janus sphere in flow parallel to the x-axis, generating torque  $T$ .

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## How to design a novel proton-conducting nanomembrane

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We describe a novel design of proton-conducting nanomembranes. Polyelectrolyte membranes, in particular Nafion, have been predominantly used as electrolyte membranes of room-temperature fuel cells. Although these membranes are highly effective under the given conditions, they cannot be used due to limited thermal stability at the intermediate temperature region (200-400°C) where advantages such as higher catalytic activity, greater energy efficiency and lower device cost are expected.

We have been developing giant nanomembranes which are characterized by coexistence of sub-100-nm thickness and centimetre-size. This approach is being extended to organic as well as inorganic precursors. Amorphous metal oxides have intrinsic advantages in their application to thin film electrolyte due to their non-granular covalent networks. Recently, we discovered that silica-based, nanometer-thick films gave high proton conductivity at 100-400°C under a non-humidified atmosphere due to formation of stable Brønsted acid sites when doped with some other metal ions.<sup>1,2</sup> Especially, the aluminosilicate,  $\text{Al}_x\text{Si}_{1-x}\text{O}_n$ , nanofilm showed the highest proton conductivity at an Al content of ca. 5%, and revealed practically-usable levels of area-specific-resistance at around 300°C. It was reported that the ion conductivity of multi-layered materials increased with decreasing layer thickness.<sup>3,4</sup> In fact, the proton conductivity of amorphous  $\text{Al}_x\text{Si}_{1-x}\text{O}_n$  films was exponentially enhanced by reduction of thickness into the sub-100 nm regime.

Extension of this approach to other kinds of inorganic materials and their efficacy in a fuel cell system will be discussed.

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**OC054**

## **MRI Contrast Agents based on Dispersed Cubic Phase Particles**

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*CSIRO Molecular & Health Technologies, Australia*

The development of MRI active colloidal systems based on encapsulation of super-paramagnetic iron oxide nanoparticles within dispersed lyotropic liquid crystalline materials is described.

## Pressure-dependent structural change of a 2D colloid crystal in supercritical ethanol

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<sup>1</sup>Japan Agency for Marine-Earth Science and Technology, Yokosuka, Japan, <sup>2</sup>Kyushu University, Fukuoka, Japan, <sup>3</sup>Kitasato University, Sagamihara, Japan, <sup>4</sup>Hokkaido University, Sapporo, Japan

Supercritical fluids are fascinating media for colloid science, because their properties such as dielectric constant and refractive index depend very much on pressure and temperature.<sup>1)</sup> As forces acting between surfaces of colloidal particles depend not only on the surface properties of the particles but also on the properties of medium, it should be possible to manipulate surface forces by changing temperature and pressure in supercritical fluids.

We studied surface forces acting between silica particles ( $d = 5 \mu\text{m}$ ) in supercritical ethanol near its critical point ( $T_c = 241 \text{ }^\circ\text{C}$ ,  $P_c = 6.1 \text{ MPa}$ ) by examining the structure of a 2D colloid crystal of the particles. Experiments were done by using an inverted optical microscope equipped with a high-temperature and high-pressure chamber.<sup>2,3)</sup> The instrument allows *in situ* observation under high temperatures and high pressures up to  $450 \text{ }^\circ\text{C}$  and  $40 \text{ MPa}$  with an optical resolution of  $2 \mu\text{m}$ .

When a dispersion of the silica particles in ethanol was introduced into the chamber, the particles sedimented on the bottom optical window and formed a hexagonally close-packed 2D crystal. The structure of the crystal remained the same when the sample was heated to a supercritical state ( $T = 253 \text{ }^\circ\text{C}$ ) at a constant pressure of  $11 \text{ MPa}$ . Decreasing the pressure to  $8 \text{ MPa}$  while maintaining the temperature did not affect the structure noticeably. However, interparticle distance increased gradually as the pressure was decreased below  $8 \text{ MPa}$ . The pressure-dependent structural change became very significant at pressures below  $7 \text{ MPa}$ , and a slight decrease of the pressure resulted in a large increase of the interparticle distance. Eventually, very long range repulsion appeared between the silica surfaces at  $6.5 \text{ MPa}$ , and the interparticle distance reached  $\sim 10 \mu\text{m}$ . The effect cannot be explained by the pressure-dependent change of ethanol properties alone. Other factors such as density fluctuation may play an important role.

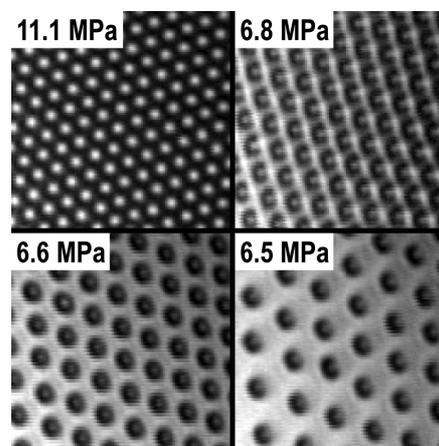


Fig. 1. Pressure-dependent structural change of 2D crystal of silica particles ( $d = 5 \mu\text{m}$ ) in supercritical ethanol ( $T = 253 \text{ }^\circ\text{C}$ )

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## The interaction between the hydrophilic side of phosphatidylcholine monolayers at an air-water interface and a silica probe

Cathy McNamee<sup>1</sup>, Michael Kappl<sup>2</sup>, Karlheinz Graf<sup>2</sup>

<sup>1</sup>Shinshu University, Ueda, Nagano, Japan, <sup>2</sup>Max Planck Institute for Polymer Research, Mainz, Germany

The interaction between a particle and the hydrophobic chains of a monolayer transferred to solid substrates has been measured using traditional Atomic Force Microscopy (AFM) methods. However, the interaction between a particle and the hydrophilic side of a monolayer at an air-water interface is still unknown. We have succeeded in measuring the force-distance curves of a silica particle approaching from below the hydrophilic side of phosphatidylcholine monolayers of various chain lengths at an air-water interface by using a combined Langmuir trough-AFM system, i.e., the Monolayer Particle Interaction Apparatus (MPIA). As a result, we were able to determine the influence of the phosphatidylcholine (PC) chain-length and the surface pressure ( $\pi$ ) of the monolayer on the adhesion force between the particle and the monolayer ( $\langle F_{ad} \rangle$ ), and the stiffness of the monolayer.

For a given PC chain length, we observed an initial increase of the interfacial stiffness of the air-water interface with increasing  $\pi$  followed by a decrease for higher  $\pi$ . The initial increase with  $\pi$  can be explained by the fact that the area between neighbouring phospholipid molecules decreases, resulting in an increase in the magnitude of the van der Waals (*vdW*) force per unit area and therefore an increase in stiffness of the monolayer. However, the surface tension of the air-water interface simultaneously decreases with increasing  $\pi$ . Thus, the decrease at high values of  $\pi$  is indicative of the decreased interfacial tension of the air-water interface. An increase in  $\pi$  resulted in a decreased  $\langle F_{ad} \rangle$ . This is caused by a decreased wetting of the particle by the monolayer and contradicts earlier findings.<sup>1</sup> This difference is caused by the fact that we probe the dynamic properties of the monolayer here, which are determined by the monolayer stiffness rather than the molecular interaction between headgroup layer and silica particle. A phospholipid chain-length increase therefore caused  $\langle F_{ad} \rangle$  to decrease and the monolayer stiffness to increase. A chain-length increase is thought to cause the attractive *vdW* interaction between neighbouring molecules to increase, due to the increase in molar cohesive energy of a non-spherical alkane with an increase in the number of CH<sub>2</sub> groups.<sup>2</sup>

In conclusion, we show that the interaction between a silica particle and the hydrophilic headgroup layer of a phospholipid monolayer at the air-water interface is mainly determined by the monolayer stiffness. This property is increased either by an increasing surface pressure or by increasing the length of the alkyl chains in the hydrophobic layer of the lipids.

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OC057

## **Supramolecular nanoparticles self-assembled from nucleotides and lanthanide ions in water and their adaptive encapsulation characteristics.**

Ryuhei Nishiyabu, Nobuo Kimizuka

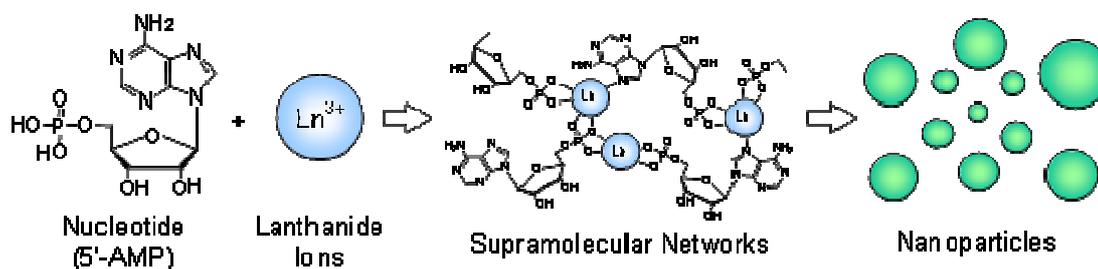
*Kyushu University, Fukuoka, Japan*

The bottom-up synthesis of nanoscale materials by using self-assembly holds promises to create nano-architectures whose structures and properties are controlled at a molecular level.<sup>1-3</sup> Studies on self-assembly of biological molecules have been attracting much interest, due to their specific intermolecular interactions and possible applications in bio-nanotechnology. To date, focuses of research in this area have been oligomeric to polymeric biopolymers such as proteins, oligopeptides and nucleic acids. In contrast, smaller biomolecules such as mononucleotides have not been considered as building blocks for creating functional supramolecular systems, except for G-quartets formed by 5'-GMP and alkali metal ions. Meanwhile we have recently reported that self-assembly of mononucleotide 5'-ATP, amino acids and cationic cyanine dyes spontaneously give supramolecular nanofibers with excitonic chromophore interactions.<sup>4-5</sup> They showed that small biomolecules without self-assembling characteristics could serve as molecular building blocks, when they interacted with suitable counterparts.

Here we report adaptive supramolecular nanoparticles (NPs) self-assembled in water from nucleotides and lanthanide ions.<sup>6,7</sup> Nucleotides are selected as components since they show rich structural diversity with multiple functional groups – nucleobases and phosphate groups – which serve as bidentate ligands. Lanthanide ions are selected as partners because they exhibit large coordination numbers and high coordination flexibility, which properties are suitable for making networks that flexibly adapt the size and shape of guest materials. Nucleotide/lanthanide nanoparticles were spontaneously obtained by mixing aqueous GdCl<sub>3</sub> with nucleotides in an aqueous environment (see figure). These nucleotide/lanthanide nanoparticles displayed unique properties such as sensitized lanthanide luminescence and excellent performance as MRI contrast agents, depending on the combination of nucleotides and lanthanide ions. Importantly, they show *adaptive* inclusion properties for guest materials which range from molecules to nanomaterials, in their self-assembly process. As applications, immobilization of enzymes and cellular uptake will be introduced.

**Figure 1.** A schematic illustration of nanoparticle formation through the self-assembly of 5'-AMP and  $Gd^{3+}$  ions.

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OC058

## **QUOKKA is Hopping Mad – Latest Results from the Small Angle Neutron Scattering Instrument at ANSTO**

Elliot Gilbert, William Hamilton

*ANSTO, NSW, Australia*

Quokka is the state-of-the-art small-angle neutron scattering instrument at the 20 MW OPAL research reactor at ANSTO. We will present the results from the first months of operation and highlight some of the current and future capabilities of the instrument of relevance to the colloid community.

Elliot P. Gilbert, Jamie C. Schulz, Terry J. Noakes, *Physica B* 385-386 (2006) 1180-1182

OC059

## Structure of Magnetically Aligned Ferrofluid Emulsions from Small Angle Neutron Scattering

Connie Liu<sup>1</sup>, Gregory Warr<sup>1</sup>, Nirmesh Jain<sup>1</sup>, William Hamilton<sup>2</sup>, Brian Hawkett<sup>1</sup>

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The structure of monodisperse aqueous ferrofluid-in-oil emulsions has been examined in a magnetic field by small-angle neutron scattering (SANS). The field induces a magnetic dipole in each droplet, which in turn causes chaining of the droplets into regular spacing determined by the colloidal forces between the droplets. The chain periodicity is typically in the visible wavelength range, giving rise to optical Bragg diffraction and the development of strong colours. The variation of this colour with field strength can be used to measure the force versus separation between droplets.

SANS presents a number of distinct advantages over optical approaches. By analysing the full anisotropic scattering pattern, droplet size is directly measured *in situ* in the presence and absence of the field, allowing changes to be monitored. Coalescence and deformation of the droplets by the field can be measured directly, as well as their centre-to-centre separation, giving accurate measurement of surface separations. SANS is sensitive to the population of both chained and unchained particles, and can reveal the presence of structures other than linear chains in the system. Finally, isotopic substitution can be used to study the effect of multiple additives on the nanostructure of ferrofluid emulsions.

Here we present SANS studies of a model highly-stable aqueous ferrofluid-in-oil emulsion, including a model for the interpretation of the scattering pattern from aligned but thermally disordered chains. The development of chaining and the coexistence of free and chained particles, as well as the force-separation curve is measured and, where possible, compared with optical measurements.

OC060

## Nitrogen Bubble Nucleation and Transport at Oil-Water Interfaces

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*Key Centre for Polymers and Colloids, School of Chemistry F11, The University of Sydney, NSW 2006, Australia*

Emulsions explosives are made by finely dispersing a supersaturated ammonium nitrate solution in a fuel oil. Small  $N_2$  bubbles are made in them to act as hot centers to initiate the detonation reactions, by mixing a small amount of a sodium nitrite to react with the  $NH_4^+$  and produce  $N_2$ . The locus of bubble nucleation and their fate in the emulsion are not well understood.

We have investigated a model interface, made by contacting a solution of  $NH_4Cl$  with an oil in a flat capillary tube. A small amount of  $NaNO_2$  was introduced to the aqueous solution to form  $N_2$  bubbles, and the formation of bubbles at the interface was examined using optical microscopy at a range of  $NH_4Cl$  concentrations (4-20% w/v).

Solution to the reaction-diffusion equation predicted a depletion zone of dissolved  $N_2$  in the aqueous phase next to the interface and a sharp rise in the  $N_2$  concentration at the interface in the oil side. This agreed well with our microscopic observations of a bubble depleted zone next to the interface in the aqueous phase, the formation of small bubbles close to the interface in the oil phase, and the formation of larger bubbles in the aqueous phase farther from the interface. Solution to the equation further revealed that  $N_2$  transport to the oil side can be decreased by bubbles near the interface in the aqueous phase, as these are strong  $N_2$  sinks.

Bubbles in the aqueous phase that came into contact with the interface were engulfed and moved into the oil phase. However when the interface was stabilized by the certain emulsifiers, the bubbles that came close to the interface shot into the oil phase at high speed. This appears to be due to the Marangoni force created on the bubbles by the surfactant concentration gradient at the interface. The effects of emulsifier type and concentration, bubble size, location and growth rate have been investigated.

## Microfluidic Solvent Extraction for Mineral Processing

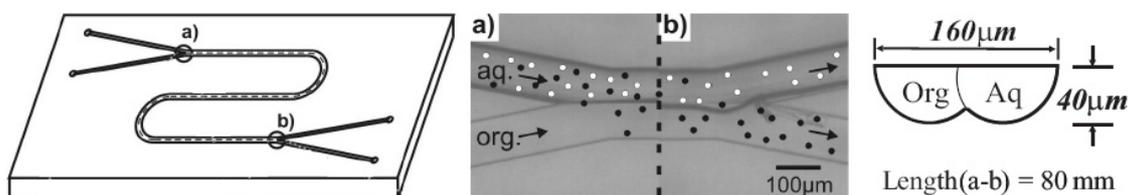
Jingfang Zhou<sup>1</sup>, Craig Priest<sup>1</sup>, John Ralston<sup>1</sup>, Rossen Sedev<sup>1</sup>, Kazuma Mawatari<sup>2</sup>, Takehiko Kitamori<sup>2,3</sup>

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The confinement of liquids in microchannels enhances the role of interfacial tension, flow fields, heat capacity, and diffusion, which can be collectively exploited to enable precise control over processing conditions. For this level of process control and the ability to efficiently handle nanolitre volumes, microfluidic processing is generally applied to low volume, high value samples. However, microfluidics is increasingly being applied to higher throughput applications[1] in which high efficiencies lead to significant commercial benefit. In this work, we have explored microfluidic solvent extraction in the context of mineral processing.

The aqueous phase (leach solution) containing various metal ions was extracted using an organic phase containing an extractant in a tailored microchannel. The two phases merge at a y-junction before travelling together for a channel length of 80 mm before diverging at a second y-junction downstream. The concurrent liquid streams were 80  $\mu\text{m}$  wide and 40  $\mu\text{m}$  deep and partially stabilized by a “guide structure”[2] at the liquid-liquid interface. The contact (extraction) time is determined by the length of the microchannel and the flow rate of the liquids.

The microfluidic approach differs remarkably from conventional extractions, where the two phases are mutually dispersed as droplets in a large-scale mixer-settler and then separated *via* coalescence. No droplets are formed using the microfluidic technique and phase separation is instantaneous at the second y-junction. The elimination of dispersions is used here to achieve highly efficient extraction of “difficult” leach solutions under continuous flow conditions. These difficult leach solutions include nanoparticle dispersions and surfactant solutions, which are known to arrest phase separation in conventional extractions using mixer-settlers. The two methods are directly compared in terms of extraction efficiency, rate of transfer, and rate of phase separation.



**Fig. 1.** Left: Schematic of microchip. Middle: Images showing the y-junctions where the liquids (a) merge and (b) diverge (phase separate). Right: Cross-section of microchannels in the contact region.

1. Microreaction technologies: microtechnologies for chemical process intensification, **2007**, Yole Développement, Lyon, France.

2. Tokeshi, M., *et al.*, *Anal. Chem.*, **2002**, 74, 1565-1571.

OC062

## Spontaneous Formation of Super Water-Repellent Fractal Structures on Wax Surfaces

Kaoru Tsujii

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Fractal structures are formed spontaneously on some wax surfaces such as alkylketene dimer and triglycerides when solidified from their melts, and the surfaces show a super water-repellent property.<sup>1-4)</sup> It is quite an interesting question why the fractal structures are formed spontaneously during the solidification of the waxes. The surface structures, wettability and phase behaviors of various waxes have been investigated in order to understand the mechanism for spontaneous formation of super water-repellent fractal surfaces. We have found an empirical general rule without any exceptions at least for the wax samples tested.<sup>5)</sup> First, the wax must form a meta-stable crystalline phase when solidified from its melt. Then, the super water-repellent fractal surfaces form spontaneously during the phase transition from a meta-stable to a stable crystalline form.<sup>3-5)</sup> The tempering method also supported the above rule for the waxes showing the fractal structure formation on their surfaces.<sup>5)</sup>

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## Microwires Network Assembly by Capillary Bridging Lithography

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Remarkable patterns of interconnected self-assembled gold microwire structures on a substrate have been produced by controlled evaporation of a gold nanoparticle suspension deposited through a two dimensional crystal of latex particles on the surface. The novel assembly process exploits the slow evaporation of regular capillary liquid bridges that form in the interstices between the latex particles and the substrate during evaporation, Figs (a) – (c). These liquid bridges were found to have an anomalous thinning stability which together with a slowing in the evaporation rate enabled the receding meniscus to squeeze the nanoparticles into compact microwire structures rather than forming the well-known “coffee ring” patterns characteristic for freely evaporating droplets. This is an inexpensive and easy to use method for making functional microwires networks of up to centimetre dimensions.

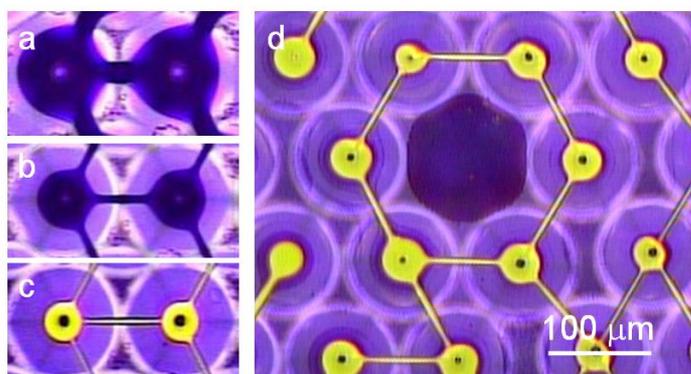


Figure 1. (a), (b), (c) Snapshots of a capillary liquid bridge drying consolidation (d) Capillary Bridging Lithography painting: “Gold on glass under latex”. Images were taken using inverted optical microscopy (through the glass substrate).

## Cooperative Clathrate Formations of Metal Organic Frameworks by Expansive Modulation

Hirofumi Kanoh

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[Cu(bpy)<sub>2</sub>(BF<sub>4</sub>)<sub>2</sub>]<sub>n</sub> (bpy = 4,4'-bipyridine) is one of metal organic frameworks having a 2-dimensional coordination space, has latent pores, and therefore is called a "latent porous complex (LPC)." LPC shows a unique sorption behaviour, a "gate phenomenon", in adsorption of CO<sub>2</sub> and other gas molecules. The sorption reaction is well described by a clathrate formation of LPC and CO<sub>2</sub> molecules. The mechanism of the gate phenomenon is based on the expansion/shrinkage behaviour of the stacking structure of a 2-dimensional grid of LPC. The sorption isotherms of CO<sub>2</sub> on LPC obtained at different temperatures can be analyzed thermodynamically based on a mechanism of a cooperative sorption on LPC.

We can control the 2-dimensional coordination space by changing metal ions, counter anions, and ligand molecules. For example, [Cu(bpy)<sub>2</sub>(OTf)<sub>2</sub>]<sub>n</sub> (OTf = CF<sub>3</sub>SO<sub>3</sub><sup>-</sup>) has a wider interlayer distance than that of [Cu(bpy)<sub>2</sub>(BF<sub>4</sub>)<sub>2</sub>]<sub>n</sub> because OTf anions are more bulky than BF<sub>4</sub><sup>-</sup>, resulting in the micropore filling at very low relative pressure, whereas [Cu(bpy)<sub>2</sub>(BF<sub>4</sub>)<sub>2</sub>]<sub>n</sub> shows no sorption uptake at such a low pressure. Moreover, [Cu(bpy)<sub>2</sub>(OTf)<sub>2</sub>]<sub>n</sub> indicates a gate phenomenon accompanied by a expansion of the interlayer distance, after the completeness of the micropore filling; the second-step sorption. Gas adsorption behaviours of other MOFs with different metals such as [Co(bpy)<sub>2</sub>(OTf)<sub>2</sub>]<sub>n</sub> will also be presented.

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OC065

## **Polymerised Vesicles versus Lamellar Fragments from Amphiphilic Diblock Oligomers**

Annabelle Blom, Jennifer O'Donnell, Gregory Warr, Brian Hawket

*Key Centre for Polymers and Colloids, School of Chemistry F11, The University of Sydney, NSW 2006, Australia*

The development of reversible addition-fragmentation chain-transfer (RAFT) has enabled the preparation of oligomers and polymers with well-defined monomer sequences and architectures by free-radical polymerisation. It is now possible to easily prepare amphiphilic block copolymers with polydispersities equal to or better than (and as amenable to chromatographic purification as) industrial polyoxyethylene-n-alkyl ethers, but with a much broader range of available hydrophobic and hydrophilic monomers. We have prepared and examined the self-assembly behaviour of block co-oligomers comprising styrene and butyl acrylate as hydrophobes, and acrylic acid (sodium acrylate) and hydroxyethylacrylate hydrophilic groups into micelles and lyotropic liquid crystals. Their patterns of self-assembly and resultant structures will be described as a function concentration, monomer type, hydrophobic and hydrophilic chain length, and for acrylic acid, degree of ionisation.

These amphiphilic molecules are macro-RAFT agents, and can be reinitiated to polymerise further, yielding a new route to polymerisation of self-assembled structures. The molecular design parameters of this approach will be illustrated by describing the successful and unsuccessful formation of hollow particles – polymersomes – by carrying out polymerisations of lamellar phases and two-phase vesicle dispersions.

## Highly Ordered Mixed Protein Patterns from Assembly of Binary Colloidal Dispersions Coated with Different Proteins

Gurvinder Singh, Saju Pillai, Ayyoob Arpanaei, Peter Kingshott

*Aarhus University, Aarhus, Denmark*

Controlling the precise locality and activity of biomolecules on surfaces, particularly more than one type, remains a big challenge in the field of colloids and interface science. The development of simple methods for generating protein patterns with controllable spacing in the nanometer to micrometer range over relatively large areas has the potential to address these issues. Information which can provide new insights into how proteins regulate cell shape and function have great interest in many areas including medical implants, tissue engineering, sustained drug delivery devices, biofilms, and biosensors. Several techniques, e.g. photolithography<sup>1</sup>, soft lithography<sup>2</sup>, colloidal lithography<sup>3</sup> and dip-pen nanolithography<sup>4</sup> have been reported recently for creating biomolecule patterns, but most of them are restricted to single protein patterning. We present here a new but simple method for generating highly ordered protein patterns that can be applied over large areas (cm<sup>2</sup>) based on the self-assembly, from very low volume fractions, of mixed, protein coated colloid particles of different size. Initially the particles are separately coated with a different type of protein before being mixed at varying concentrations at low total volume fraction. Experiments are performed with human lysozyme, a model enzyme that adsorbed strongly to negatively charged surfaces, human serum albumin or bovine serum albumin (BSA), and a human anti-lysozyme antibody. A range of different particles are utilised in the study. One example is the use of FITC-labelled human anti-lysozyme, which is adsorbed to 2µm carboxylated polystyrene particles, and rhodamine-labelled BSA, which is adsorbed to 200nm aminated polystyrene particles both in PBS at pH=7.4. In separate experiments either both types of protein-coated particles are mixed in solution, or one protein coated particle is mixed with an uncoated particle. The particle suspensions are drop-cast onto the centre of a rubber ring (1 or 2 cm in diameter) placed on a hydrophilic Si wafer substrate. A concave shaped layer of solvent is formed allowing for long range assembly of binary colloidal particles firstly through lateral capillary forces, and later by convective flow and entropic forces. The resultant patterns consist of highly ordered hexagonal arrays of large particles as a single layer encapsulated by crystals of the smaller particles, in which single or binary proteins patterns are generated. The coverage is simply controlled by calculating the area of particles needed to fill the rubber ring, and the spacing is controlled by the appropriate ratio of starting particles. The ordered protein patterns are shown using fluorescent microscopy combined with AFM and SEM analysis. The extent of protein adsorption to the particles is determined using XPS and zeta potential measurements.

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OC067

## **Cubic Phase Nanoparticles: Preparation and Structural Investigations.**

Durga Acharya, Dori Pegalajar Jurado, Ben Muir, Anastasios Polyzos, Patrick Hartley

*CSIRO Molecular and Health Technologies, Clayton, VIC 3168, Australia*

Polar lipids such as glycerol monooleate and phytantriol are known to form various lyotropic phases, when mixed with water. At sufficiently high concentration of water, a bicontinuous cubic phase with reversed curvature is formed at room temperature and reversed hexagonal phase is formed at higher temperature. Due to its structure consisting of interwoven hydrophilic and hydrophobic channels separated by a surfactant layer, a cubic phase is suitable as delivery vehicles for compounds / materials of different solubilization behavior and provide complex diffusion pathways for controlled release of entrapped molecules. A hexagonal phase with a relatively simple structure can also be used in these applications. A relatively unique feature of the cubic and hexagonal mesophases is their ability to exist in presence of excess water. However, for their applications as delivery vehicles, stable dispersions of nanoparticulate mesophase called cubosomes and hexosomes, respectively, are prepared by emulsifying the mesophases in water in presence of a suitable stabilizer such as pluronic block copolymer. Although several methods have been developed for the preparation of dispersions, there is still no clear understanding of the factors that govern the formation, size and structure of the mesophase nanoparticles.

In this presentation, the effect of various parameters such as the concentration of stabilizers, presence of additives, processing conditions on the size and structure of the nanoparticulate mesophase will be discussed.

## Control of Drug Release In Vitro and In Vivo using Self Assembled Liquid Crystalline Mesophase Materials

Wye-Khay Fong<sup>1</sup>, Kathy Lee<sup>1</sup>, Tracey Hanley<sup>2</sup>, Ben Boyd<sup>1</sup>

<sup>1</sup>Monash Institute of Pharmaceutical Sciences, Parkville, Australia, <sup>2</sup>Bragg Institute, ANSTO, Menai, Australia

The interest in self assembled mesophase materials as drug delivery systems has been growing in recent years, in part due to increased ability to characterise these materials using techniques such as small angle x-ray scattering (SAXS), and hence to control their properties from a structural and drug delivery perspective. We have been investigating self assembled mesophase materials that can exist in excess aqueous environments as potential controlled release delivery systems.

We have recently shown that the mesophase structure can be tuned to control drug release rates both in vitro and in vivo on oral administration<sup>1</sup>. Mesophase materials that differ subtly in composition were designed to exhibit either the reverse hexagonal (H2) or reverse bicontinuous cubic phase (Q2) structure by addition of vitamin E acetate to phytantriol. Release from the H2 phase was significantly slower than that from the Q2 phase using radiolabelled glucose a model hydrophilic compound, and this behaviour was preserved on oral administration.

More recently, by fine tuning the composition of the mesophase, we have designed systems that exhibit a transition from the H2 phase structure to the Q2 phase structure at close to physiological temperature. Phase structures and their response to temperature were characterised using SAXS. In vitro release studies using these materials have shown that release rates can be controlled externally through manipulation of the nanostructure, and that it is possible to reversibly switch drug release 'on' and 'off' through the use of external stimuli such as temperature.

One potential application of these systems is as 'on demand' subcutaneous injections for frequently injected short acting compounds. A proof of principle study involving the subcutaneous injection of materials and formation of H2 phase for slow release ('off'), followed by application of a cool pack to stimulate formation of Q2 phase with increased drug release ('on'), was conducted in rats. The rate of drug absorption increased after application of the cool pack four hrs after injection, providing the first indication that these materials may have application as stimuli responsive delivery systems.

<sup>1</sup> K. W-Y. Lee, T. Hanley, B.J. Boyd "Nanostructure of liquid crystalline matrix determines in vitro sustained release and in vivo oral absorption kinetics for hydrophilic model drugs" Accepted for publication in Int. J. Pharm. 19th August, 2008

OC069

## Surface Plasmon Spectroscopy of Single Gold Nanocrystals

Paul Mulvaney

*University of Melbourne, Parkville, Australia*

In this talk I will provide an overview of our recent research into the spectroscopy and surface chemistry of single metal nanocrystals. In the first part, I focus on the possibility to study the optical properties of single metal particles using dark-field microscopy (Figures A and B). It is now possible to routinely collect the scattered light from single metal nanocrystals and use this to study the effects of particle size and shape on the surface plasmon (SP) resonances. I show that the line width and energy of the SP resonance is acutely sensitive to the particle end-cap geometry, to the aspect ratio and to atomic roughness on the particle surface.

In the second part I will discuss the possibility to study catalysis on single nanocrystals and the ability to actively modulate the surface plasmon bands of single gold nanocrystals by electrochemical charging of the particles. This enables the reversible tuning of the band by some 15nm. In principle it should be feasible to optically detect just a single electron.

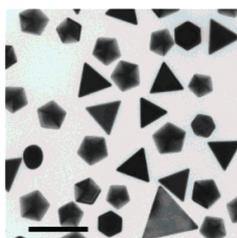


Figure A) Electron microscope image of gold triangular prisms, decahedra and spheres. Using dark field microscopy we can study chemical reactions on each individual nanocrystal. Scale bar = 100nm.

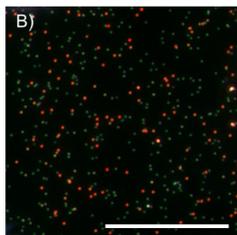


Figure B) Dark field microscope image of individual gold nanorods (red dots) and gold spheres (green dots). Scale bar = 50 microns. The size of the specks of light is determined by the pixel size.

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## Superparamagnetic Nanoparticles in the Hyperthermia Treatment of Cancer and Other Medical Applications

Nirmesh Jain<sup>1</sup>, Brian Hawke<sup>1</sup>, Yanjun Wang<sup>1</sup>, Binh Pham<sup>1</sup>, Michael Luke<sup>1</sup>, Gregory Warr<sup>1</sup>, Stephen Jones<sup>2</sup>

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The potential of superparamagnetic nanoparticles for medical applications such as the hyperthermia treatment of cancer has long been recognized<sup>1,2</sup>, but has not been fully realized because of the difficulty achieving unaggregated dispersions of very high specific surface area particles at adequate concentrations within polymer matrix particles. In this work we have designed stabilizing polymers based on Reversible Addition Fragmentation chain Transfer (RAFT) controlled radical polymerization processes to largely overcome these problems.

The anatomy of a liver cancer tumour is such that ~32 micron particles injected into the hepatic artery will become lodged in the blood vessels of the tumour. Sirtex Medical Limited has successfully exploited this behaviour in their radioactive SIR-Spheres® microspheres product, which enables the highest intensity of the radioactive dose to be confined to the tumour itself. If a sufficient concentration of superparamagnetic nanoparticles can be incorporated into polymer microparticles of appropriate size they can similarly be made to accumulate within the tumour. The patient can then be put into a suitable oscillating magnetic field so that the particles generate heat and kill the tumour with little collateral damage. Composite 32 micron particles containing approximately 10<sup>9</sup> individually stabilized magnetic nanoparticles have been prepared, for use in this therapeutic hyperthermia application.

Superparamagnetic nanoparticles also have potential as imaging agents for MRI<sup>3</sup>, largely unrealized because of difficulties in adequately stabilizing sufficiently small particles without appreciably adding to their size due to the stabilizing coating. In separate work 5 nm superparamagnetic particles have been individually stabilized with hydrophilic block copolymers that are stable to dilution in phosphate buffered saline and to dialysis. NMR studies have shown that they have potential as negative contrast agents with a relaxivity ratio of about 186. In vitro experiments have demonstrated that the attachment of targeting ligands can lead to the uptake of stabilized magnetic nanoparticles by ovarian cancer cells.

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OC071

## **Non-aqueous Liquid Toners: Observation of Particle Charge via Electrophoretic Movement**

Drew Evans

*Research Laboratories of Australia, Adelaide, SA, Australia*

The use of electrophotographic techniques to print liquid toners provides an exciting direction for the printing industry, creating the potential for digital printing with quality comparable to offset prints and at speeds approaching that of offset presses. It is well known that the electrical properties of conventional liquid toners significantly influence the quality of printed images; where the electrical properties of the toner are primarily the electrophoretic response of the particles to an applied electric field. The liquid toners used in this study are based upon the High Viscosity Toner (HVT) technology which, in essence, is colloidal pigmented resinous particles dispersed in non-aqueous carriers at volume fractions ranging from 0.2 to 0.4.

Offline methods for observing the electrical performance of the liquid toner are essential, as they minimize material usage and reduce analysis time. More specifically the Optical High Field Toner Cell (OHFTC), a custom built instrument, represents such a novel method for observing the electrical properties of liquid toners using the measuring conditions closely replicating those in the actual printing machines. In principle the OHFTC measures simultaneously the electrical current and optical transmission of light through and reflection from a thin volume of liquid toner under the influence of an external electric field (typically  $> 1\text{MV/m}$ ). The results can be used to calculate the charge to mass ratio of the toner (which is a common parameter to quantify charge in liquid toners), as well as qualitatively describing the deposition of the particles onto the OHFTC electrodes by the changing intensity of transmitted and reflected light.

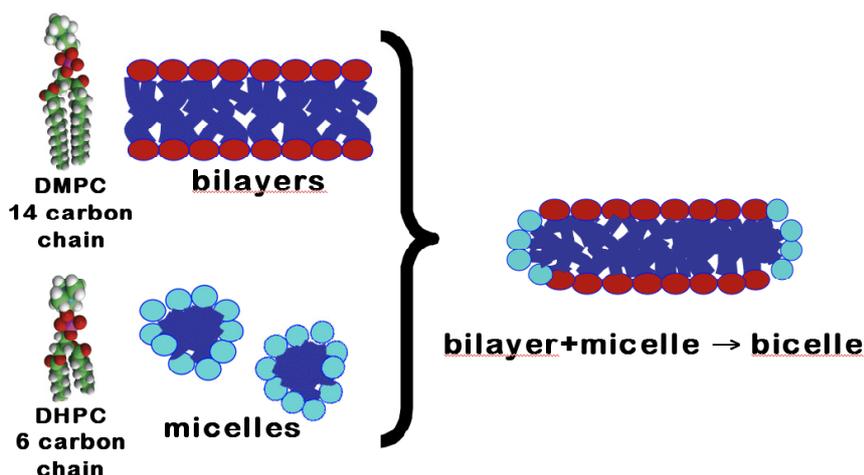
Within this study, the OHFTC was used to analyse the response of the HVT toner particles with respect to their electrophoretic movement and their charge to mass ratio. The findings and the underlining theories will be supported by visualisation trials performed using a custom built transparent cell allowing the dynamic motion of toner particles to be observed.

## Small Angle Scattering Study of Self Assembly in Mixed Lipid Systems

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A recent study performed on the NG3 and NG7 SANS instruments at the National Institute of Standards and Technology Center for Neutron Research illustrates the power of SANS in the area of biomolecular engineering. The so-called “bicelle” systems comprise a mixture of long and short chain lipids and have received considerable attention in the last few years due to their unique combination of biocompatibility and of strong orientational properties in magnetic fields. For a decade they have been used routinely as alignment media for nuclear magnetic resonance (NMR) protein structure determinations. There is now general agreement that these properties arise from self-assembly of the mixture into the discoidal morphology which gives rise to the name (See Figure). More recently bicelle phases have shown promise in membrane protein crystallization and drug delivery applications. However, many details of their phase behaviour and self-assembly remained poorly understood. Using isotopic SANS contrast techniques we have determined details of the segregated packing of lipids that results in this morphology and have begun to develop a quantitative model going beyond simple molecular packing arguments and taking in to account the thermodynamic nature of these systems [1,2].



Schematic of “bicelle” formation in the DMPC/DHPC system.

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The biennial Australian Colloid and Interface Symposium and the  
10th Australia-Japan Colloid and Interface Science Symposium

OC073

## Structure of Emulsions Stabilised by Mixtures of Particles of Different Wettability

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Small particles present in food emulsions and foams, oil recovery processes and pharmaceutical formulations affect the stability and structure of these colloidal systems. [1-4] Investigations of emulsions stabilised by a single kind of particle revealed that the emulsion stability and structure are determined by the particle surface properties. Commercial formulations rarely contain, however, a single type of particle.

We have studied the stability and structure of oil-in-water emulsions formed in the presence of colloidal mixtures of partially hydrophobised titania particles and hydrophilic silica particles. The partially hydrophobised titania particles stabilise oil-in-water emulsions. In the absence of silica, the average drop size in the emulsions increased as the titania concentration was reduced, however the emulsions remained stable to coalescence except at very low titania concentrations. In contrast, emulsions underwent rapid phase separation in the presence of hydrophilic silica particles alone. Mixing silica and titania particles enhanced the extent of coalescence in the emulsions dramatically. We investigated the role of the silica particles in emulsion formation by varying the proportion and size of the silica particles in the mixtures as well as the method by which the particle mixtures were prepared.



The figure shows photos of dodecane-in-water emulsions prepared in the presence of 1 wt% mixtures of hydrophobic titania and hydrophilic silica where the silica particle concentration was (from left to right) 0.1, 0.7 and 0.9 wt%.

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## Hierarchical Macroporous Structures Formed by a Facile Colloidal Templating Strategy

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Hierarchically ordered porous materials have drawn intense attention owing to the drastically enlarged surface area, the defined multiscale porous structure, and the new route of introducing additional functionality. This class of materials present significant potential in the fields of molecular separation, catalysis, micro-reactors, tissue engineering, photonic bandgap (PBG) materials, and phononic bandgap (PhBG) materials.<sup>1</sup> Binary colloidal crystal, a binary crystal structure formed by two sizes of colloidal particles, has proven to be an excellent template for fabricating hierarchically ordered porous materials. Strategies such as a.) vertical lifting co-deposition<sup>2</sup> and b.) infrared-assisted co-assembly<sup>3</sup> have been reported to fabricate binary colloidal crystals. With method a, limits exist in the long preparation time (days to weeks) and the particle size (< 600 nm); while method b has addressed the drawbacks in method a, it is more equipment intensive. Here we report a facile method in creating large area (cm scale) binary colloidal crystals via horizontal deposition within a couple of hours. Their inverse replicas have been fabricated to expose the internal structures. The significant advantages of such a fabrication method lie in its simplicity, which requires no elaborated equipment, the fast production rate (about 2 hours over an area of 2.2x2.2 cm<sup>2</sup>), and the ability in handling large colloids (>600 nm). By the variations of the volume fraction ratios of the small spheres to that of the large spheres, the stoichiometric structures of the binary colloidal crystals can be changed. The optical properties of both the binary crystals and their inverse opals have been characterized. The spectra of all samples confirm the long-range order of the binary system, which originate from the large sphere packing. We will also present the unveiled formation mechanism in the presentation.

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OC075

## The Effects of Polydispersity on the Self Assembly of Block Copolymers

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The art of the chemist in striving to produce narrow, almost monodisperse block copolymers, initially by anionic methods, later by controlled radical techniques has led to a belief that monodisperse block copolymers are required to produce ordered structures. However, recent research has shown that this is not the case. We will present results that show that polydispersity alters the stability of the structures formed. In particular the stability of the gyroid phase in relation to the other phases is reduced. Additionally the HPL phase and mixed morphologies occur over a wider compositional space. We will present results from a range of copolymer systems, both from blends of monodisperse and truly polydisperse samples.

OC076

## **Capsosomes: Liposomes as Sub-Compartments in Polymer Capsules**

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Artificial cells, bio-inspired objects which are engineered to mimic specific cellular processes, are expected to find manifold therapeutic applications.

Recently we introduced a novel vehicle, a capsosome, which combines a micron-sized polymer multilayer capsule with intact nanometer-sized liposomes. While the advantages of both concepts are preserved, some of the main challenges are overcome i.e. liposomes are capable of stable trapping small cargo, while the polymer shell allows for the controlled interaction with the environment e.g. the diffusion of smaller molecules in a well-defined manner.

The sequential immobilization of the building blocks, liposomes and polymers, onto a sacrificial silica template particle is the basic procedure to obtain capsosomes. Liposomes are adsorbed onto a polymer precursor layer, followed by the assembly of a number of polymer capping layers via the layer-by-layer (LbL) technique in order to form a polymer capsule membrane. Additional liposome layers can be embedded into the polymer shell during the LbL process. Finally, capsosomes are formed upon the removal of the silica core.

A multi-technique study (Quartz Crystal Microbalance with Dissipation monitoring (QCM-D), Dual Polarization Interferometry (DPI), flow cytometry, and microscopy) on planar and colloidal surfaces was performed in order to characterize the embedding of liposomes consisting of different types of lipids (zwitterionic, charged, saturated or unsaturated) into polymer multilayer films. This concept was extended to biocompatible and biodegradable polymers after the first model system using poly(allylamine hydrochloride) (PAH), poly(styrene sulfonate) (PSS) and zwitterionic 1,2-dioleoyl-*sn*-glycero-3-phosphocholine (DOPC) liposomes was successfully characterized. The amount of adsorbed liposomes was optimized by using cholesterol-modified polymers (i.e. poly(L-lysine), polymethacrylic acid and polyvinylpyrrolidone) as precursor, separation and capping layers. The presence of intact liposomes within the polymer capsules was confirmed via electron microscopy. Moreover, enzyme-preloaded liposomes were embedded into the polymer multilayers and the presence and activity of the cargo during the polymer film assembly and after template core removal was characterized.

Capsosomes, the combination of polymer capsules with liposomes, are expected to find diverse applications in biomedicine i.e. the creation of an artificial cell which requires the performance of enzymatic cascade reactions within a confined environment.

## Water at Hydrophobic Interfaces Explained by a New Fluctuation Force

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Theoretical studies<sup>1,2</sup> that conclude that the surface of neat water is acidic, due to the preferential adsorption of hydronium ions, are contrary to the available experimental evidence.<sup>3,4</sup> Water behaves similarly at all inert hydrophobic interfaces with the preferential adsorption of hydroxide ions to give a negatively charged surface at neutral pH. The surface charge density at the oil/water interface in mM salt solutions is  $-5$  to  $-7 \mu\text{C cm}^{-2}$ , which corresponds to one hydroxide ion on every  $3 \text{ nm}^2$  of the surface.<sup>5</sup> The homogenisation of an inert oil such as hexadecane in water in the absence of any salt or base still leads to formation of an emulsion. The hydroxide adsorbed on the large surface area of the emulsion greatly exceeds that present at  $10^{-7} \text{ M}$  in neutral water; it is created by the increased autolysis of water, driven by the strong adsorption of hydroxide ions at the oil/water interface. These surfactant-free, salt-free emulsions are stable for some hours, with protons as the only counterions to the negative hydroxide surface.

We can now explain this phenomenon in terms of a force that attracts certain ions in aqueous solution to regions of low dielectric constant. We incorporated this force into a simple Poisson-Boltzmann based model and obtained agreement with the  $\zeta$ -potential measured from pH 3 to 9 on surfactant-free hexadecane-in-water emulsions and on single oil drops. Our model predicts one hydroxide per  $4.5 \text{ nm}^2$  on the interface, compared to the experimental figure of  $3 \text{ nm}^2$ .<sup>5</sup> The agreement is obtained by varying a single parameter, the radius of the region in which moment fluctuations are suppressed,  $a$ , and best-fit value of this parameter of  $6.2 \text{ \AA}$  was independently confirmed by molecular-dynamics simulation.

This approach also explains the observation by AFM of charge inversion as a “universal electrostatic phenomenon”,<sup>6</sup> and reproduces the dependence of inversion concentration on valence, ion size, pH and ionic strength.

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## Bubbles and Salt and Ion-specificity

Vincent Craig, Christine Henry

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At high concentrations of electrolytes the double layer electrostatic interaction is screened and short range forces dominate. Consequently the type of ions that are in solution becomes all important and interactions become considerably more complex. In a sense there is a transition from a physics regime (where ions are treated as point charges) to a chemistry regime where the precise character (charge, size, polarisability etc) and pairing of ions is important. Such complexity is exploited universally in nature where it is commonly recognised that ion-specificity is commonplace. It remains a great challenge to develop a detailed understanding of ion-specificity. Perhaps the simplest system that reveals such complex behavior is that of gas bubbles in salty water.

For one hundred years it has been recognized that electrolytes at sufficiently high concentrations can inhibit bubble coalescence, but an understanding of this phenomenon is lacking. Further, some electrolytes have no influence on bubble coalescence. This complex situation has been described using empirical rules [1,2] in the early 1990's, but an understanding of these rules has not been forthcoming. Many propose that the ordering of ions at the interface influences the surface forces and this controls bubble coalescence; alternatively the electrolytes may influence the hydrodynamic boundary condition and this may control the rate of bubble coalescence [3]. Our investigations have sought to investigate both of these proposals.

Here we report our latest studies in this area using a number of non-aqueous solvents. We find that the addition of electrolytes in these systems gives rise to a rich variety of behaviour indicating that perhaps water is not special in this case and that a surface forces explanation is not likely [4]. We also report on bubble rise velocity measurements which reveal the nature of the boundary condition in these electrolyte solutions [5].

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OC079

## **The Influence of Surface Charge on Static and Dynamic Wetting**

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The static and dynamic wetting properties of partially modified octadecyltrihydrosilane titania surfaces were investigated as function of solution pH and ionic strength. We observed substantial decreases in contact angle above and below the point of zero charge of the titania substrate. The effect is enhanced when a higher salt concentration was used. The behaviour is due to the protonation and deprotonation of surface titanol groups. The result can be explain by Helmholtz free energy of electrical double layer formation that consists of both electrical and chemical terms and then to the solid-liquid interfacial tension. The maximum contact angle occurred at the point of zero charge of the titania. For the dynamic wetting, forced wetting and contact angle relaxation studies were perform on the same surface. The result can be interpreted by the molecular-kinetic theory. We observed a strong dependency of frequency of molecular displacement and distance of displacement as well as contact line friction on the static contact angle. This work will provide a better understanding of dynamic wetting on a metal oxide surface.

## Interfacial layering of ionic liquids at charged interfaces from a self-consistent mean-field perspective.

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Ionic liquids are salts that exist in a liquid form at or near room temperature. Typically, ionic liquids are composed of a bulky cation and a small anion. They have broad potential applications, e.g., as electrolytes, catalysis, and 'green' solvent. It is now emerging that fundamental studies of the structure/property relationships in ionic liquids and ionic liquid solutions may provide breakthrough results, which will assist not only in the choice of ionic liquids for specific applications but also with the design of new ionic liquids with tailored properties. A better understanding of the ionic liquid structure, especially at charged interfaces, will enable us to understand transport processes in electrochemical systems and to modify and improve these systems.

Some recent publications describe that ionic liquids form multi layers at air-liquid surfaces and at charged interfaces.<sup>1-3</sup> An electric double-layer formed at a charged interface can generate a large electrostatic potential field. The large potential drop across the interface between a solid conductor and ionic liquid will influence the rate of electrochemical reactions at the interface by assisting or retarding electron transfer. Theoretical and experimental studies of the structure of electrical double-layer (EDL) of ionic liquids at interfaces have intensified in the last few years.<sup>4-6</sup> Analytical predictions on the electrical double-layer structure based on mean-field approximations were generated either by solving the Poisson-Fermi equation<sup>4</sup> or by considering the classical Gouy-Chapman theory.<sup>5</sup> Both models were able to predict the experimental capacitance-potential curve reaching a maximum close to the potential of zero charge and decreases asymptotically at large potentials.<sup>7</sup>

We apply a numerical self-consistent mean-field theory (SCMFT) to study the structural and thermodynamical properties of pure and impure ionic liquids at charged interfaces. Based on the numerical results, we predict an undulating electrostatic potential field at the interface caused by a layering of ionic liquid molecules.

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OC081

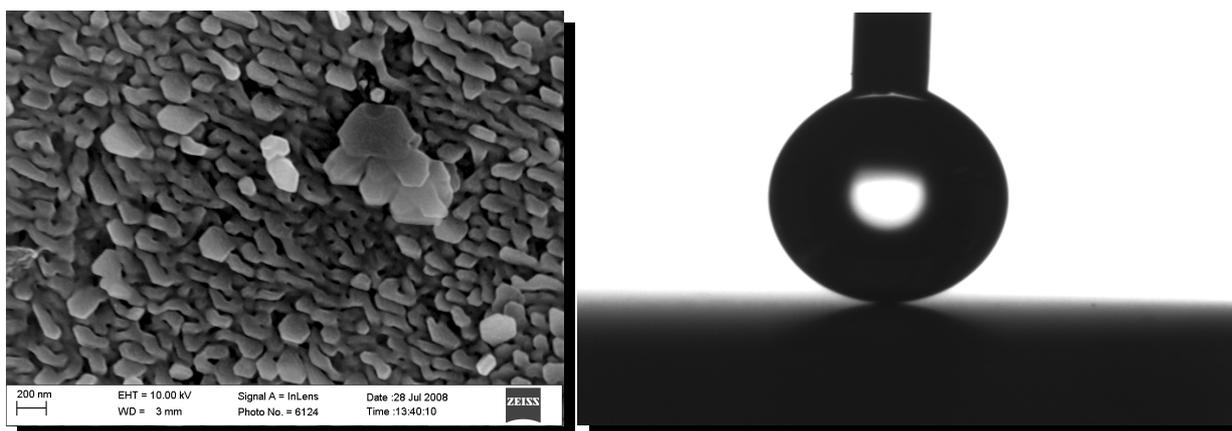
## Superhydrophobic Surfaces Based on Metal and Alloys

Jairo Garnica Rodriguez<sup>1</sup>, Rossen Sedev<sup>1</sup>, Nikolay Dimitrov<sup>2</sup>, John Ralston<sup>1</sup>

<sup>1</sup>*Ian Wark Research Institute - UniSA, Adelaide, South Australia, Australia,*

<sup>2</sup>*Binghamton University - SUNY, Binghamton, New York, United States*

Superhydrophobicity (the ability of surfaces to support water contact angles over  $140^\circ$  and very low contact angle hysteresis at the same time) has been extensively studied in various biological and artificial systems. The strong interest is driven by applications such as surface protection, low friction systems and microfluidics. On a qualitative level, the basic physics of superhydrophobicity was developed by Wenzel and Cassie some 60 years ago. Low surface energy and significant surface roughness have been identified as the key requirements for the induction of superhydrophobicity. Numerous studies have been focused on the preparation of superhydrophobic surfaces by roughening surfaces using techniques as diverse as electrospinning, microfabrication, crystallisation and subsequent surface modification.



Electrochemically etched copper surface

Water sessile drop on a superhydrophobic surface

We have developed rough metallic substrates by chemical and electrochemical etching. After modification with alkanethiols, these surfaces with one or two distinctive roughness scales (micro- and/or nanometre) display a robust superhydrophobic behaviour. We propose new approaches to quantify the superhydrophobic state (critical surface tension and critical hydraulic pressure for wetting transition) and describe a detailed relation between the topography of the surface and the wetting behaviour.

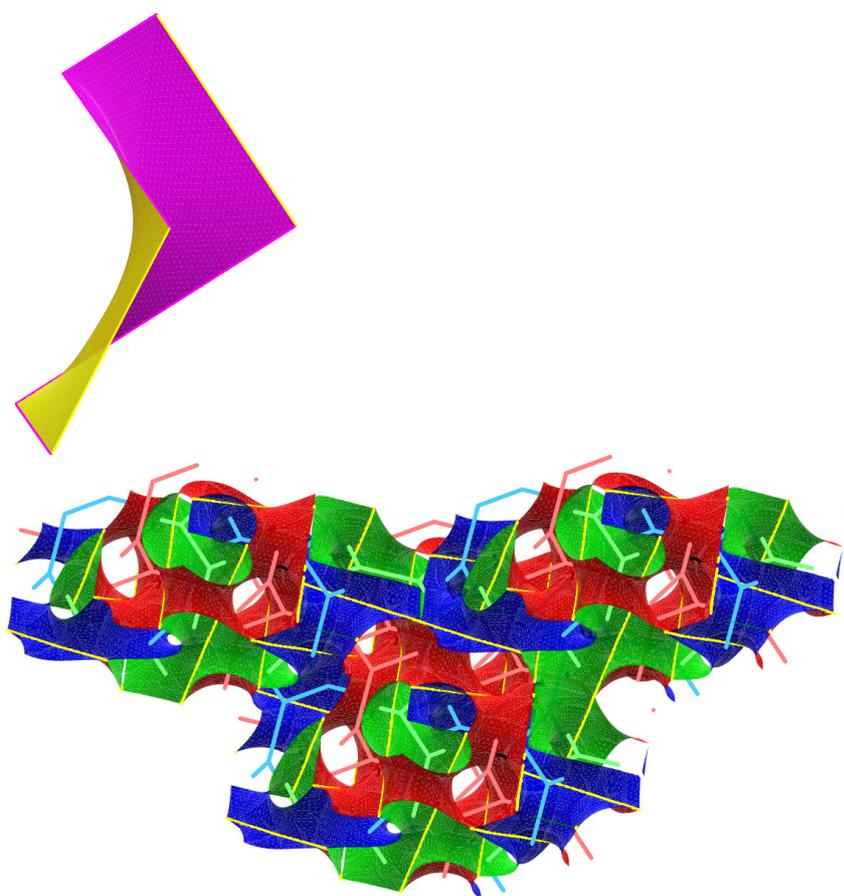
OC082

## New polyfunctional molecules: liquid crystallinity in star polyphiles

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Star polyphiles are generalised amphiphiles with 3 (or more) mutually immiscible arms joined at a common centre. We are exploring the self-assembly of these polyphiles experimentally, numerically and theoretically. We are particularly interested in forming novel tricontinuous patterns that are analogues of bicontinuous structures found in amphiphilic systems as well as patterns related to bicontinuous mesophases. Tricontinuous patterns share features of hexagonal and bicontinuous mesostructures; with three-fold branch lines and minimal surface interfaces. One example, whose smallest minimal surface element and resulting cellular pattern is shown here, is the analogue of the well-known Gyroid structure, with 3 rather than 2 interwoven labyrinths:



A simple quasi-steric model for the self-assembly of star polyphiles will be introduced, that relates the structure of the self-assembly to the shape of the polyphile. This theory allows us to deduce the most likely structures to be favoured in tricontinuous mesophases and design polyphiles likely to form these mesophases. We will show the results of those calculations and compare those with recent numerical simulations and small-angle X-ray and neutron scattering experiments.

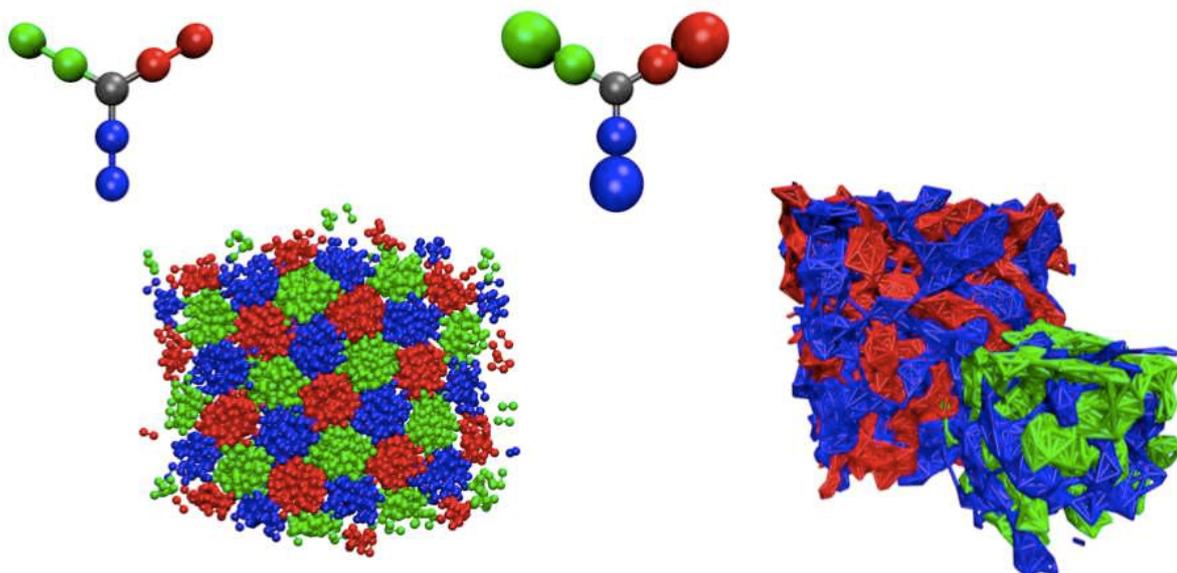
OC083

## Coarse-grained simulations of polyphilic molecules

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We have simulated the self-assembly of a novel class of three-arm molecules, \$ABC\$ star-architecture \textit{polyphiles}, using coarse-grained bead simulations. A number of topologically complex liquid crystalline mesostructures arise that can be related to the better-known bicontinuous mesophases of lyotropic amphiphilic systems. The simulations reveal 3D self-assemblies whose structural variations follow those expected assuming a simple steric molecular packing model as a function of star polyphile splay and relative volumes of each arm in the polyphile. The splay of each arm, characterised by the 3D wedge-shape emanating from the core of each molecule to its exterior induces torsion of the interfaces along the triple lines, whereas differences in the relative volumes of arms induces curvature of the triple lines. Three distinct mesostructures are described, characterised by their micro-domain topologies, which are unknown in simpler amphiphilic systems, but resemble in some respects bicontinuous mesophases. These three- (or more) arm polyphilic systems offer an interesting extension to the better-known self-assembly of (two-arm) amphiphiles in solution.



## Characterisation of the CMC of Amphiphiles in Protic Ionic Liquids

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Protic Ionic Liquids (PILs) are the simplest ionic liquids to prepare, and are analogous to the well known PIL, ethylammonium nitrate (EAN). These PILs have poor ionic behavior when compared to the far more studied aprotic ionic liquids. However, some of the other physico-chemical properties possessed by these solvents are highly promising and it is anticipated that these, or analogous protic solvents, will find applications beyond those already identified for aprotic ionic liquids [1].

An exciting property of PILs containing an alkylammonium cation is that many of them have the ability to support amphiphile self-assembly. It has been shown that these PILs support all the main lyotropic phases, including micellar, cubic, hexagonal, lamellar and inverse hexagonal phases [2-4]. Consequently, these PILs markedly increase the number of known solvents capable of supporting the self-assembly of amphiphiles. The changes in the lyotropic liquid crystal phase behavior as a result of structural modification of the PILs have been investigated. A significant advantage of PIL-amphiphile systems is that they represent the first broad range of solvents whose structure can be changed in conjunction with the amphiphiles to modify the self-assembly phases.

In the 1980's Evans et al. determined the CMC for various cationic amphiphiles in EAN [5,6], showing that the CMC was about 10x greater in EAN than in water. We have extended the work conducted by Evans to include other PILs, enabling trends to be identified between the CMC and the structure of the PILs.

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## **AFM and STM Studies on the surface interaction of [BMP]TFSA and [EMIm]TFSA ionic liquids with Au(111)**

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The surface interaction of two air and water stable ILs (ILs), 1-ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl) amide ([EMIm] TFSA) and 1-butyl-1-methylpyrrolidinium bis(trifluoromethylsulfonyl) amide ([BMP] TFSA), with Au(111) has been investigated using atomic force microscopy (AFM), cyclic voltammetry and scanning tunneling microscopy measurements (STM). AFM experiments reveal that multiple solvation layers are present at the gold interface for both ILs, and that the strength of the interaction between the innermost layer and the substrate is dependant on the cation type; the force required to rupture the innermost solvation layer is greater for [BMP] TFSA than for [EMIm] TFSA, attributed to stronger cation surface interactions. In situ STM elucidates the influence of IL species on restructuring of the Au(111) interface. In the presence of [BMP]TFSA, the Au(111) surface restructures to produce a wormlike pattern, but this unusual morphology is not observed for the [EMIm]TFSA –Au(111) system. This remarkable difference in electrochemical behavior is ascribed to the greater strength of interaction of [BMP]<sup>+</sup> compared to [EMIm]<sup>+</sup> with the Au(111) surface. These results demonstrate that such interfacial effects have to be considered for all electrochemical reactions, and provide insight into the electrical double layer structure in IL systems.

## Sonochemical Synthesis of Lysozyme Microspheres

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Gas and liquid-filled lysozyme microspheres were synthesized by emulsification and cross-linking of protein molecules in aqueous medium under high-intensity ultrasound. The experimental data show that the protein denaturation time, sonication power, sonication time and funnel separation procedures significantly affected the size, size distribution and morphology of the lysozyme microspheres. Scanning electron microscopy and optical microscopy revealed that the size of the microspheres decreased with increase in the sonication power. The aggregation of protein particles can be controlled by the denaturation time and through the funnel separation stage. Fluorescence imaging of dye/oil-filled lysozyme microspheres demonstrated that the ability to ultrasonically encapsulate liquid within lysozyme microspheres and hence the potential applications for the encapsulation of dyes, flavours or fragrances and as drug delivery vectors.

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## Modification of Structure and Functionality of Deamidated Wheat Proteins via Maillard Conjugation with Dextrans

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There is a significant interest by the food industry in the use of glycation via the Maillard reaction, to modify the structure and functionality of proteins. Glycation involves the covalent attachment of reducing sugars or the reducing group of polysaccharides to  $-NH_2$  residues of the protein backbone. Studies have found that the glycated proteins can provide improved emulsification properties [1], anti-oxidation properties [2], anti-microbial activity [3], and better stability on heating [4], than the native proteins.

In this study, the structure and functional properties of the Maillard conjugated deamidated wheat proteins with two different  $M_n$  of dextrans (i.e. 6.4 kDa and 41 kDa) were investigated. The deamidated wheat proteins used in this study are primarily a mixture of deamidated gliadins (~MW 25-75 kDa) and deamidated glutenins (MW 30-120 kDa).

The formation of conjugates was confirmed by SDS-PAGE and SE-HPLC coupled with hydrodynamic light scattering detection. Although the conjugation of dextrans to deamidated wheat proteins did not alter the isoelectric point of the proteins, the conjugated proteins are more resistant to aggregation on acidification in solution, an effect that is ascribed to the steric stabilisation afforded by the attachment of dextran to the protein. The effects of conjugation on the protein interfacial properties were studied by absorbing protein and conjugates to latex beads. The results showed that the conjugation of dextran to the protein increased the steric layer thickness; with the increase being greater with the attachment of the higher MW dextran. The results demonstrate the potential of the Maillard reaction to be used to modify the structure and functionality of deamidated wheat proteins for maintaining emulsion stability.

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OC088

## **Sonophotocatalytic degradation of Orange G using Titanium dioxide**

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The decoloration and mineralization of Orange G (OG) in aqueous phase by means of ultrasound irradiation at a frequency of 213 kHz and its combination with a heterogenous photocatalyst ( $\text{TiO}_2$ ) was investigated. The effects of various operational parameters such as, the concentration of the dye and pH of OG were studied. The degradation of the dye followed first-order kinetics under the conditions examined. The studies revealed that the extent of sonolytic decoloration was found to be increasing with decreasing initial dye concentration and the degradation rate was also found to be dependent upon the solution pH. This was confirmed by comparing the sonolytic degradation of OG at pH 5.8 and 12, which showed that the decoloration efficiency was relatively higher at pH5.8 than pH12. However, an alkaline pH was favoured for the photocatalytic decoloration of OG using  $\text{TiO}_2$ . Total Organic Carbon (TOC) measurements were also carried out in order to evaluate the mineralization efficiency of OG using sonolysis, photocatalysis and sonophotocatalysis. TOC analyses of the dye solutions at various times following sonication revealed that sonolysis was effective in the initial degradation of the parent dye but very slow in achieving mineralization.

The hybrid technique of sonophotochemical degradation was compared with the individual techniques of photocatalysis and sonolysis. It was observed that the sonophotocatalytic oxidation of OG using  $\text{TiO}_2$  was additive. TOC results also confirmed the above results.

OC089

## **Self Assembled Monolayers of Functionalised Amphiphilic PAMAM Dendrimers for pH and Metal-Ion Sensing**

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In this research, we report the sensitivity of dendrimer monolayers towards different pH and metal ion (including  $\text{Al}^{3+}$ ,  $\text{Mg}^{2+}$ , and  $\text{Co}^{2+}$  as salts) concentrations. Fourth generation poly(amidoamine), or PAMAM, dendrimers have been functionalized at their periphery with fluorescent molecules and then covalently linked to self assembled monolayers (SAM's) of mixed alkane-thiols on gold surfaces. The presence of different metal ions and different pH concentration results in fluorescence quenching of these films. The dendrimer monolayer sensitivity has been investigated by UV-visible and photoluminescence spectroscopy.

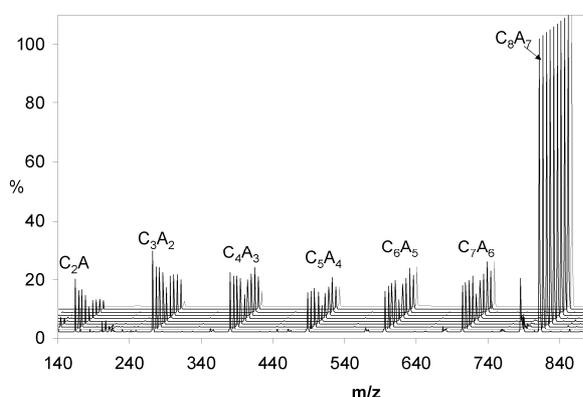
## Large Ion Aggregates in Protic Ionic Liquids observed by ESI-MS

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Ionic liquids (ILs) are comprised entirely of ions in their liquid state.<sup>1</sup> They usually consist of a relatively large organic cation and a small inorganic anion, but there are other subclasses of ILs including protic and eutectic ILs which do not fit this simplified description. ILs have found application across all fields of chemical research and recently in industrial applications.<sup>1</sup> Protic ionic liquids (PILs) are formed by the stoichiometric reaction of a Brønsted acid and a Brønsted base. The first reported room temperature ionic liquid was, in fact, a protic ionic liquid. Ethylammonium nitrate was reported by Walden in 1914 and remains to date the most highly studied protic ionic liquid.<sup>2</sup> What sets PILs apart from other ILs is the presence of an available proton which is able to promote extensive hydrogen bonding. Despite extensive studies of the physicochemical properties of PILs the bulk phase structure of the materials remains poorly understood.<sup>3</sup>

Unusually large aggregated parent ions,  $C_8A_7^+$ , have been observed for the first time within protic ionic liquids using ESI-MS. We have also shown that the formation and size of stabilised aggregates is dependant on the nature of the anion and cation. When solutions of PILs were investigated it was also observed that the size of the stabilised aggregate formed was independent of the concentration of PIL in the solution, Figure 1.



**Fig. 1** Stacked plot of ESI-MS spectra of  $CH_3CH_2NH_3NO_3$  (EAN) at a series of concentrations 1.4 mM (front), 3.5 mM, 8.8 mM, 22 mM, 55 mM, 0.138 M, 0.346 M, 0.863 M, 2.16 M in MeOH and neat EAN (back). Spectra are offset for clarity.

This study offers insights into the bulk phase structure of protic ionic liquids.

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OC091

## Using Self-Assembled Copolymer Thin Films to Control the Orientation of Carbon Nanotubes

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Forming a uniformly dispersed carbon nanotube material has long been sought after to increase the mechanical properties of the bulk polymer matrix [1]. Many chemical techniques have been employed to increase such dispersions [2], however orientation has not been greatly studied and is often ignored.

In this work, the carboxylic acids that result from purification, are manipulated to form a carbon nanotube macro-initiator. This initiator was used in the polymerisation of styrene to form polystyrene grafted carbon nanotubes. In addition, because the polymer chains are grown from the nanotube walls, the polymer chain lengths could be controlled by reaction time. This results in tailor made polymer brushes on multi-walled carbon nanotubes. Up to 60% polymer coverage has been achieved with a 19°C increase in the  $T_g$  when compared to commercial polystyrene.

The polymer grafted nanotubes have a greater affinity for polystyrene; “like-dissolves-like”. Employing the “like-dissolves-like” principle during the self-assembly process of copolymer micro-domain formation, the nanotubes uniformly align to the polystyrene phases. A thin film of a cylindrical copolymer has been explored and studied in further applications.

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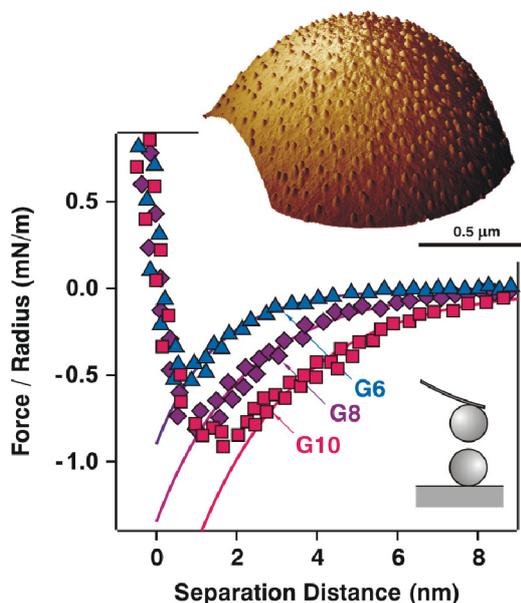
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## Colloidal Aggregation and Interaction Forces Induced by Adsorbed Dendrimers

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Poly(amino amine) dendrimers (PAMAM) provide a novel and well-defined model system to study adsorption of highly charged globular macromolecules on oppositely charged water-solid interfaces and the respective interaction forces. The adsorption process is studied using electrophoresis for colloidal particles, and these studies are complemented with reflectivity for planar substrates. In both cases, the adsorbed dendrimers are individually imaged with atomic force microscopy (AFM), see figure. Dendrimers of sufficiently high generation adsorb irreversibly and lead to charge reversal and subsequent saturation [1]. The kinetics of the adsorption process is rapid and diffusion controlled. The isotropic saturated monolayers feature a liquid-like two-dimensional structure characterized with a correlation peak in the pair distribution function. The saturation coverage depends strongly on the ionic strength and the charge density of the substrate. We rationalize the adsorption process with the random sequential adsorption (RSA) model. Thereby, it is essential not only to consider the pair-wise screened Coulomb electrostatic repulsion between the dendrimers, but an additional electrostatic three-body attraction acting between a pair of dendrimers and the substrate. The latter force is similar in nature to the attractive electrostatic three-body forces observed between a three charged colloidal particles at low salt conditions [2]. The interactions between the dendrimer-covered colloidal particles are measured directly by colloidal probe AFM, or indirectly through the rate of aggregation by light scattering [3]. Close to the charge reversal point, attractive interactions between the surfaces are evidenced, whose strength increases with increasing dendrimer generation, see Figure. We suspect that these attractive forces originate from electrostatic interactions between lateral patch-wise heterogeneities in the surface charge distribution. Far away from the charge reversal point and particularly in the saturation regime, interactions between such surfaces are dominated by classical double layer overlap forces.



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OC093

## Direct Peptide Synthesis on a Solid Surface

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This work introduces the use of solid phase peptide synthesis on a silicon substrate as a means of directly forming a peptide layer on a surface. We have synthesised a 15 residue peptide from the surface of an aminosilanized silicon wafer; the peptide contains a zwitterionic sequence of alternating lysine and glutamic acid residues. We confirmed the presence of the peptide layer on the surface by X-ray photoelectron spectroscopy (XPS) and ellipsometry. Atomic force microscopy (AFM) was then used to study the forces between the peptide-modified surface and a borosilicate glass sphere, and pH dependent behaviour consistent with the presence of the peptide was observed. Immobilisation of peptides at interfaces has previously been achieved by either physisorption or a “grafting to” approach. The “grafting from” method detailed in this work will allow the formation of peptide brushes and layers with much higher density than was previously possible, while also minimising the expense associated with the commercial purchase of peptides. Layers formed by this technique may be used instead of conventional polymer brushes to make use of the fine sequence control and range of functionalities available in peptides; the method also allows easy biofunctionalization of a surface for nanotechnology and biomedical applications.

## Phoretic Motion via Self-Generated Solute Gradients: (i) Confinement Effects and (ii) Shape Dependence for Axisymmetrical Objects

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For applications in, e.g., drug-delivery systems or micromechanics, one of the most challenging problems at this stage is to develop ways to enable small-scale objects to perform autonomous, controlled motion. One possibility is the phoretic transport via actively generated gradients [1]. For most such applications one has to deal with a complicated internal structure of the system, like networks of narrow channels or pores and various impenetrable impurities, and this spatial confinement can significantly influence the efficiency of transport. Moreover, geometrical details, such as the shape of the particles, play an important role in optimizing the phoretic motion. The present work is devoted to a study of the influence of such factors on the phoretic motion of a particle which generates solute gradients by chemical reactions active on certain parts of its surface [1-3].

Using as a model system that of a spherical particle with a point-source of solute particles on its surface [3], which is enclosed together with the surrounding solvent in a concentric spherical vessel, we show that the presence of confining inert walls increases significantly the gradients along the surface of the self-propelling particle. In the particular case of an interaction between the particle and the product molecules that consists of steric repulsion only [3], this increase is generally larger than that in the hydrodynamic resistance and leads to an increase in the phoretic velocity of the particle (which remains, however, very small). These effects are expected to be significantly more pronounced in the case of attractive interactions. For this case, the phoretic velocities can be of the order of  $\mu\text{m/s}$  [4].

The dependence of the phoretic velocity of such self-propelled objects on the shape of the object is discussed for the case (which is technologically feasible) of a prolate-shaped particle. We derive an analytical solution that includes as limiting cases those of a cylindrical rod [1-3] (here approximated by a prolate with a large aspect ratio) and of a spherical object [3], respectively. Both diffusio-phoresis by steric repulsion only [3] and surface-tension gradient phoresis mechanisms [1,2] are analysed as particular cases, following the classical results of Anderson [4]. For the case of cylindrical objects, our solution accounts for the correct hydrodynamic flow in phoresis (similarly to [3] and in contrast to [1, 2]), and avoids the need of using the 'slender body approximations employed by [1-3].

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OC095

## Electronic Tuning of the Surface Plasmon Resonances of Single Gold Nanorods

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The spatial confinement of conduction electrons in sub-wavelength structures such as metal nanocrystals leads to surface plasmon resonances. The energy of the plasmon resonance for a given particle is extremely sensitive to the structural details of the crystals, including size, shape and surface roughness at the atomic level. For very small particles, the surface plasmons excited by light are primarily dipolar in character.

The dielectric function of gold is well described in the visible region using the Drude model and is a function of the electron density in the particle. If the electron density changes, the bulk plasma frequency alters correspondingly and therefore the dielectric properties of the gold.<sup>1</sup>

Previously we investigated the change in surface plasmon resonance as a result of chemical charging in ensemble and single particle measurements.<sup>2,3</sup> We demonstrate here that the surface plasmon resonance of a single gold nanocrystal can be actively modulated directly by altering the electron density of the metal through an applied voltage.

To measure the surface plasmon shifts, we use dark field microscopy to study the scattered light (Rayleigh Spectra) from single gold nanocrystals of different morphologies. We have modified this technique to enable electrochemical processes to be studied simultaneously. The SEM image of the particles investigated were collected before and after electrochemical charging using the Focussed Ion Beam Registration Method<sup>4</sup> to assess morphological changes occurring as a result of charging as well as to determine the exact particle morphology and therefore avoid the effects of polydispersity.

The scattering spectra of single gold rods have been measured as a function of the applied potential in an electrochemical cell using dark field microscopy. It is demonstrated that the surface plasmon resonance can be reversible and rapidly tuned by tens of nanometres. The dependence of the particle shape on the magnitude of the shift is discussed. This modulation of the scattering spectra provides a basis for information storage in single gold rods and a method for transmitting signals through coupled plasmonic superstructures.

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## **Measurements of the Forces Between Bubble and Particle with AFM – Effect of Surface Charge and Hydrophobicity**

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Surface forces play an extremely important role in understanding the interaction of air bubbles with solid particles as this type of interaction has a wide application from basic academic studies to chemical engineering and mineral processing. Therefore, the measurement and interpretation of these forces is of great importance. In our studies a colloid probe AFM technique has been used to measure the interaction forces between an air bubble and a spherical, smooth titania particle. The interaction forces between the air bubble and the particle have been studied as a function of simple (1:1) electrolyte concentration and pH of the solution in order to determine the contribution of the electrostatic double layer forces to the observed interaction. The titania surface charge is sensitive to changes in pH and by adjusting the pH above and below the point of zero charge either attractive or repulsive interaction were observed between the bubbles, which bear a negative charge over a large pH range. In the case where the bubble and particle bear the same charge, the wetting film stayed stable due to electrostatic repulsion while for oppositely charged bodies the wetting film “transformed” into stable ultrathin film and weak adhesion between the particle and an air bubble was observed on retraction. We also have studied the effect of particle hydrophobicity on wetting film rupture.

OC097

## Superlubricity using Repulsive Van der Waals Forces

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Friction force measurements using colloid probe atomic force microscopy have been conducted to investigate superlubrication between surfaces interacting with a repulsive van der Waals force. We show that if a repulsive van der Waals force exists between two surfaces prior to their contact then friction is essentially precluded and supersliding is achieved. Normal force measurements between a gold sphere against a smooth Teflon surface (templated on mica) in cyclohexane, revealed a repulsive van der Waals force that diverged at short separations. The friction coefficient associated with this system is on the order of 0.0003. When the refractive index of the liquid is changed, the force can be tuned from repulsive to attractive and adhesive. The friction coefficient increases as the Hamaker constant becomes more positive and the divergent repulsive force, which prevents solid-solid contact, gets switched off

The friction measurements presented here are of the same order as the lowest ever recorded friction coefficients in liquid. This work clearly shows that two surfaces experiencing a repulsive surface force, which diverges at small separations, can slide essentially without friction. The number of systems in which repulsive van der Waals forces could occur is limited but includes metal bearings in a PTFE housing with organic lubricant and certain combinations of technically interesting ceramic materials.

Feiler A. A., Bergström, L; Rutland M. W. "Superlubricity Using Repulsive van der Waals Forces" *Langmuir*, 24 (6), 2274 -2276, 2008.

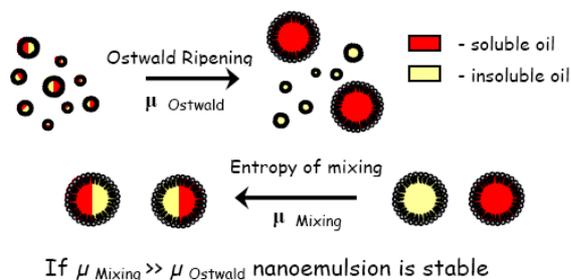
## Pushing the Limits of Emulsification – Creating Edible Nanoemulsions that are Inherently Stable to Ostwald Ripening

Tim J. Wooster, Matt Golding, Helen French, Peerasak Sanguansri

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Nanoemulsions are kinetically stable multi-phase systems with a particle size in the region of 10-200 nm. Their remarkably small size gives nanoemulsions advanced properties over conventional emulsions, including: optical transparency, high physical stability and a large interfacial area. Despite their attraction, and considerable scientific interest for over 10 years, nanoemulsions have remained more of a promise than a reality because of the fundamental challenges that their creation presents. These challenges are twofold: the ability to form very small emulsion droplets and the greater challenge of stabilising these droplets against Ostwald ripening.

Our present research focuses on the creation and potential applications of edible triglyceride (TAG) nanoemulsions. The creation of nanoemulsions is a challenging task that requires application of extreme shear and the optimisation of the surfactant system. This task is further complicated when one is limited to edible surfactants. Furthermore, typical TAG oils that are acceptable for ingestion have moderate viscosities, which restrict the efficiency of droplet deformation.



**Figure 1:** When the excess chemical potential that drives Ostwald ripening is balanced by the entropy gain associated with oil de-mixing the resulting nanoemulsions will be stable against Ostwald ripening if one oil is completely insoluble in water (e.g. a long chain triglyceride).

This presentation will outline how edible surfactants can be used to create transparent nanoemulsions. It describes how microemulsion design principles can be used to create nanoemulsions that are remarkably small, ( $d_h < 40$  nm). We also outline how careful selection of the oil phase can result in nanoemulsions that are inherently stable to Ostwald ripening. By taking advantage of this inherent stability we were able to create physically stable transparent nanoemulsions from oils that would normally undergo Ostwald ripening. These edible nanoemulsions are suitable for the delivery of active ingredients in cosmetic, pharmaceutical and food applications.

OC099

## Electrowetting of Ionic Liquid in Solid/Liquid/Liquid Systems

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We have studied the electrowetting behaviour of an ionic liquid (1-butyl-3-methylimidazolium tetrafluoroborate) in an ambient phase of hexadecane. We have focused our attention on the fundamental aspects of electrowetting, including the maximum contact angle change, the onset of contact angle saturation and reversibility of the wetting-dewetting process.

The surface electrode was a layer of indium tin oxide which was electrically insulated from the droplet by a layer of an amorphous fluoropolymer. A platinum wire was used to electrically contact the droplets and apply an external voltage.

Using DC potential, contact angle changes in excess of  $100^\circ$  could be achieved and the reversibility was very good with hysteresis less than  $2^\circ$ . The Young-Lippmann equation was very well followed until contact angle saturation was reached. Similar electrowetting curves were obtained with an AC voltage. However, contact angle saturation for the ionic liquid was significantly reduced to almost  $0^\circ$ . The large contact angle changes observed in liquid-liquid systems together with their reversibility and predictability may be well suited for several applications. Our results are also significant for elucidating the mechanism of contact angle saturation.

OC100

## Phase transitions and solvency studied using surface forces measurements: adsorbed polymer layers

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Many water soluble polyelectrolytes have varying solubility depending on the solution conditions with variables such as pH and ionic strength causing shifts from good to poor solvency. Such examples include polyacrylic acid and carboxymethylated cellulose with the charge density on the polymer also highly influential. Furthermore, other polyelectrolytes exhibit interesting behaviour in binary solvent systems, particularly close to the critical point where the structure of the polyelectrolyte will change in accordance with the preferential solvophilicity. In many cases, such subtle variations in macromolecular conformations are difficult to probe using conventional techniques, especially in circumstances where changes may only occur in highly dilute solutions. Here, we present results from our investigations of adsorbed polymer and polyelectrolyte layers using both single molecule and colloidal probe force measurements as a function of solution conditions as well as in a binary liquid system.

Single molecules that bridge between an AFM cantilever tip and flat substrate are pulled into solution. The force-extension profile is typically one of two sorts depending on solvency, those being Langevin (good solvent) and Plateau (poor solvent). Furthermore, the magnitudes of the adhesive forces generated in this manner can provide information on persistence length, contour length, loop distribution and the presence of intra-chain association. A number of polymer/solvent systems will be discussed with an attempt to relate the results to the bulk solution properties of the polymer. The requirement for low concentrations for many interesting systems of study is overcome using this approach by stretching tethered single molecules into solution.

Furthermore, an ensemble method will be described involving the measurement of the forces on approach of two surfaces bearing an adsorbed layer. Such experimentally obtained interaction data can be modelled in a number of ways including using the Alexander-de Gennes theory for a homopolymer brush with good agreement. This provides information on the extent of the steric layer away from the interface. Here, results will be presented outlining the adsorbed layer thickness as a function of solvent quality including for a polymer in a binary liquid near the critical point.

## Influence of Adsorbed Film Viscoelasticity on the Superior Lubrication Properties of Saliva

Lubica Macakova<sup>1,2</sup>, Gleb Yakubov<sup>1</sup>, Damiano Rossetti<sup>1</sup>, Mark Plunkett<sup>2</sup>, Jason Stokes<sup>1</sup>

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Nature has many sources of inspiration in the area of aqueous lubrication<sup>1</sup>. One of these biological lubricants is saliva, a complex fluid containing various biomolecules and ions. It has been shown to be an excellent boundary lubricant, which instantly reduces boundary friction between soft hydrophobic polydimethylsiloxane (PDMS) surfaces by two orders of magnitude to 0.01<sup>1</sup>. PDMS is used to obtain a low pressure tribological contact (iso-viscous elastohydrodynamic lubrication) that mimics tongue-palate/teeth interactions as well as other biolubrication processes. In addition to low boundary friction, saliva also promotes wetting and entrainment into full-film lubrication. Through a combination of tribological measurements and surface characterisation techniques (quartz crystal microbalance, providing us with the hydrated adsorbed mass, and surface plasmon resonance, providing us with the dry adsorbed mass), we could attribute the superior boundary lubrication properties of saliva to the adsorption of salivary proteins to the PDMS surface in the form of an extended, multi-component, highly hydrated film. However, lubrication deteriorated when the salivary film was exposed to certain food related stimuli, such as solutions with low ionic strength or low pH. The loss of lubrication is related to changes in the film structure. In particular, of critical importance was the viscoelasticity of the adsorbed salivary layer; for similar film thickness, adsorbed mass and hydrated surface layers, a solid-like viscoelastic film provides an ultra-low boundary friction coefficient in comparison to an adsorbed film that has more 'fluid-like' character. We discuss the implications of this result in terms of understanding other biolubrication processes and producing an oral mimetic. In addition, we highlight the use of our 'oral mimetic' to investigate the influence of bioactive phytonutrients (typically found in wine, fruit and tea) on oral lubrication and mouthfeel; these so-called health benefit agents cause the negative mouthfeel sensation of astringency that has long been associated with a loss of saliva lubrication.

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OC102

## Contact Angle Relaxation in Dewetting Processes

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We investigate the spontaneous dewetting process that occurs when a bubble strikes a hydrophobic surface immersed in an aqueous solution. Using high-speed video microscopy the growth of the three phase contact area is monitored, and dynamic contact angle data are calculated. As model systems we chose titania surfaces gradually coated with a self-assembled monolayer of octadecyltrihydrosilane to achieve a wide range of surface wettability. For all surfaces, we found that the initial stage of the dewetting process is captured by hydrodynamics, whereas the regime of low contact line speeds is well described by the molecular kinetic theory. Our results show that the mean distance of displacements at the three phase contact line systematically depends on the substrate composition; the displacement rate, however, is rather randomly distributed and does not confirm the prediction for dewetting on homogeneous surfaces. We interpret these unexpected results by means of surface heterogeneity and contact line pinning.

OC103

## **Comparative Study of the Benefits of Lignite Addition to the Flocculation of Different Types of Sludges**

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Dewatering of sewage sludge is an important part of proper sludge management practice. It is becoming a challenging issue for water industries as new regulations on sludge disposal are being imposed. Three different types of sludges (activated municipal, anaerobic digested municipal, and pulp and paper) are studied in laboratory. The effect of using lignite as a filtration aid was investigated for each sludge.

The stability of the sludges was investigated by measuring the pH, moisture content (MC) and zeta potential for twelve weeks. It is found that the pH, MC and zeta potential change slightly for digested and pulp and paper sludge, but change significantly for activated sludge. Two cationic polyelectrolytes (ZETAG 7650 and ZETAG7501) are used to investigate sludge flocculation behaviour and dewaterability. Flocculation using cationic polyelectrolytes improves the sludge dewaterability significantly through both particle bridging and charge neutralization. For all three sludges the zeta potential (negative) value decreases towards zero (the isoelectric point) as the amount of the polymer for flocculation increases. ZETAG7650 requires a higher polymer dose to decrease the zeta potential and the isoelectric point is never reached even at very high doses.

Lignite (low-rank coal) is added to the flocculated sludge to increase the rate of dewatering. For a mixture of one to one sludge solids to lignite solids, the pH of the sludge and lignite mixture for activated and digested sludge is between 7 and 8, close to that of flocculated sludge, but for pulp and paper sludge the pH after mixing with the lignite is close to the pH of lignite slurry. The dewatering rate of sludge is improved after flocculation. The optimum dose of polyelectrolyte is determined by conducting vacuum filtration tests. The optimum dose is different for different sludges and polyelectrolytes. Of the three sludges, the pulp and paper sludge is found to be the easiest to dewater followed by activated sludge then digested sludge. Lignite as a skeleton builder greatly improves the sludge dewatering rate in all cases, as a result of increased permeability of the solid product. Both the applied pressure and the lignite sludge ratio are found to have an effect on sludge dewaterability. Higher extents of dewatering rate are found when the amount of lignite added and the applied pressure are increased.

## Acoustically-Driven Interfacial Destabilisation and Atomisation in a Microfluidic Device

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We demonstrate the rapid generation of micron and sub-micron aerosol droplets in a microfluidic device in which a fluid drop is exposed to surface acoustic waves as it sits atop a single-crystal lithium niobate piezoelectric substrate [1]. Little, however, is understood about the processes by which these droplets form due to the complex hydrodynamic processes that occur across widely varying length and time scales. Through a combination of experiments, scaling theory and simple numerical modelling, we elucidate the interfacial destabilisation mechanisms that lead to droplet formation. Large aerosol droplets on the length scale of the parent drop dimension are ejected through a whipping and pinch-off phenomenon, which occurs at the asymmetrically formed crest of the drop due to leakage of acoustic radiation from the substrate into the drop. Smaller micron order droplets, on the other hand, are formed due to the axisymmetric break-up of cylindrical liquid jets that are ejected as a consequence of interfacial destabilisation. The 10  $\mu\text{m}$  droplet dimension correlates with the jet radius and the instability wavelength, both determined from a simple scaling argument involving a viscous-capillary dominant force balance [2]. The results are further supported by numerical solution of the evolution equation governing the interfacial profile of a sessile drop along which an acoustic pressure wave is imposed. Viscous and capillary forces dominate in the bulk of the drop, but inertia is dominant in the ejected jets and within a thin boundary layer adjacent to the substrate where surface and interfacial accelerations are large. With the specific exception of drops that spread into thin films with thicknesses on the order of the boundary layer dimension prior to atomisation, the free surface of the drop is always observed to vibrate at the capillary-viscous resonance frequency despite the frequency of the surface acoustic wave being several orders of magnitude larger. This is contrary to common assumptions used in deriving subharmonic models resulting in a Mathieu equation for the capillary wave motion [3], which has commonly led to spurious predictions in the droplet size.

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OC105

## **Cleaning of Protein Coated Surfaces Using Nanobubbles: An Investigation Using a Quartz Crystal Microbalance**

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The existence of nanobubbles at interfaces has recently been established in the literature. Here we present an investigation into a novel application of nanobubbles as cleaning agents. The production and growth of a three phase line at the surface provides for a unique mechanical method of removing fouling agents from a surface. To this end the use of nanobubbles as cleaning agents to remove bovine serum albumin from the solid-liquid interface has been investigated using a Quartz Crystal Microbalance to both qualitatively follow the production of nanobubbles and to quantify the adsorption to, and removal of, protein using nanobubbles from both hydrophobic and hydrophilic surfaces. The protein is completely removed from both hydrophobic and hydrophilic surfaces using a few cycles of electrochemically produced nanobubbles for periods of 10 seconds. The cleaning efficiency compares favourably with treatment for 20 minutes with a common surfactant, SDS. As nanobubbles are easily produced electrochemically, this process forms the basis of a highly effective, rapid cleaning technique that is environmentally friendly and can be applied to any conducting substrate. Further studies are underway to investigate how the combination of nanobubbles and SDS may be used to improve the cleaning efficiency. We also comment on the efficiency of cleaning obtained using other methods of nanobubble production, such as solvent exchange or temperature change, which may be employed even when the surface is non-conducting.

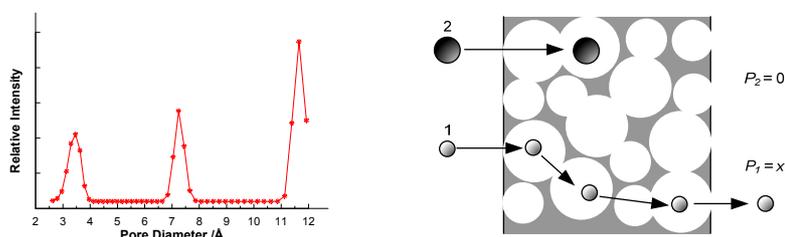
## Utilising Positron Annihilation Lifetime Spectroscopy to Reveal the Functional Molecular Sieving Framework of Amorphous Silica

Mikel Duke<sup>1</sup>, Steven Pas<sup>2,3</sup>, Anita Hill<sup>3</sup>, Jerry Lin<sup>4</sup>, Joao C. Diniz da Costa<sup>5</sup>

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Despite extensive research into silica gels, little exists that describes the porous properties of the fundamental molecular sieving framework due to limitations of current characterization techniques. This work [1] describes the novel use of positron annihilation lifetime spectroscopy (PALS) for rapid quantitative measurement of sub-nanometer pores in amorphous molecular sieving silicas. We compare the results with the popular N<sub>2</sub> adsorption on the same bulk materials and gas permeation cut-off on fully developed membrane films.

N<sub>2</sub> adsorption isotherms at 77K of different amorphous silica samples indicated that materials were either non-porous (lack of isotherm) or microporous (isotherm type I). For the microporous sample, the popular HK method was used and showed pore size peaking at 5.3Å. PALS on the other hand detected a trimodal porous structure for all samples, peaking at approximately 3, 8 and 12Å pore sizes as shown below (left). This was validated against permeation cut-off of the membranes made using the same material. For example permeation of one membrane cut-off between the size of H<sub>2</sub> (2.89Å) and CO<sub>2</sub> (3.3Å) implying its peak pore size must be less than 3Å. The PALS result for this small pore size for the same bulk material was 2.2Å, which is smaller than the size of H<sub>2</sub>, but sieving of He (2.6Å) occurred over H<sub>2</sub> suggesting the actual peak is smaller than He and therefore aligning well with the PALS result. The larger pores must therefore not be fully connected through the membrane, but instead it was found that their quantity and size determined membrane flux. The concept for selective gas permeation ( $P$ ) of molecules 1 and 2 through the multimodal porous silica is shown below (right):



The selective function of the silica is therefore determined by the fundamental silica framework, while the flux is determined by the spaces left behind during colloidal assembly conforming to popular descriptions in sol-gel science [2]. Previously however, only the porous property of the inter-colloid domains has been described. With PALS, we can now see the molecular dimensioned framework which will further

expedite silica functionalisation efforts for gas separation membranes as well as in applications such as catalysis and controlled chemical release.

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OC107

## **Adsorption of Submicrometer-sized Cationic Sterically-Stabilised Polystyrene Latex at the Air-Water Interface: Foam Behavior and Contact Angle Determination by Ellipsometry**

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Near-monodisperse, sterically-stabilised cationic polystyrene latexes of either 122 nm or 310 nm diameter were prepared by aqueous emulsion polymerisation using cheap, readily available reagents. At low pH, these latexes stabilised foams prepared by either hand-shaking or by using a foam column. SEM studies confirmed that the dried foam mainly comprised well-defined bilayers, which suggests that each air bubble is stabilised with a latex monolayer. Adsorption of the same latexes at the planar air-water interface was studied using the Langmuir-Blodgett trough technique. Surface pressure isotherms confirmed particle desorption from the interface on repeated compression of the latex monolayers. For the 122 nm latex at pH 2, ellipsometric analysis enabled a contact angle of approximately 43° to be calculated from a simple two-layer model, which suggests that these particles have only moderate wettability. Similar results were obtained for the 310 nm latex, but the data were much less reliable in this case due to additional background particle scattering.

## Dynamic Forces between Bubbles in Foams using Atomic Force Microscopy

Raymond Dagastine, Ofer Manor, Ivan Vakarelski, Geoffery Stevens, Franz Grieser, Derek Chan

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The dynamic interactions between bubbles are highly sensitive to the nature of the adsorbed molecules at the air-water interface. We have extended the experimental and theoretical methods developed to study the dynamic interactions between droplets<sup>1</sup> using Atomic Force Microscopy (AFM) to the interactions between two micro-bubbles<sup>2</sup> or a micro-bubble<sup>3</sup> and a flat surface in aqueous solution. These measurements show that bubble collisions, even at speeds comparable to Brownian motion, are dependent on a combination of equilibrium surface forces, hydrodynamic drainage forces and interfacial deformation. Bubble collisions were studied in the presence and absence of added stabilizers exhibiting extreme differences in their dynamic force behaviour. Quantitative modeling<sup>3,4</sup>, which shows excellent agreement between experiments and calculations, demonstrates that the variations in the dynamic forces arise from changes in both the equilibrium surface forces and hydrodynamic drainage effects. These results have implications in applications as wide ranging as froth floatation to micro-fluidics.

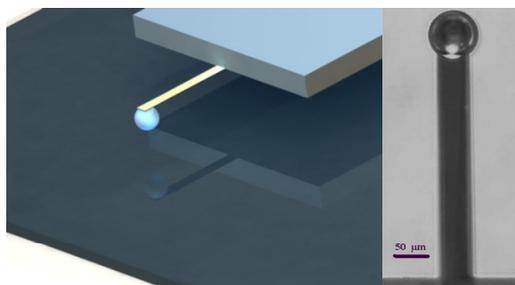


Figure 1: (left) A schematic of a microbubble attached to a custom made AFM cantilever. (right) A microscopy image of an actual microbubble ( $R \sim 50$  microns) attached to an AFM cantilever.

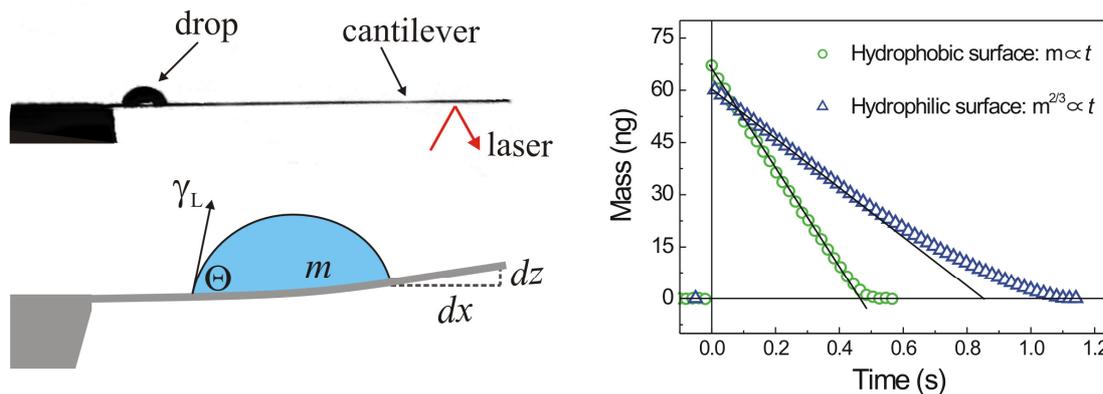
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## Evaporation Models for Microdrops of Water on Hydrophobic and Hydrophilic Surfaces tested by AFM-Cantilever Measurements

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We introduce a technique, which allows measuring the mass and shape of microdrops during evaporation with a mass resolution of 100 pg and a time resolution of 5 ms. The technique is based on the bending of micro-machined silicon cantilevers. The bending is induced by the mass of the drop, by its capillary pressure, and its surface tension  $\gamma_L$ . We demonstrate that microscopic water drops evaporate differently from hydrophobic ( $m \propto t$ ) and hydrophilic ( $m^{2/3} \propto t$ ) silicon surfaces. For the evaporation from hydrophilic surfaces we observed an additional surface stress during the last stages of evaporation. The drop flattens while evaporating and finally becomes a thin water film, stabilized by the disjoining pressure, before completely drying. For hydrophobized silicon our experimental results agree with evaporation laws for macroscopic drops, allowing us to extend their validity to microscopic drops with diameters from 100  $\mu\text{m}$  to below 10  $\mu\text{m}$ .



**FIGURE** Left: Image of cantilever with water droplet deposited close to its base with schematic of laser optical lever, and not-to-scale cartoon of bent cantilever with a drop. Right: Drop mass versus time on hydrophobic and hydrophilic surfaces.

OC110

## Ion-specific Bubble Coalescence Inhibition: Nonaqueous Solvents

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Bubbles in pure water, or any pure liquid, are unstable and rapidly coalesce because the interface is energetically unfavourable. The mechanism of inhibition of bubble coalescence in water by non-surfactants, and in particular by high concentrations of electrolyte, is an unresolved problem in surface science. An example of this phenomenon is the surf observable in salty seawater, but not in fresh water. Notably, some electrolytes have no effect on bubble stability. It has been found that an electrolyte's effect depends on the combination of cation and anion present.<sup>1</sup> A set of empirical combining rules was developed, but the reasons behind this ion-specificity of bubble coalescence inhibition remain unknown. I report recent findings using terminal bubble-rise velocity measurement to show that the gas-aqueous solution interface is mobile in both inhibiting and non-inhibiting electrolyte solutions. Thus, inhibiting salts, unlike surfactants, do not act via immobilisation of the interface and slowing of thin-film drainage.

I also report on bubble coalescence inhibition in non-aqueous solvents. The interface should be unstable in any pure liquid, and we have found that electrolytes can inhibit bubble coalescence in several solvents. Some solvents (formamide and propylene carbonate) also show ion-specificity and evidence of combining rules analogous to those in water. Thin-film balance measurements of film drainage in nonaqueous electrolyte solutions are presented, and compared with data from aqueous films.

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## The Interaction Between a Very Small Rising Bubble and a Hydrophilic Titania Surface: Experiment

Luke Parkinson<sup>1</sup>, John Ralston<sup>1</sup>, Rogerio Manica<sup>3</sup>, Derek Chan<sup>2</sup>

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The approach of a gas bubble and a hydrophilic, charged solid in an aqueous electrolyte is influenced by hydrodynamic, as well as surface forces. The hydrodynamic resistance to drainage depends greatly on whether a slip, or no-slip boundary condition applies at the L-V interface. Electrostatic, and repulsive van der Waals dispersion forces influence drainage from the intervening liquid film and determine the final, equilibrium film thickness ( $h_{\text{equil}}$ ). Very small bubbles are ideal for making measurements of both the film drainage process and dynamic disjoining forces as their small buoyancy, combined with high Laplace pressure, minimises deformation, in a flow regime where the Reynolds number approaches zero.

This work uses high-speed, dynamic, thin-film interferometry, to measure film drainage and  $h_{\text{equil}}$  as a function of buoyancy force. Novel apparatus was used to produce single gas bubbles, in the diameter range 15  $\mu\text{m}$ -120  $\mu\text{m}$ . These were allowed to rise freely, before normal collision with a planar, hydrophilic  $\text{TiO}_2$  surface in  $0\text{-}10^{-1}$   $\text{mol}\cdot\text{dm}^{-1}$  aqueous KCl or  $\text{N}(\text{CH}_3)_4\text{Br}$  at pH 3.5 or pH 6.3. This reversed the sign of the potential at the  $\text{TiO}_2$  surface. Recording the collision process at 1000 frames per second enabled calculation of the equilibrium film thickness and the time evolution of this film. Incorporation of dynamic surface forces into a drainage model allowed evaluation of dynamic and equilibrium surface forces, in addition to describing the hydrodynamic boundary condition at the liquid-vapour interface. Where both the bubble and  $\text{TiO}_2$  were negatively charged, drainage occurred with a no-slip hydrodynamic boundary condition at the bubble surface, even though it was mobile prior to interaction. Reversing the charge at the  $\text{TiO}_2$  surface induced an attractive component to the drainage curve. In addition, partial hydrodynamic slip was apparent at pH 3.5 for higher ionic strengths. Equilibrium film thickness was sensitive to differences in buoyancy force, surface potential and ionic strength. A process involving complex ionic redistribution during drainage of the thin film is inferred.

## Plasmon Interactions of Closely-Spaced Au Nanoparticles

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The interaction of electromagnetic light with conductors causes the free electrons on the surface of the metal to oscillate in resonance with the light wave. These waves are referred to as surface plasmons and are known to propagate along the surface of metals. The further miniaturization of the metal to form nanoparticles results in the spatial confinement of conduction electrons within the particles. The collective oscillation of the conduction electrons then forms the well-known localised surface plasmon resonance (LSPR) which gives rise to the intense colours of such particles. The resonance energy is highly sensitive to the morphology of the particle.

A direct consequence of the LSPR is an enhancement of the field close to the nanoparticle surface, known as the near field. When two particles are located close to one another, the near-fields of the two particles interact. The LSPR interaction between nanoparticles is highly distance dependent and near-field coupling of particles spaced less than one diameter apart allows the transmission of light energy through an array or down the nanoparticle chain. Previous investigations into these interactions have predominantly utilised electron beam lithography (EBL). However, the resolution limit of modern EBL is about 2 nm. Whilst there have been many theoretical investigations of the nanoparticle interactions when the nanoparticles are less than 2 nm apart, experimental fabrication and investigation of such particle pairs has remained a challenge.

We report our investigation into the coupling between two discrete nanoparticles, specifically gold nanorods, with interparticle distances smaller than 2 nm and with the pairs in different orientations. The particles were chemically synthesized and are single crystals. The investigation was carried out utilizing the recently reported Focussed Ion Beam Registration Method,<sup>1,2</sup> allowing correlation of the SEM image of the particle pairs with their scattering spectrum. The scattering spectra and SEM images of particle pairs arranged both side-to-side, end-to-end and at right angles were collected, as well as some pairs arranged side-to-side but with a lateral displacement between the two particles. The observed spectra are compared with those calculated using the discrete dipole approximation (DDA) and discussed in terms of plasmon hybridization.

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OC113

## **Carboxymethyl Cellulose Adsorption on a Model Hydrophobic Surface Studied with QCM-D: Effect of Ionic Strength and pH on Conformation and Surface Wettability**

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*Ian Wark Research Institute, University of South Australia, Mawson Lakes, SA 5095, Australia*

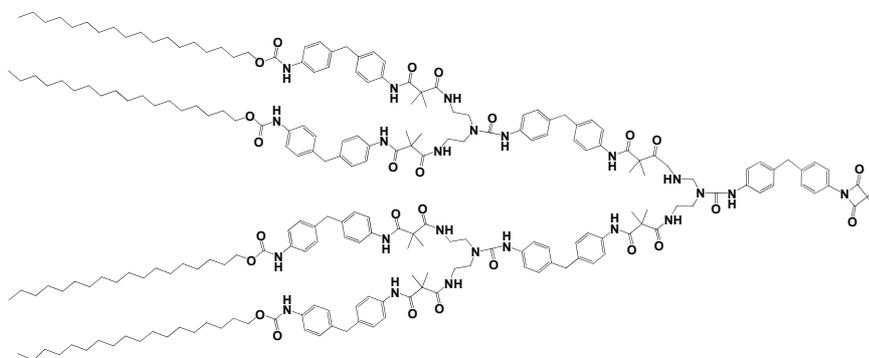
Carboxymethyl cellulose (CMC) is a polymer of significant industrial importance in the area of mineral processing. It has two primary applications in this area: as a dispersant to modify the rheology and particle interactions in a flotation feed; and as a depressant for gangue minerals. In the latter application, the adsorbed amount of CMC is directly related to its effectiveness in preventing the recovery of gangue minerals. Solution conditions (pH and ionic strength) can be altered to maximise this adsorbed amount. Many studies have been performed to quantify the adsorption of CMC on hydrophobic surfaces (such as talc), but few reports have been made on the adsorption kinetics, or the conformation of the polymer at a hydrophobic surface, both of which will affect the ability of the polymer to reduce gangue mineral recovery. We have studied the adsorption of CMC on a model hydrophobic surface (mixed thiol layer on gold) using the Quartz Crystal Microbalance with Dissipation (QCM-D) under conditions of varying pH and ionic strength. The substrate and methodology allow for the *in situ* study of CMC adsorption, with the ability to determine the adsorption kinetics, the adsorbed layer conformation, and how this adsorbed layer conformation changes with alteration to solution conditions. Complementary data on the polymer adsorption process has been obtained with tapping mode atomic force microscopy (TMAFM). In addition, the wettability of the substrate, with and without an adsorbed polymer layer, has been determined using captive bubble contact angle measurements. The adsorbed layer conformation has been found to be very sensitive to solution conditions, due to the varying degree of ionisation of the carboxyl-substitution on the cellulose backbone, and the screening of these charged groups within the polymer layer. In addition, the ability of the polymer to reduce the wettability of the substrate has been found to be very sensitive to the conformation and water content of the adsorbed layer.

## Superhydrophobic Polymer Films Based on Malonamide Dendrons with Peripheral Long Alkyl Chains

Ru-Jong Jeng, Wei-Ho Ting, Shenghong A Dai, Chao-Chin Chen

National Chung Hsing University, Taichung, Taiwan

A new class of hydrogen bonding rich malonamide dendrons with peripheral long alkyl-chains have been developed (Scheme 1). Different generations of dendrons were respectively grafted to amine-containing polystyrenes to form side-chain dendritic polymers, which were used for thin film preparation. Self-assembly phenomenon would be brought about by the presence of side-chain grafted dendrons via the subtle balance between hydrogen bonding interaction and van der Waals force. The dendrons of relatively higher generation accompanied with more urea/malonamide linkages and alkyl chains enhance the hydrogen bonding interaction at inner segment and the van der Waals force at periphery, respectively. Therefore, the honeycomb-like polymeric films could be easily induced by the breath-figure process. To further mimic the rough hill-and-valley structure of lotus leaves, a physical method was adopted in this study by peeling off the first layer of honeycomb-like polymer film. By this way, a rod-valley-like structure would be present on the surface to exhibit superhydrophobicity. In view of the above, it is believed that the superhydrophobic polymer films investigated in this study could be utilized as a potential tool in special applications, such as bio-tape (physically attached) for daily use, in vivo vascular stent tissue engineering, vesicle self-assembly for drug delivery, and microanalysis for analytical chemistry.



**Scheme 1.** Schematic drawing of [G-2.5] dendron with peripheral long alkyl chains

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OC115

## **Dynamic Interactions forces between particles and droplets in response to perturbations of surfactant adsorption**

Hemayet Uddin<sup>1,2</sup>, Geoffrey Stevens<sup>2</sup>, Derek Chan<sup>3</sup>, Franz Grieser<sup>2</sup>, Raymond Dagastine<sup>1,2</sup>

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The dynamic interaction forces between a silica particle and an oil droplet immobilized in gold coated silica surface immersed in surfactant solution have been measured using atomic force microscopy. The measured forces are characterized during the perturbation of surfactant adsorbed at the oil/water interface to a variety of perturbations to the environment (e.g. concentration, pH, illumination, temperature). The effects of these perturbations on both equilibrium and dynamic surfaces forces as well as the time scales of these processes will be discussed in the context of hydrodynamic drainage of the thin film and the resultant deformation of the oil/water interface.

OC116

## The Interaction Between a Very Small Rising Bubble and a Hydrophilic Titania Surface: Theory

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We developed a theory to model recent experimental data in which a bubble rises under gravity towards a hydrophilic titania surface. The model takes into account surface tension, surface forces and deformation of the bubble. It was adapted from a previous version in which a drop was driven towards a flat surface at constant velocity [1]. The velocity is now allowed to change according to a balance between gravity and interaction forces. Taking into account the small size of the bubbles (15-120  $\mu\text{m}$ ), which implies a small buoyancy force and a high Laplace pressure, we can further simplify the model by neglecting deformation. This implies a simple evolution equation in time in which the gravity force is equated to the drag and surface forces (including van der Waals and double-layer interactions). The drag force is calculated from Stokes flow in the limit of close separations [2]. Important features to be investigated are the repulsive surface forces acting to stabilize the film close to contact. The boundary condition at the bubble interface [3] is another important issue since it can range from fully mobile to immobile depending on properties of the experimental system.

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OC117

## It's Easy To Understand Particle Dispersion In Air – Isn't It?

Ingrid Heinicke, [Ian Larson](#)

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Given the immense knowledge and understanding of particle behaviour in both aqueous and non-aqueous systems, its surprising that the particle dispersion in air is still a significant, and costly, problem in the pharmaceuticals discipline. We all know that in air capillary forces dominate van der Waals forces and therefore if we want to completely disperse a powder it must consist of hydrophobic particles. This study challenges this belief and throws up some unexpected, and as yet unexplained, results.

Pharmaceutical powders for inhalation consisting of drug and inactive components with different contact angles were employed to assess the contribution of capillary forces on the dispersion of dry powder mixtures. The contact angles of the particles were obtained by a capillary rise method or from literature. Mixtures consisting of different combinations of hydrophilic and hydrophobic particles were prepared and their in vitro aerosol dispersion was determined. As expected, the dispersion of the hydrophobic drug increased when mixed with hydrophobic particles. However, the dispersion of our model hydrophilic drug increased with INCREASING hydrophilicity of added particles.

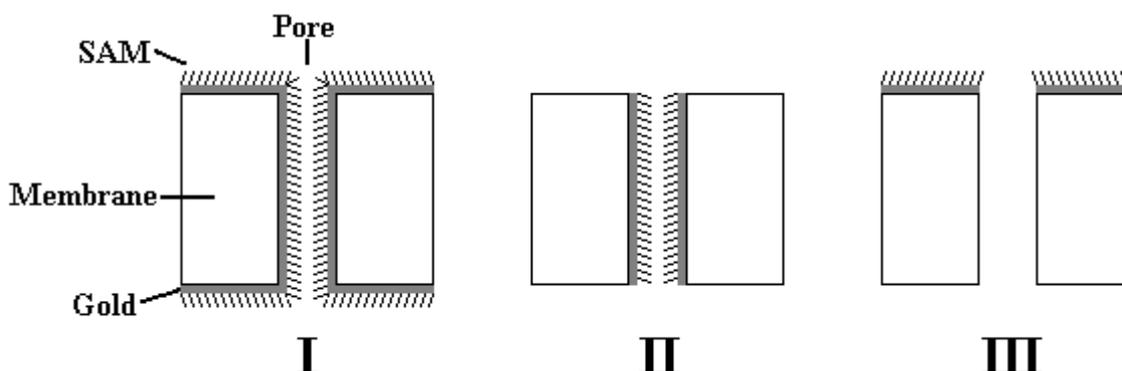
Overall though, only small differences were found in dispersion efficiency due to the contact angles of the drug and inactive particles in the model systems investigated, indicating that capillary forces were not the dominant force acting between the particles in these dry powder mixtures. This leads us to wonder: what are the dominant forces?

## Controlled Thiol Deposition on Hybrid Gold-Polycarbonate Membranes

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Polycarbonate (PC) membranes were coated with gold via sputtering and electroless deposition. Several hybrid membrane structures were produced in which the sputtering technique was used to coat gold only on the top surface of the PC membrane. Electroless deposition was used to prepare PC membranes coated entirely with gold and also to prepare samples with gold deposition only within the pores of the membrane. Gold-thiol chemistry was exploited in which the thiols only assembled on the gold coated regions of the membrane thus providing controlled positioning of functional regions (see Fig). The highly hydrophobic thiol, 1H,1H,2H,2H-perfluorodecanethiol, was used to form self assembled monolayers (SAMs) on the membranes. Transport of hydrophilic and hydrophobic dyes across the membranes were used to investigate the effects of the controlled positioning of SAMs. The selectivity of these three membrane structures were investigated based on whether the membrane is entirely functionalised, functionalised only within the pores or functionalised only on the top surface.



OC119

## Adsorption and Dipole Surface Orientational Order at Liquid Surfaces

Bruce Law, Jae-Hie Cho, John Carpenter, Dan Smith

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Adsorption at surfaces has been a topic of considerable interest since Gibbs introduced his famous adsorption equation in 1875. However, only in the last few years, has adsorption become quantitatively understood (at least in the vicinity of a critical point). Adsorption is far more complex than perhaps one might envision. At the liquid-vapor interface of a binary liquid mixture one can find (i) strong adsorption (where one component completely saturates the surface),<sup>1</sup> (ii) competitive adsorption (where the two species compete for surface sites),<sup>2</sup> as well as, (iii) dipole surface orientational order (due to dipole-image dipole interactions).<sup>3</sup> In this talk we discuss these various modes of adsorption.

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## Poster Abstracts

PP001

## Concentration Depth Profiles of Inorganic Ions at Liquid Surfaces

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A point of discussion is whether or not inorganic ions like iodide or bromide adsorb preferentially at liquid surfaces. For a long time it was assumed that ions of inorganic salts are depleted at liquid surfaces since the surface tension increases with increasing the concentration of the salts.

Thermodynamic relations can not be used to derive detailed information about the molecular structure of surfaces. Thus it is important to investigate the structure of liquid surfaces directly. Neutral Impact collision ion scattering spectroscopy (NICISS) is one of the very few techniques that can be used to determine directly the molecular structure of liquid surfaces. Among others concentration depth profiles with a depth resolution of a few Å can be determined. Up to now NICISS was limited to liquids having a low vapour pressure since the measurements are carried out in high vacuum. Recently we succeeded also to investigate aqueous surfaces with NICISS.

Investigating aqueous surfaces became possible by placing the target in a closed housing. The investigation of the surface is carried out through a small aperture. The aperture acts as a differential pumping stage and the pressure inside the housing is close to the vapour pressure of the aqueous solution. The depth information in a NICISS experiment is determined from the energy loss of the projectiles in matter. Since the gas phase in the case of aqueous surfaces can not be neglected the energy loss in the gas phase has to be gauged separately.

We investigated aqueous solutions of LiI and solutions of LiI, LiBr and LiCl in formamide [1]. The concentration of the formamide solution was less than 1 molal and the measurements were carried out at 6°C. The concentration depth profile of iodide in the formamide solution is non-monotonous. It shows a maximum at the surface followed by a minimum below the surface. The aqueous solutions had a concentration of about 5 molal and the measurements were carried out at -5 to -14 °C [2]. The concentration depth profile of the aqueous solution increases monotonous from the surface to the bulk and does not show a preferential adsorption of iodide at the surface.

1 G. Andersson, H. Morgner, L. Cwiklik, and P. Jungwirth, "Anions of Alkali Halide Salts at Surfaces of Formamide Solutions: Concentration Depth Profiles and Surface Topography", *J. Phys. Chem. C*, 111 (2007) 4379.

2 G. Andersson, H. Morgner, and P. Pohl, "Energy Loss Straggling of Helium Projectiles at Low Kinetic Energies: Concentration Depth Profiles of Inorganic Salt Solutes in Aqueous Solutions", *Phys. Rev. A*, 78 (2008) 032904.

PP002

## **Medicinal Plant Resources for Bioprospecting and Drug Development in Parbat District of Nepal**

Ram Lal Shrestha<sup>1</sup>, Lekh Nath Gautam<sup>2</sup>

<sup>1</sup>*Tribhuvan University, Amrit Science Campus, Kathmandu, Nepal,* <sup>2</sup>*Natural Product Laboratory, Thapathali Kathmandu, Nepal*

The present paper describes the important medicinal plant species that have been used by local people and tribal healers of Nepal. Based on the locality and availability, the herbal wealth has enormous potentiality for commercial cultivation of some useful herbs and production of safe green medicines by establishing plant based industries in the tribal rich tract for the socio-economic development and conservation of genetic diversity. The wide geographical and climatic diversity provides a repository of valuable medicinal and economic plant wealth as a natural gift for the Aarthar Dadakharka, Panchase forest, Saunepane of Ramja Thanti and forest of nearby Silmi as well as Pang and Phalebas of Parbat district. Today, the search for new drugs having potential therapeutic compounds is of vital importance globally.

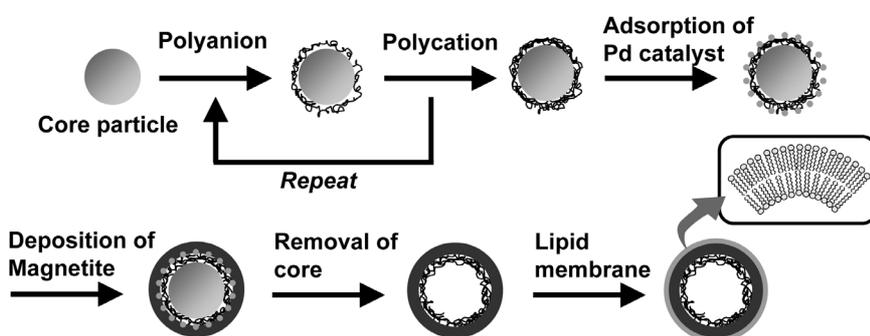
## Magneto-Responsive Hollow Capsules Prepared via Colloid Templating

Kiyofumi Katagiri, Masato Nakamura, Yuji Imai, Kunihito Koumoto

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Magnetite ( $\text{Fe}_3\text{O}_4$ ) is a magnetic material used for recording media. Recently, due to its high biocompatibility, it is applied to medical fields such as hyperthermia therapy. Previously, we succeeded in preparing  $\text{Fe}_3\text{O}_4$  patterning thin films on self assembled monolayer via the aqueous solution process [1]. On the other hand, a various functional organic-inorganic hybrid capsules have been successfully fabricated via the layer-by-layer (LbL) assembly technique [2]. In this study, novel hybrid capsules formed with  $\text{Fe}_3\text{O}_4$  nanoparticles and lipid membrane were prepared via colloid templating. First, the polyelectrolyte multilayers were formed on the colloidal particles by alternative adsorption of oppositely charged polyelectrolytes using LbL assembly. Then,  $\text{Fe}_3\text{O}_4$  was deposited on the polyelectrolyte multilayers in aqueous solution. Hollow capsules were obtained after removal of the core particles. Lipid bilayer membrane was additionally coated on the capsule to control the molecular permeability of the shell of the capsules.  $\text{Fe}_3\text{O}_4$  nanoparticles heat in alternative magnetic field as a result of magnetic hysteresis loss. On the other hand, the permeability of lipid membrane increases above the phase transition temperature. Therefore, the  $\text{Fe}_3\text{O}_4$ /lipid hybrid capsules can be expected as magneto-responsive capsules which release entrapped materials in the magnetic field.

The homogeneous deposition of  $\text{Fe}_3\text{O}_4$  on the colloidal particles and the formation of the hollow capsules were confirmed by electron microscopy. The average size of deposited  $\text{Fe}_3\text{O}_4$  nanoparticles was ca. 13 nm. The ferromagnetism of the deposited  $\text{Fe}_3\text{O}_4$  nanoparticles was confirmed by vibrating sample magnetometer. The temperature of the dispersion of  $\text{Fe}_3\text{O}_4$  deposited capsules increased higher than the phase transition temperature of lipid membrane when the alternative magnetic field was applied to the dispersion. In addition, it is confirmed that the release of entrapped dye molecules from the capsules by applying alternative magnetic field.



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PP004

## Study on Formation Process and Structure of Polyproline SAM on Gold Surface

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The formation of monolayer of a functional peptide on a solid surface has attracted much attention because one can introduce a wide range of functionalities. Polyproline is an interesting peptide as its conformation varies dramatically with solvent. For example, it takes ppl and pp $\Pi$  conformation in water and methanol, respectively. In this study, we have investigated the formation process and the structure of self assembled monolayer(SAM) of polyproline on gold surface in water and methanol using various techniques including electrochemical reductive desorption and infrared(IR) spectroscopy.

The Formation process of SAM of polyproline was investigated by immersing gold coated silicon prism in 1  $\mu$ M polyproline D<sub>2</sub>O solution. As shown in Fig. 1, an amide I band at 1628  $\text{cm}^{-1}$ , which is assigned to C=O stretching in ppl conformation, and CH bending at 1449  $\text{cm}^{-1}$  were increased, but were constant with immersion time. The formation process of SAM of polyproline was also followed by reductive desorption by dipping gold electrode in 5  $\mu$ M polyproline aqueous solution and then sweeping the potential negatively in 0.5 M KOH aqueous solution.

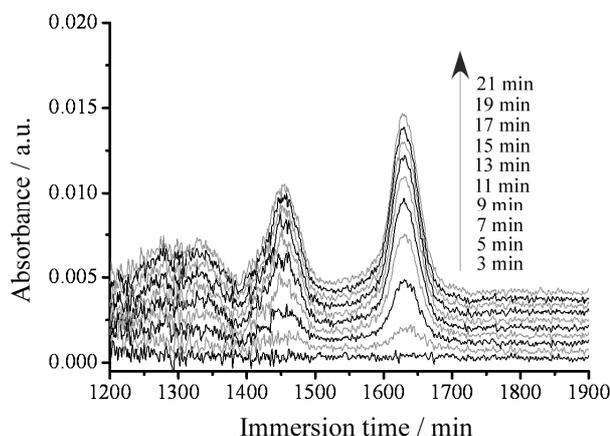


Figure 1. IR spectra of gold surface during adsorption process of polyproline in 1  $\mu$ M polyproline D<sub>2</sub>O solution.

The saturated coverage and height of SAM of polyproline were determined to be 56  $\mu\text{C}/\text{cm}^2$  and 3.96 nm for SAM formed in water and 39  $\mu\text{C}/\text{cm}^2$  and 2.86 nm for SAM formed in methanol, respectively, which is in good agreement with those expected for the structure of ppl and pp $\Pi$  of polyproline.

PP005

## Adsorption Behaviour of Polyelectrolyte onto Alumina Particles and its Effect on the Particles' Dispersion State

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It is very important to control slurry properties in order to fabricate products with high quality and reliability in various material processes. However it is difficult to evaluate and control particles dispersion state properly, so the optimal conditions for slurry preparation have been often determined by trial and error. In general a dispersant such as a polyelectrolyte is added to control the particles' dispersion state. It is well known that the dispersion states were classified into these three states and it changes with an increase in the additive amount of dispersant, that is, network flocculation, dispersion and aggregation. Therefore the adsorbed amount of dispersant is a key factor in determining the particles dispersion state.

If the dispersant adsorb physically on the particle surface then the adsorbed amount of the dispersant should depend on the residual concentration and it should not depend on the particle concentration, so the adsorption isotherm of a dilute slurry seems to agree closely with that of a dense slurry. However some researchers reported that the adsorbed amount was independent of the residual concentration. Therefore in this paper we measured the adsorbed amount of dispersant in extensive concentrations of both particles and dispersant, and besides that we tried to make the adsorption mechanism of dispersant on ceramic particles clear.

In this study slurries were prepared by ball milling for 1h. The raw material was alumina with an average particle size of 0.5  $\mu\text{m}$ . Initial particle concentration was changed from 2.5 to 35 vol%. A commercially available ammonium salt of polycarboxylate was used as a dispersant, changing the additive amount from 0.5 to 6.0 mg per g-alumina. The prepared slurries were poured into test tubes and kept at least two days. After that the slurries were centrifuged and the sampled supernatant was analyzed by TOC. The apparent adsorbed amount of dispersant was determined by deducting the residual amount from the additive amount.

It was shown that the apparent adsorbed amount of dispersant depends on only the additive amount, not on the residual concentration in wide-ranging particle concentration. It was also found that the ratio of adsorbed amount to residual amount of dispersant was almost constant regardless of both particle concentration and dispersant concentration. The absorbed dispersant hardly desorbs even if the solution was diluted, suggesting that the dispersant should very strongly adsorb on alumina surface.

PP006

## Control of Oxygen Adsorption Control on Organometallic Complexes due to Magnetic Fields

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Magnetic fields may bring about serious influences on structures and properties of weak magnetic materials.<sup>1</sup> We examined whether or not the structure of mesoporous silicas and porous organometallic complexes can be changed by applying steady magnetic fields to reactant solutions during synthesis. Also, magnetic field-promoting adsorption (magneto-adsorption) of oxygen and hydrogen on zeolites and carbon materials at low temperature have been examined.

An aqueous pyrazine-2,3-dicarboxylic acid ( $H_2pzdc$ ) solution was added to an aqueous  $Cu(ClO_4)_2$  solution containing pyrazine ( $pyz$ ) under zero magnetic field and magnetic fields at 298 K for 1 h. Blue precipitates prepared under zero field showed an XRD pattern of  $Cu_2(pzdc)_2(py_2) \cdot 2H_2O$  (CPL-1)<sup>2</sup> which was spherical aggregates comprising plate-like microcrystals, but those prepared under magnetic fields contained needle-like microcrystals whose amount increased with increasing magnetic field intensity. The needle-like crystal prepared at 6 T was  $Cu(pzdc)(pyz) \cdot ClO_4$  having no micropores. Magnetic fields led to the new structure or composition of the complex. The latent pore crystal (LPC) having pores opened by adsorption over a critical (gate) pressure  $P_c$ ,  $[Cu(bpy)(H_2O)_2(BF_4)_2](bpy)$ <sup>3</sup>, was also changed in morphology by magnetic fields, but not its crystal structure.

We measured the magneto-adsorption at low temperature using a new pressure-feedback adsorption system, which can keep a defined pressure during the adsorption progress. The magneto-adsorption of  $O_2$  and  $H_2$  on CPL-1 at 77 K and  $O_2$  on LPC was observed. It suggests the electron transfer between adsorbed molecules and solid surfaces, because the pressure change  $\Delta P$  by magnetic field is given by  $\Delta P \propto \Delta\chi H^2 P_0$  ( $\Delta\chi$ , magnetic susceptibility change during adsorption;  $H$ , magnetic field intensity;  $P_0$ , total pressure). Moreover, the  $P_c$  of LPC shifted to higher pressure by magnetic fields, i.e., from  $P_c^0$  at zero field to  $P_c^M$  at 6 T. Thus, a 6 T magnetic field induced change of adsorption amount at an  $O_2$  pressure between  $P_c^0$  and  $P_c^M$ . The new magnetic field effect on adsorption may be referred to as magneto-gate-adsorption.

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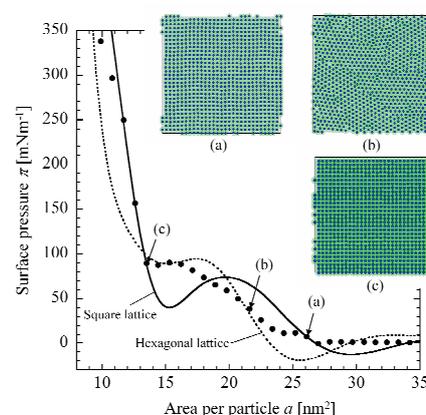
## Hexagonal-Square Lattice Phase Transition in 2D Colloidal Monolayer Induced by Steric Layer Potentials: Analysis by Means of Monte Carlo Simulations

Masayuki Aoshima<sup>1</sup>, Akira Satoh<sup>1</sup>, Roy Chantrell<sup>2</sup>

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Recently, self-assembled monolayers composed of FePt nanoparticles have been studied actively in order to develop an ultra-high density magnetic recording media. Scanning electron microscope observations of the self-organized monolayer composed of highly concentrated FePt [1] or Co [2] nanoparticles clearly show both hexagonal and square microstructures. It is considered that the overlapping of steric layers surrounded by the metal nanoparticles induces this characteristic change in the lattice structure. Hence, it is very important to investigate the influence of the steric layer potentials on the microstructures of the monolayer, especially for high densities. In this study, we carried out Monte Carlo simulations of the monolayer by considering a phenomenological steric layer potential consisting of both repulsive and attractive terms, which can qualitatively explain the results observed with the electron microscope [3]. We also analyzed the microstructures of the monolayer by means of radial distribution functions, and calculated the pressure( $\pi$ )-area( $a$ ) isotherms.

Figure 1 shows the simulation results for the  $\pi$ - $a$  isotherms, as well as snapshots at each characteristic density. The solid and the dotted lines represent isotherms for the assumed systems which are forced to maintain their square and hexagonal lattice structures, respectively. The simulated microstructures change from (a) square into (b) hexagonal lattice structure with increasing density. The reason for the appearance of the square lattice at low densities is that particles tend to occupy larger areas in order to maximize the entropy. When the system is under pressure, hexagonal lattice structures form in order to decrease the overall area of the system. However, at even higher densities (c), the square lattice structure appears once again. The decrease in coordination number from 6 to 4 avoids significant increase in repulsive energy, and as a result the particles at second-neighbor distance become energetically stabilized since the distance coincides with the distance of the minimum of the phenomenological potential.



**Fig. 1**  $\pi$ - $a$  isotherms and snapshots at characteristic densities. Closed symbols represent a simulated isotherm, while the solid line and the dotted line represent the estimated isotherms for the assumed square and hexagonal lattice structures, respectively.

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**PP008**

## **Behaviour of Aqueous Foam Stabilised by Nanosilica & Non-ionic Surfactant**

Timothy Hunter, Graeme Jameson, Erica Wanless

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The use of nanoparticles as stabilisers in foams and emulsions is a subject of interest for many scientific and industrial fields and there are a number of potential applications, from food colloids to cosmetics, chemical cleaners, novel sintered ceramic foams and mineral flotation. Most research has focused on the use of nanoparticles as a substitute for traditional surfactants; however, research into mixed systems is also very important. This is because many natural and industrial systems contain combinations of different species and because of the evidence for synergistic stabilisation. Using partially hydrophobic, 270nm silica particles and non-ionic Triton X-100 surfactant, the foam stability of various mixed systems was investigated to probe the parameters required for enhanced stabilisation. These results helped to highlight the possible interactions between the two species at the air-water interface. The interfacial particle-surfactant interactions were related to studied changes in particle contact angle, surfactant adsorption, system surface tension and surface pressure behaviour.

It was found that adsorption occurred in a two stage process, with the particles being rendered completely hydrophilic at high surfactant concentrations. In low concentrations, addition of surfactant led to a ~20% increase in long-term foam volume generated from 4 wt% particle dispersions. The reason for this stabilisation synergy was principally from the surfactant causing bridging flocculation of the particles at the interface, producing enlarged sterically-strong interfacial barriers, which reduced bubble coalescence.

PP009

## **Self Assembly of a Polybutadiene-Poly(methacrylic acid) Copolymer in Water: Effect of pH on Morphology and Kinetics**

Christine Fernyhough, Giuseppe Battaglia, Tony Ryan

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Polybutadiene-poly(methacrylic acid) belongs to a class of materials known as amphiphilic block copolymers. The polybutadiene is very hydrophobic but it is covalently bonded to poly(methacrylic acid) which is hydrophilic in character. The copolymer can be directly dissolved in water where it forms different structures depending on the pH. Increasing the pH increases the degree of ionisation of the PMAA and thus the degree of repulsion between neighbouring chains. As a result, very large vesicles become smaller vesicles and then worm-like micelles and finally micelles are formed as the solution becomes more basic. Transmission Electron Microscopy, Dynamic Light Scattering and zeta-potential measurements have been used to examine the transitions between the different species and it has been possible to elucidate the mechanisms by which the transitions occur. The kinetics of the transformations have also been studied with the vesicle to cylinder to micelle transition being found to be much quicker than the reverse process.

PP010

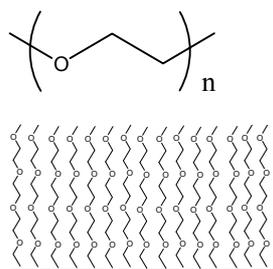
## Bacterial Adhesion to Poly(ethylene oxide) Polymer Brush Surfaces – Influences of Temperature and Salt Concentration.

Jacob Shephard

*University of Otago, Dunedin, New Zealand*

Over the last decade there has been considerable interest in the properties of poly(ethylene oxide) (PEO) polymer brush surfaces, partly due to their resistance to protein adhesion and bacterial attachment. Potential applications include coatings for prosthetic implants to reduce infection and surface modification to prevent biofouling in a wide range of environments. The initial stage of marine fouling and infection in implant patients often involve the deposition of dissolved organic material and the attachment of microorganisms.<sup>1,2</sup>

The reported resistance of PEO surfaces to microbial attachment and protein adhesion varies dramatically between different studies however, PEO polymer brushes have been shown to be extremely effective when compared to other surface chemistries.<sup>3,4</sup> In recent work the adjustable parameters of chain length and surface density have been shown to affect protein adhesion. Optimum parameter values have been proposed for the experimental conditions but a clear understanding of the mechanisms that reduce adhesion has not yet been achieved.<sup>5</sup>



**Fig. 1.** Poly(ethylene oxide) (PEO) and a PEO polymer brush surface

In this study PEO polymers were anchored to boehmite (AlOOH) surfaces. The response of the PEO polymers to changes in electrolyte and temperature were monitored using Wilhelmy plate tensiometry (contact angle), zeta potential measurements and ATR-IR spectroscopy. Temperature and electrolyte concentration influenced the polymer brush and the hydrophilicity of the surface. The impact of polymer brush dynamics on the initial rate of attachment of the gram negative bacterium *Pseudomonas aeruginosa* will be discussed.

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**PP011**

## **Water Soluble Polymers for Water Purification and Vesicular Encapsulation**

Patrick Fairclough, Christine Fernyhough, Craig Fairgrieve, Sarah Kettlewell

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Poly(acrylic acid) (PAA) is a pH responsive commodity polymer. Its major use is in disposable nappies (diapers), however it also finds use where water absorption is required. We report on a series of measurements on pH responsive vesicles that have the potential for controlled release of DNA, RNA and a range of drugs. We have explored the stability of these vesicles over a range of salt concentrations and pH values. In addition we have studied colloidal particles of PAA homopolymer and copolymers as water purification systems in the developing world.

## Reversible Coalescence in Kinetically Stabilised Emulsions

Nelly Bulgarelli, Kathryn McGrath

*MacDiarmid Institute for Advanced Materials and Nanotechnology, School of Chemical and Physical Sciences, Victoria University of Wellington, Wellington, New Zealand*

Emulsions, which are kinetically stabilised mixtures of two immiscible fluids (e.g. oil and water), are the main stay of the dairy, cosmetic and road industries and are also important in as far reaching areas as drug delivery, polymer synthesis and paint technology. Their customised exploitation however, remains largely empirical; despite their wide spread use. Relationships between ingredients, composition, formulation method and energy, interfacial parameters and microstructure define the emulsion size distribution (nm –  $\mu\text{m}$ ), its lifetime, stability, mechanism of destabilisation and use. However, the nature of the linkages between these parameters is largely unknown and little work has focused on the basic understanding of these systems from a kinetic perspective [1,2], particularly the interaction of the solvents with the emulsifiers.

Emulsions superpose much of the complexity of thermodynamically stable self-assembled systems, for example their dynamic nature, on the general phase separation that takes place in these systems due to their inherent kinetic stabilisation. Hence, within an emulsion, parameters such as the interfacial tension need not equate to their thermodynamic value. This increases the complexity of these systems enormously and potentially augments the range of dynamic processes that occur.

We have investigated the dynamic nature of emulsions from the perspective of the emulsifier (here triton X-100, a commercially available non-ionic surfactant) and its interaction with the oil (toluene [3], p-xylene, and a series of straight-chain hydrocarbons, hexane through to tetradecane [4]). The dynamics of the oil phase was analysed using diffusion-NMR (pulsed field gradient (PFG-NMR) or pulsed gradient stimulated echo (PGSE-NMR)), confocal microscopy in addition to light scattering. Diffusion-NMR data indicate that for O/W emulsions, prepared with toluene and xylene, a single exponential decay of the attenuation as a function of gradient strength is observed which can be described by a single diffusion coefficient, correlating with the oil molecules undergoing motional averaging. This belies the inherent polydisperse microstructure of the emulsions and indicates that a dynamic process is occurring on a time scale faster than the characteristic time of the NMR experiment. Decreasing this time results in a switch between a single exponential and a multiexponential decay and hence a characteristic time for the process can be measured.

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PP013

## Surface Force Measurements between Mineral Oxides: Under what conditions does DLVO Theory Apply?

Rick Walsh, Vince Craig

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In order to describe the behavior of minerals in a range of separation and processing steps it would be desirable to measure the forces directly, particularly under conditions of high salt concentrations and extremes of pH. The direct measurement of interaction forces between mineral oxide surfaces has been hampered by the requirement that the surfaces are sufficiently smooth and representative of the mineral of interest. In particular the crystallinity of the surface is important. We are particularly interested in Titania and Alumina surfaces. Larson et al. [1] have measured the forces between a flat titania surface and a spherical titania particle however, the roughness of the colloidal mineral particle influenced the data at small separations. At high salt concentrations the surface forces are short ranged and roughness adds considerable uncertainty to the interpretation of the data. Our efforts in producing extremely smooth mineral like surfaces suitable for force measurements will be presented.

In order to compare our experimental data to the DLVO theory a software package has been developed that implements the numerical solution of Chan, Pashley and White [2]. This package greatly reduces the time and effort required to analyse the measured force data.

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PP014

## Core/shell structured PMMA Microspheres with Polyaniline and MWNT and their Electrorheology

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Core/shell structured microbeads with a poly(methyl methacrylate) (PMMA) core and either a conducting polyaniline (PANI) or multi-walled carbon nanotube (MWNT) shell were synthesized in order to prepare model electrorheological (ER) fluids. In general, ER fluids are composed of conducting particles dispersed in an insulating liquid and their phase states are reversibly changed under external applied electric fields [1, 2]. Initially, monodisperse PMMA microsphere with 5 micron in diameter as a core material was synthesized by dispersion polymerization. In the case of PANI/PMMA microbead, the PANI was coated on the PMMA core via an in-situ chemical oxidation polymerization of aniline by adding an oxidant in an aqueous acidic solution [3]. In the case of MWNT/PMMA microbeads, amino-functionalized MWNT was incorporated to PMMA particles under ultrasonication. Starting from the pristine MWNT, we first obtained carboxylic acid-functionalized MWNT via strong acid treatment, and then acyl chloride functionalization was followed. Finally amino-functionalized MWNT was obtained using hexamethylenediamine [4]. Various characteristics were examined via SEM, TGA, and optical microscope, demonstrating its successful formation of core/shell structured PMMA microspheres. The flow curves of PANI/PMMA based ER fluids under several applied electric field strengths and particle concentrations were constructed using a rotational rheometer under an applied electric field, and their flow characteristics were examined. Yield stress of the ER fluid under an applied electric field was observed to be increased with an applied electric field, and this result was analyzed via a dielectric spectrum. Meanwhile, since electrical conductivity of the MWNT/PMMA microbeads was found to be too high for ER measurement using a rheometer, its ER characteristics was observed under optical microscopy [4].

This work was supported by Science and Technology Amicable Research Program between France and Korea (2008).

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PP015

## **Bovine Serum Albumin Adsorption on N-Methyl-D-Glucamine Ligand Immobilized Colloidal Silica Surface**

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N-methyl-D-glucamine (NMDG) ligands were grafted onto the surface of colloidal silica nanoparticles by covalent coupling. The novel modified silica nanoparticles were characterized by ATR-IR spectroscopy, zeta-potential analysis and elemental analysis. NMDG was estimated to account for 9.24% of the weight of the modified silica nanoparticle and as the size of the nanoparticles and their size distribution did not noticeably increase after grafting of NMDG it was assumed that modification of the silica nanoparticles with NMDG only changed the surface chemical composition and surface properties. The nanoparticles had an isoelectric point (IEP) at pH 7.8. The adsorption of BSA to the NMDG ligand immobilized colloidal silica surface was influenced by protein concentration, pH, ionic strength and temperature. The thermodynamic constant of BSA adsorption to the NMDG immobilized silica nanoparticles was  $-18.21 \text{ kJ mol}^{-1}$ . The maximum adsorption capacity of the modified nanoparticles was  $7.46 \text{ mg BSA g}^{-1}$  nanoparticles at pH 5.5. A higher or lower pH dramatically decreased BSA adsorption, indicating that electrostatic interactions played a role in the adsorption process. BSA adsorption initially increased as ionic strength increased to around 50 mM. The rate of adsorption then decreased to reach a plateau value around 500 mM. Therefore protein adsorption to the NMDG modified silica nanoparticles can be controlled by modifying the external pH or ionic strength meaning that these NMDG modified silica nanoparticles could have potential applications in the field of biotechnology as supports for enzyme immobilization or in environmental science as sorbents to bind pollutants.

PP016

## Marine Bioadhesives: Electron Microscopy and *in situ* ATR-IR Spectroscopy Characterization.

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All benthic marine organisms having a dispersal phase in their life histories require an adhesive strategy that allows them to form a strong and permanent bond to a range of substrates, under water, over a wide range of temperatures, salinities and conditions of turbulence. Algae and adult mussels are classical examples of permanent adhesion, secreting holdfasts to stick on virtually any hard surface in the tidal marine environment<sup>1</sup>.

We present results for the adhesion study of *Perna canaliculus* mussel larvae and *Undaria pinnatifida* alga spores which are considered important marine fouling species. Mussel larvae are of great interest mainly for the aquaculture industry and, on the other hand, the alga spores exhibit an invasive behavior. Therefore, a better understanding of their adhesion strategies is required in order to develop new approaches to enhance or to inhibit the fouling of these species.

The presence of the bioadhesives was revealed by conventional scanning electron microscopy (SEM) and environmental SEM (ESEM). Moreover, ESEM allowed an investigation of the adhesive morphology in its natural hydrated state, highlighting its highly hydrophilic nature. Energy dispersive X-ray (EDX) microanalysis was also performed, revealing in particular the presence of elements such as S, P and Ca in the adhesives, which are likely to be involved in the bioadhesion process. Additionally, adhesion studies were conducted by *in situ* attenuated total reflection infrared (ATR-IR) spectroscopy. IR spectra showed protein and polysaccharide characteristic vibrational absorptions along with carboxylate, sulphated and phosphorylated moieties.

To date this is the first study on *Perna canaliculus* mussel larvae and *Undaria pinnatifida* alga spores adhesion. Electron microscopy techniques and ATR-IR spectroscopy may shed a new light on the adhesion of marine microorganisms, providing accurate images of the bioadhesive and knowledge of the functional groups involved in the bioadhesion process.

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PP017

## **Polymeric            Silicone-Containing Microemulsions**

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Microemulsions are thermodynamically stable, isotropic mixtures in which substantial amounts of oil and water (an alternative polar solvent) are brought into a single phase by means of an appropriate surfactant, mostly combined with cosurfactant. The formation and characterization of microemulsion formulations, mostly based on hydrocarbon oils and medium-chain alcohols as cosurfactants, have been studied extensively. Due to low surface tension, excellent spreading capacity on the substrate, and giving a unique dry-lubricant feel to surfaces such as hair and skin, silicone-based oils are gaining much popularity in the cosmetics as skin and body care products. The preparation of oil-in-water (O/W) droplet type microemulsion of polydimethylsiloxane compounds is extremely difficult task due to spreading tendency of polymeric silicone chain. In this context, we present a report on the microemulsion which can be formed in a system containing water, polyoxyethylene (20 mol) glycerin isostearate (abbreviated as POE-GIS), random copolymer of polyoxyethylene (POE, 38 mol) / polyoxypropylene (POP, 10 mol) pentaerythritol tetramethyl ether [abbreviated as PEPTME (38/10)], polyoxyethylene (POE, 19 mol) / polyoxypropylene (POP, 19 mol) polydimethylsiloxane copolymer (abbreviated as POE/POP-PDMS) with or without oleic acid (abbreviated as OA). The characterization of microemulsion has been performed by phase behavior, rheometry, and freeze–fracture transmission electron microscopy (FF-TEM). Finally, formation of bicontinuous microemulsion of mixed hydrophobic polymeric silicones having very high molecular weight is also presented.

PP018

## AFM Bubble Colloidal Probes

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Interaction forces between small gas bubbles are important in a number of scientific, medical and technological developments. Direct measurements of such forces have been reported using the atomic force microscopy (AFM) colloidal probe technique. However these have been restricted to cantilever attached solid particles and a large bubble (few hundred microns) fixed on the substrate surface. Here we introduce a simple and effective experimental approach to extend the colloidal probe technique to cantilever-attached bubbles and surface-attached bubbles of various sizes. By using an ultrasonic source we generated numerous bubbles on a mildly hydrophobic surface of a glass slide sample. A single bubble was then picked from the surface with a strongly hydrophobized cantilever and the interaction between the cantilever bubble and a surface bubble or other surface sample was measured. Sample force measurements were used to evaluate the pure water bubble cleanliness and the general consistency of the measurements (1,2).

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PP019

## Anti-Fouling Surfaces Grown in Multi-Well Plates: Surface Initiated Atom Transfer Radical Polymerisation of Polymer Brushes

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Fabrication of low protein-binding surfaces on devices commonly used in life sciences applications will greatly add purpose and value to these tools [1]. For example, protein assays or cell-culture studies conducted in multi-well plates would benefit from the reduction or elimination of non-specific binding of unwanted fouling species. While a few examples of such tools already exist in the marketplace based on coating methodology, it is worthwhile to investigate a new class of materials developed for growing polymers directly from the surface. Providing that proper control is maintained during polymerisation and that dense-enough polymer growth occurs from the surface, it is possible to create antifouling surfaces functionalised with polymer brushes. Advances in controlled radical polymerisation using methods such as surface initiated atom transfer radical polymerisation (SI-ATRP) make this possible [2].

We have investigated a new approach to manufacturing low-protein binding surfaces based on surface immobilisation of ATRP initiators within 96-well plates followed by polymerisation at room temperature in water. First, allylamine plasma polymer was immobilised on the well surfaces using radio frequency glow discharge (RFGD) followed by covalent coupling of an ATRP initiator / acrylic acid copolymer. SI-ATRP was then carried out directly in the plate wells in aqueous solutions. The composition and concentration of the monomer and initiator amount were varied independently in order to produce a library of antifouling surfaces with different properties. Characterisation of the surfaces was carried out using x-ray photoelectron spectroscopy (XPS) and atomic force microscopy (AFM). Antifouling performance of the surfaces was evaluated by europium-tagged human serum albumin (HSA) binding studies.

We have demonstrated that the use of polymer brushes grown from the surface of multi-well plates is a novel approach for creating antifouling surfaces. Furthermore, since the grafting methodology can be applied cross-platform towards many devices, we predict a broad applicability of this technique for modification of an array of surfaces used in the life sciences.

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PP020

## Study of Adsorption Kinetics Using Optical Reflectometer with Improved Sensitivity and Stability

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Optical Reflectometry (OR) is a form of ellipsometry that is ideal for following the kinetics of adsorption for surfactants, polymers and even particles at the solid-liquid interface. We have designed and constructed a new optical reflectometer based on the original [1] with significant improvements to sensitivity and long-term stability. These improvements allow us to examine behaviours that were previously undetected due to drifts and noise in the raw data. Specifically, we are able to further examine the slow adsorption phenomena seen previously [2], and explore the hysteresis effect observed during sequential adsorptions from increasing and decreasing bulk concentrations [3]. The meaning of, and our interpretation of the true value of equilibrium surface excess is presented.

In addition we explore the role of specific cations in the adsorption of CTAB to silica. NaBr, KBr and CsBr are used in varying concentrations to elucidate the behaviour and identify a common intersection point corresponding to the isoelectric point and charge compensation point [4].

Finally we discuss the interesting behaviour of CTAB in the presence of the organic salt sodium salicylate at varying ratios and concentrations. Optical reflectometry, QCM and AFM are used to demonstrate the atypical behaviour of this system.

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## Study on the surface tension of water-based adhesive on the 3-D prototype application

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Recently, many types of 3-Dimensional Rapid Prototyping (3D-RP) [1] were developed and commercialized, including Stereo Lithography Apparatus (SLA), Laminated OBJet Manufacturing (LOM), Selective Laser Sintering (SLS) and Z-corp. 3DP, etc.[2][3][4] Among those different types of 3D-RP, only Z-corp. 3DP instrument can manufacture the colour prototype. The manufacture mechanism of Z-corp. instrument utilizes an ink jet technology to shoot adhesive droplets to plaster powder forming a layer of an RP model. The prototype can be obtained by accumulating these layers. In other words, the properties of adhesive is a key-point for this type of 3D-RP because the properties of adhesive should fit with the specifications of the sprinkle-nozzle of the jet types and should provide a good adhesive strength for the green part of prototype. Meanwhile, colour adhesives, including yellow, cyan, magenta and black, also follow the specifications.

In this research, polyvinyl alcohol (PVA, sigma Mw= 30000~70000) and polyvinylpyrrolidone (PVP, fluka K15) were added to regulate the surface tension and viscosity of the adhesive solution, respectively. When PVA content was 14 wt% and PVP content was 17 wt%, the viscosity of adhesive solution was 30 cp and 28 cp, respectively. However, the surface tension of adhesive solution was only depended of the PVA content, dropped from 60 mN/m to 46 mN/m as the PVA content decreased. The stress of the green part was enhanced from 167 mN/mm<sup>2</sup> to 993 mN/mm<sup>2</sup> when the water content of adhesive was over 90 wt%.

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## Interactions of Ultrafine Particles with Bubbles

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The interactions of fine particles with bubbles are inefficient due to the particles following the fluid streamlines around the bubbles. However, it has been reported that the interaction between particles that undergo Brownian diffusion (diameter < 1  $\mu\text{m}$ ) and bubbles will be enhanced as the particle size decreases [1-6]. This is due to the random movement of the particles increasing the probability of collisions with bubbles. A minimum in the interaction efficiency of particles by bubbles has been found at the particle size at which both Brownian diffusion and interception mechanisms contribute to the particle-bubble collision process. Recent studies have observed the existence of this minimum in collection efficiency as particle size decreases below 5  $\mu\text{m}$  [2, 7]. However, there is disagreement in relation to the particle size at which Brownian diffusion starts to dominate. The same disagreement exists in the calculations of collection efficiency using various theoretical models [2-6]. The aim of this study is to investigate the particle-bubble interaction in the size range of 0.1 – 5  $\mu\text{m}$ . Single bubble flotation is used to study the interaction between silica particles and bubbles. The particle surfaces were hydrophobised to various contact angles by reaction with a silanol group. For particles in the size range of 0.1-1  $\mu\text{m}$ , fluorescent core-shell particles were used due to the difficulties in quantifying the concentration of such fine particles with any other technique except fluorescence spectroscopy. For particles larger than 1  $\mu\text{m}$ , the concentration of particles collected by bubbles was determined by light obscuration. The combined experimental results showed that the collection efficiency of particles by bubbles increases with decreasing particle size and increasing particle surface hydrophobicity.

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PP023

## **Novel Characterization of Hollow Microspheres using AFM**

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The use of hollow microspheres has attracted immense attention in recent decades. Not only are they actively engaged in industrial processes, such as catalyst transportation, targeted drug delivery and volatile pigment protection, these microcapsules have also imparted significant aid to laboratory work. Although many researchers have been expanding their applications into different fields, insufficient quantitative data on the mechanical properties and surface morphology of these microspheres prompted their characterization using Atomic Force Microscopy. In this project, hollow silica shells, generated by condensing tetraethoxysiloxane (TEOS) on monodisperse PDMS emulsion droplets, are characterized by surface roughness, compression and breakage measurements. The porosity of these hollow silica shells and their suitability to study the dynamics of particles travelling under Brownian motion will also be discussed.

PP024

## Surface Tension as a Function of Surface Structure of Ionic Liquids

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Investigations of surface structure and surface tension were carried out in ionic liquids (ILs). ILs are organic salts melting at or near room temperature. Due to a unique combination of properties such as non-volatility, high ability to dissolve organic and non-organic substances, surfactant nature, electro-conductivity, etc, ILs have many potential applications in industrial processes, involving surface and colloid chemistry<sup>1</sup>. Therefore the knowledge of their surface properties is necessary but is in its infancy at the present time.

The surface structure of a homologous series of imidazolium ionic liquids was studied with angle-resolved X-ray spectroscopy (ARXPS)<sup>2,3</sup>. The orientation of anions and cations in the outermost surface layer, as well as the mutual orientation of counterions normal to the surface was obtained.

The surface tension of these ionic liquids was measured in an inert atmosphere using the pendant drop technique. The two sets of data were compared and demonstrated a direct correlation between surface tension and structure of ILs.

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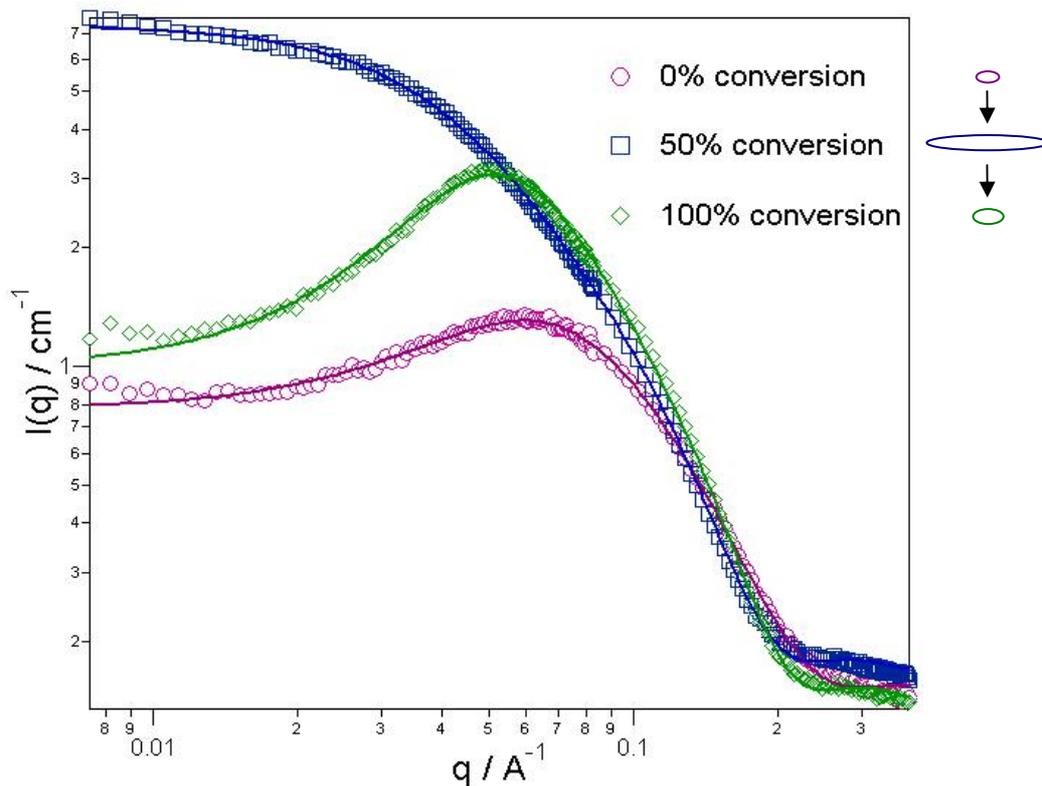
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## Shape changes of tail-polymerizable surfactant aggregates during polymerization

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Self-assembled structures of a tail-polymerizable surfactant, 11-(methacryloyloxy)undecyltrimethylammonium bromide (MUTAB), were studied at various polymerization conversions in aqueous solution using Small-Angle Neutron Scattering (SANS). SANS showed that the aggregates were initially prolate ellipsoids (with radii of ~1.5 nm and ~3 nm), but grew significant in length during polymerization to form rods (with a radius of ~1.8 nm and a length of ~10 nm). Interestingly, the aggregates became shorter as the polymerization proceeded towards completion, returning almost to their initial prolate ellipsoidal form. These strange shape transitions can be explained by correlating with the self assembly behaviour of the monomers, monomer with polymer, and just the polymer under the same solution conditions.



## Adsorption and Structure of Nonionic Surfactants at the Ionic Liquid/Air Interface

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Ionic liquids are currently attracting considerable research interest for a variety of reasons, but most notably due to the ability to tune key properties via variation in molecular structure. While some physical properties of ionic liquids have been well characterised, their interfacial properties are relatively unexplored. Determination of the structure of ionic liquid interfaces is essential if they are to find widespread applications in industry and academia.

Small angle neutron scattering has shown structural heterogeneity in bulk ethylammonium nitrate (EAN)<sup>1</sup>, a protic, H-bonding ionic liquid, while surface force apparatus<sup>2</sup> and atomic force microscopy<sup>3</sup> measurements have shown similar structure at the liquid/solid interface. In this work we examine the structure of the EAN liquid/air interface, and the structure of adsorbed surfactant at this interface, using vibrational sum frequency spectroscopy (VSFS) and neutron reflectometry (NR). VSFS reveals the ethyl moiety orientates towards the air, maximising H-bonding between the ethylammonium ion and the bulk liquid, to minimise surface energy. NR and VSFS have been used in combination to ascertain the morphology of nonionic surfactants adsorbed at the EAN/air interface as a function of concentration and temperature.

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PP027

## **Conformal Nanometric Surface Patterning Using Polymer Film Dewetting**

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The development of nano- and micro-patterned surfaces is crucial to many technological applications, such as the design of biotechnological and electronic devices, biosensors, and substrates for tissue engineering. Surfaces with ordered patterns are commonly fabricated with techniques, such as optical lithography, which are costly and require several steps to obtain the required pattern. Moreover, the application of these techniques is limited to flat substrates, and to micrometric dimensions.

In this study, we focused on ordered patterns by means of a simple and cost-effective technique, based on polymer thin film dewetting, to obtain chemically and topographically patterned surfaces for the immobilization of biomolecules and cells. The dewetting approach could potentially achieve conformal patterns on curved surfaces, which opens exciting prospectives for the development of biocompatible coatings for prostheses and implants.

PP028

## Synthesis and Characterisation of Self-Assembled Monolayers of N-[3-(Trimethoxysilyl) propyl] diethylenetriamine on Silica Particles

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This study focuses the synthesis of N-[3-(Trimethoxysilyl) propyl] diethylenetriamine, ( $C_{10}H_{27}N_3O_3Si$ , TRIS in short) self-assembled monolayers of silica particles without the use of any organic solvents. In order to determine the coverage and characterise the stability of the TRIS-monolayer the active amine functional groups of the monolayer are quantitatively characterise by titration method. Its thermal stability is then characterised by Thermogravimetric analysis (TGA) in the range of 30-800°C at the rate of 10°C/min. The analysis will be correlated with a model calculation of the maximum TRIS-coverage considering the surface area of hydroxyl (OH) concentration on the surface of the silica particles.

XPS analyses clearly prove the existence of the TRIS-monolayer on the particles. The titration results indicate an ideal coverage of the TRIS-monolayer at a  $NH_2$ -concentration of about  $8.48 \times 10^{-4}$  mmol/m<sup>2</sup>. The TGA results show that the TRIS-layers are stable up to 225°C and fully degraded at 650°C in air. The determined weight loss correlates within the analytical error with the values determined by titration. At significant high concentrations of TRIS during the synthesis, both, titration values and weight loss, increases. However, the correlation of the experimental results with model calculations of the maximum TRIS-coverage shows that this effect is presumably caused by TRIS-multi-layer formation.

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PP029

## Synthesis of Mesoporous Titanium Dioxide from Protic Ionic Liquids

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Nanocrystalline TiO<sub>2</sub> materials have been synthesized in various ionic liquids<sup>1-4</sup>. Protic ionic liquids (PILs) are an interesting subset of ionic liquids. PILs are prepared through proton transfer from a Brønsted acid to a Brønsted base. Ethylammonium formate (EAF) and ethylammonium nitrate (EAN) were prepared according to literature<sup>5</sup> and were used to synthesize nanostructured TiO<sub>2</sub> with the assistance of various surfactants (Brij56, P123 and myverol 18-99K) using a sol-gel approach. The ionic liquids and surfactants were firstly removed from the titania gels by solvent extraction and then the residual of them were removed by calcined in air at 450°C. Upon the completion of calcination, mesoporous anatase TiO<sub>2</sub> materials were obtained in all systems studied with reasonable surface areas (~70 to 80m<sup>2</sup>/g).

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PP030

## **Fabrication of nanoporous anodic alumina oxide membranes with tailored chemical functionalities**

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Nanoporous anodic alumina oxide (AAO) membranes with distinct internal and external chemical functionalities were successfully designed and fabricated. Well ordered nanoporous AAO membranes that have different external and internal surface properties were formed in a two step anodisation process in dilute oxalic acid electrolyte and a custom-built etching cell. The process in the first step employs functionalisation of AAO membranes obtained after the first anodisation with 3-aminopropyltriethoxysilane (APTES) via chemical vapour deposition. This is followed by anodisation of the preassembled alkylsilane at the membranes surface to obtain new internal pore surface that has different properties than the external surface. The AAO with formed pores were then modified by a second modification step to achieve new chemical functionalities inside of pores which are distinct from the top of pores (APTES). The surface morphology of nanoporous AAO membranes during these fabrication and modification steps were characterised by scanning electron microscopy (SEM), atomic force microscopy (AFM), infrared spectroscopy (IR), X-ray photoelectron spectroscopy (XPS) and contact angle measurements. SEM and AFM images confirmed the pores were not clogged after the second anodisation and pores sizes ranged from 20-30 nm (top) and 40-60 nm (bottom) of the membranes. The presence of alkylsilanes before and after anodisation is corroborated by the IR spectra, where a 2 fold absorption increase in the regions near 2800 to 3000  $\text{cm}^{-1}$  was observed. These absorbancies were assigned to symmetric and antisymmetric of  $\text{CH}_2$  bands. Survey and high resolution C1 XPS scans showed a distinct increase of both carbon content and silicon peak, suggesting the presence of APTES on the surface of the membranes after completed anodisation. The wetting properties and transmembrane electrical resistance of alkylsilane-nanofabricated AAO membranes were studied by means of contact angle measurements and impedance spectroscopy, respectively. It was demonstrated that this method allows a simple fabrication of AAO membranes with distinct interior and external surface chemistries. This approach opens opportunities for surface nanopatterning of nanoporous AAO membranes and fabrication of complex nanoarchitectures based on AAO for emerging applications in area such as biological and chemical sensors, biomimetic membranes and nanofiltration.

## Gel Spinning of Atactic Poly(vinyl alcohol)/Sodium Alginate Blend Solution

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Through the blending of a flexible polymer, atactic poly(vinyl alcohol) (PVA), and a rigid polymer, sodium alginate (SA), with various ratios of PVA and SA and through the gel spinning PVA/SA solution. The first thing in this study, the rheological properties of PVA/SA solutions with different feeding amount of SA was studied by rheometer. And then PVA/SA blend fibers were typically characterized by differential scanning calorimetry (DSC), X-ray diffraction (XRD), attenuated total reflectance (ATR), and scanning electron microscopy (SEM).

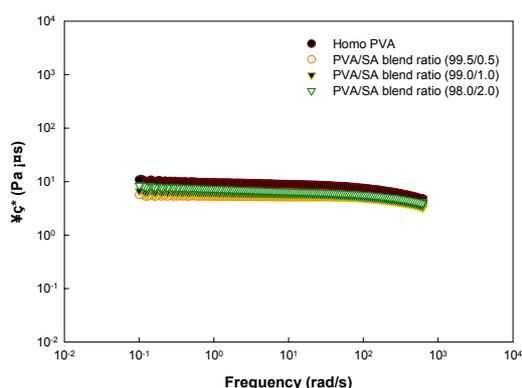


Figure 1. Complex viscosity of PVA/SA blend solutions with different ratios of 100/0, 99.5/0.5, 99.0/1.0, and 98.0/2.0 (wt%/wt%) in DMSO/Water (7/3, v/v) mixture with frequency at 70 °C.

Figure 1 shows complex viscosity ( $\eta^*$ ) of different ratios of PVA/SA solutions. Over the range of frequencies examined, pure PVA and PVA/SA solutions exhibited almost Newtonian flow behavior. On the other hand, at high frequency from  $10^2$  to  $10^3$ , pure PVA and PVA/SA solutions exhibited shear thinning behavior. This seems to originate from shear-induced molecular orientation [1]. It is expected that these result can be used to establish conditions of gel spinning using PVA with SA.

Acknowledgements: This work supported by grant No. RTI04-01-04 from Regional Technology Innovation Program of the Ministry of Knowledge Economy (MKE).

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PP032

## Leaching Mechanism and Kinetic Behaviour of an Aluminosilicate Clay Mineral

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Leaching and re-precipitation behaviour of gangue clay (e.g. muscovite, chlorite) and oxide (e.g. hematite, quartz) minerals play a pivotal role in determining the processability and recovery of valuable minerals (e.g. copper, gold, uranium). During aluminosilicate clay mineral leaching at low pH ( $\sim 1$ ) and elevated temperature ( $\sim 70$  °C), the formation of a highly viscous gel ascribed to attractive particle interactions, facilitated by polycondensation of Si(IV) and Al(III) species, released into the leachate by clay minerals, may occur. Adhoc methods, such as water dilution and temperature reduction, to alleviate gelation may be implemented; however this can adversely impact on valuable mineral recovery rate and yield. Consequently, new knowledge and greater understanding of how the interfacial and pulp chemistry, mineralogical characteristics and particle interactions synergistically act to control the degree of gelation need to be established through fundamental studies.

This study investigates the leaching behaviour, particle surface and bulk mineralogical characteristics of muscovite clay,  $(K_{1.82}, Na_{0.13})(Al_{3.64}, Fe_{0.29}, Mg_{0.16})[(Al_{1.86}, Si_{6.14})O_{20}](OH)_4$ , as a function of pH (1 vs. 7) and temperature (25 °C vs. 70 °C) in a batch system.

Supernatant speciation data (for pH 1 conditions) revealed a greater Al(III) ion concentration in comparison with other major species (Si(IV),  $K^+$  and Fe(II/III)) present in solution, suggesting incongruent leaching. Furthermore, concentration values (for pH 1) revealed an increase in leaching rate by  $\sim 15 - 20$  % with an increase in temperature (from 25 °C to 70 °C), however, this is less than one would anticipate for a purely chemical rate controlled reaction, and thus, may be regarded as a complex system. It is further observed that two, different sequential leach mechanisms, and hence, kinetic rates following two separate regimes takes place; one initial, rapid transition ( $t < 10$  min), and a second, much slower ( $t > 10$  min).

Resulting electrokinetic potential data, bulk / surface mineralogy and chemistry of pre and post leached muscovite indicate the formation of specific aluminosilicate and hydrolysis products, while crystallo-chemical restructuring takes place in the bulk and surfaces of particles with leaching time. Surface chemical state analysis of leached muscovite residue indicated a more thermodynamically stable octahedral Al(VI) state and an increase in polymerisation of tetrahedral Si(IV) from an aluminosilicate to an oxide state (i.e.  $(SiO_4)_n$ ), emerging with time under high intensity (i.e. pH 1, 70 °C) leach conditions.

## Preparation and Characterization of High Molecular Weight Atactic Poly(vinyl alcohol)/Sodium Alginate/Silver Nanocomposite by Electrospinning

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In recent years, there has been a growing interest in the incorporation of functional nanoparticles in the polymer nanofibers due to their uniquely promising properties and applications. Within the past decade, incorporating silver nanoparticles into a polymer matrix [1] has received more attention, because the resulting nanocomposites exhibit applications [2] in catalysts, drug and wound dressings, optical information storage, and surface enhanced Raman scattering (SERS), etc.

High molecular weight poly(vinyl alcohol) (PVA)/sodium alginate (SA)/silver nanocomposites were successfully prepared via electrospinning technique. Water-based colloidal silver in a PVA/SA blend solution was directly mixing without any chemical and structural modifications into PVA/SA matrix to form an organic-metallic nanocomposite. The effect of the addition of silver colloidal solution on the PVA/SA/silver nanocomposite was investigated through a series of experiments varying molecular weight of PVA and electrospinning processing parameters such as concentration of PVA solution, PVA/SA blend ratio, applied voltage, and tip-to-collector distance. In the case of PVA with number-average degree of polymerization of 1700, by increasing the amount of SA in spinning solution, the morphology was changed from fine uniform fiber to beaded fiber or bead-on-string fiber structure. Increase of the amount of silver colloidal solution resulted in higher charge density on the surface of ejected jet during spinning, thus more electric charges carried by the electrospinning jet. As the charge density increased, the diameter of the nanocomposites became smaller. Transmission electron microscopy images showed that the dense silver nanoparticles were well separately dispersed in PVA/SA matrix. Energy-disperse X-ray analysis indicated that carbon, oxygen, sodium, and silver were the principle element of PVA/SA/silver nanocomposite.

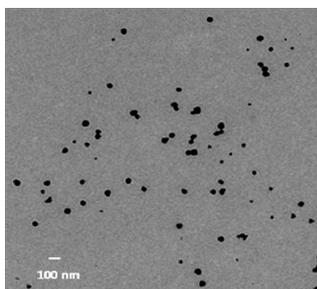


Figure 1. TEM images of silver nanoparticles in a water-based silver colloidal solution.

Acknowledgements: This work supported by grant No. RTI04-01-04 from Regional Technology Innovation Program of the Ministry of Knowledge Economy (MKE).

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The biennial Australian Colloid and Interface Symposium and the  
10th Australia-Japan Colloid and Interface Science Symposium

## Preparation of Syndiotactic Poly(vinyl alcohol) Gel Microspheres by Heterogeneous Surface Saponification of Poly(vinyl pivalate/vinyl acetate) under Various Saponification Conditions

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Poly(vinyl alcohol) (PVA), obtained by the saponification of poly(vinyl ester)s such as poly(vinyl acetate) (PVAc) or poly(vinyl pivalate) (PVPi), is a linear and semicrystalline polymer that has been widely used as fibers for clothing and industrial uses, films, membranes, medicines for drug delivery systems, and cancer-cell-killing embolic materials [1]. The P(VPi/VAc) microspheres were saponified in aqueous alkali solution containing sodium hydroxide, sodium sulfate, and methanol.

The swelling effect of PVA particle in an aqueous contrast medium have a deep relation to embolization. PVA has good binding properties, and ease of treatment [2-4], which are the reasons why PVA among various particular embolic materials, is preferred and extensively used for the selective embolization of vascular lesions. Embolization has been still increasingly used for management of profuse bleeding and for treatment of both malignant and benign tumors [5]. And it is a non invasive procedures an abnormal artery or vein (blood vessel) through the injection of a special embolic material through a catheter.

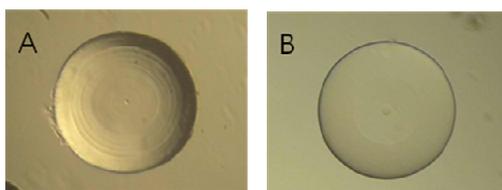


Figure 1. Video Microscope photographs of the PVA microspheres with various saponification conditions by heterogeneous surface saponification (DS; 99.9%): alkali solution A) in methanol, B) in ethanol.

We prepared PVA microspheres examined the structure properties of surface by video microscope (VMS), the proton and carbon nuclear magnetic resonance (<sup>1</sup>H NMR, <sup>13</sup>C NMR), spectrometer and infrared spectroscopy (IR), differential scanning calorimeter (DSC).

Video Microscope photographs of the PVA microspheres are presented in Figures 1A and 1B, respectively. It is noteworthy that two different appearances of surface, on with irregular surface (Figure 1A), and another with smooth surface (Figure 1B). It was expected that hydrogel type PVA microspheres obtained by the heterogeneous

surface saponification would be one of the promising embolic materials. This phenomenon is attributed to the driving force to minimize the interfacial free energy.

Acknowledgements: This work was supported by grant No. RTI04-01-04 from the Regional Technology Innovation Program of the Ministry of Knowledge Economy (MKE).

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PP036

## Development of a High Performance Continuous Cake-less Filtration System

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In general filtration flocculant is added to feed suspension to prevent making dense cake. The loose cake reduces the flow resistance and increases the filtration rate. The looser cake, however, contains much water. Sometimes the water content of the cake is more than 90 vol%. This high water content requires another operation and high-energy consumption for dehydration and drying after filtration. On the contrary, if particles in a suspension repel each other, the particles can be concentrated to high concentration keeping fluidity. A new filtration system filtering a suspension in which particles are dispersed well has the following big advantages. Equipments for cake scraping are not necessary because the particles trapped on a filter can be swept by the gravity, centrifugal force or shear stress of fluid. It means that we can design a continuous filtration process not batch process. Moreover we can save the energy for drying and shorten the process because of low water content of the swept slurry.

We developed a new filtration system based on this concept [1]. In this first filtration system the concentrated slurry on a filter medium is swept by centrifugal force. We have developed another filtration system in which the concentrated slurry is swept by shear stress of suspension flow. The filter consists of a ceramic tube filter and core rod having a spiral guide. Since the core is inserted to the filter tube, the shear stress is increased much more than a tube filter and the slurry is mixed well.

We have tried to filter some suspensions such as cericite, pulp, alga, iron oxide and activated sludge. In the case of cericite, 1vol% suspension can be concentrated to 35vol% and 1 cubic meter of 1vol% suspension can be reduced by half in 20 minutes by using a filtration system of 20x20x40cm. In the case of activated sludge the original sludge from a piggery can be concentrated more than ten times and the filtration rate does not depend on either filtration time nor sludge concentration.

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PP037

## Correlation between Interfacial and Dermal Delivery Characteristics of Nanoparticle-coated O/W Emulsions

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The influence of hydrophilic silica nanoparticles on the emulsification of triglyceride oil (Miglyol<sup>®</sup>812) in the presence of charged surfactants (lecithin or oleylamine) and the long term stability of the resultant oil-in-water emulsions are reported. The attachment energy of silica nanoparticles at the oil-water interface has been calculated from the experimentally determined equilibrium oil-water interfacial tension and three phase contact angle and correlated to the formation and long-term stability of the emulsions (Ghouchi Eskandar et al., 2007). Compared to control emulsions, nanoparticle coated emulsions decreased (up to 90%) the steady-state flux of all-trans-retinol through cellulose acetate membrane, and significantly ( $p \leq 0.05$ ) increased skin retention. Skin distribution of all-trans-retinol and a fluorescent probe (acridine orange 10-nonyl bromide) showed epidermal targeting of the lipophilic agents in the presence of silica nanoparticles with negligible permeation through full-thickness porcine skin. The improved dermal delivery from nanoparticle-coated emulsions showed a close correlation to the interfacial characteristics of the emulsions, and potential silica/emulsifier/drug interactions. Nanoparticle-coated O/W emulsions can serve as novel topical delivery vehicles for the lipophilic agents with controlled and targeted drug delivery.

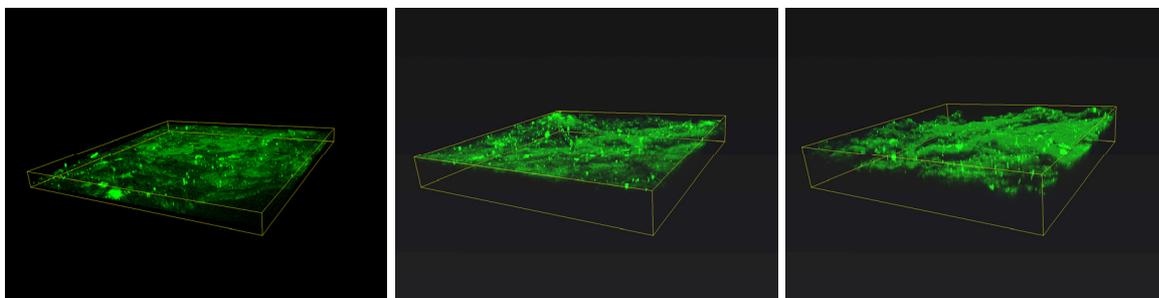


Figure 1- 3-D images reconstructed (using Amira Version 3.1 software) from z-stacks of skin treated with the control lecithin (left); and silica-coated emulsions with nanoparticle inclusion from the oil phase (middle); and the water phase (right) acquired by confocal microscopy.

Ghouchi Eskandar, N.; Simovic, S.; and Prestidge, C.A. Synergistic Effect of Silica Nanoparticles and Charged Surfactants in the Formation and Stability of Submicron Oil-in-water Emulsions. *Phys. Chem. Chem. Phys.* 2007, 9, 6426-6434.

PP038

## The Effects of Polydispersity on the Self Assembly of Nanostructures

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Block copolymers have been of particular interest in the materials field due to their ability to undergo microphase separation. In general, block copolymers are produced with a low polydispersity index as they have been made primarily through anionic polymerisation, which is a demanding and laborious technique. As a result, they have not been commercially exploited due to the relatively high cost of manufacture. The recent development of controlled radical techniques such as ATRP and RAFT while lacking the control finesse of anionic produced polymers opens up the possibility that production of block copolymers will become economically viable in the future. ATRP and RAFT produced polymers have higher PDIs than their Anionic counterparts and in particular it important to note how this change in polydispersity will alter the microphase separation and resultant structure of block copolymers.

The effects of polydispersity on diblock copolymer melts will help address some conflicting results in the materials field [1,2]. A number of the polymers are synthesised via anionic, ATRP and RAFT polymerisation and are specifically designed to achieve varying degrees of polydispersity. The resultant block copolymer melts are then analysed through scattering techniques (SAXS and SANS), microscopy (Electron and Optical) as well as rheology. Additionally, recent work by Hillmyer and Lynd [3], demonstrated how temperature was used to initiate the randomisation of one chain of a diblock copolymer. This can be used effectively for poly(DL-lactide) and poly(caprolactone) and builds upon previous research performed by the group in this area.

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## Environmental Marine Bacteria Interactions with Poly(Ethylene Terephthalate) Polymer Surfaces

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Plastic debris causes extensive damage to the marine environment, largely due to its ability to resist degradation. The ability of plastic to persist is the major factor behind the danger posed.<sup>1</sup> Other dangers associated with plastic debris include entanglement in larger objects<sup>2</sup>, absorption of toxic chemicals such as polychlorinated biphenyls (PCBs) and nonylphenol, and transportation of non-indigenous harmful algal blooms (HAB)<sup>3</sup>. Many plastic materials, such as the material used for most soft-drink and water bottles poly(ethylene terephthalate) (PET), are specifically designed to be physically and chemically durable, and a component of this is microbial resistance<sup>15</sup>. As a result most microbes will preferentially associate with other, more nutrient-rich surfaces. The current study aims to investigate the capability of bacteria from the marine environment to associate with and adhere to the surface of a common plastic packaging material, namely PET. Understanding the factors that influence bacterial attachment on plastic surfaces will be useful for promoting bacterial growth on such substrates in order to better facilitate their biodegradation.

The tendency of environmental marine bacteria to interact with poly(ethylene terephthalate) plastic surfaces was investigated, as a precursor to potential biodegradation studies. It was found that overall number of heterotrophic bacteria in the original sea water sample was significantly reduced after six months from  $4.2 - 4.7 \times 10^3$  cfu ml<sup>-1</sup> to 0 cfu ml<sup>-1</sup> on both full-strength and oligotrophic marine agar plates. The extinction of oligotrophs after six months was detected in all samples. Heterotrophic bacteria recovered on full-strength marine agar plates after six months were found to employ a specific attachment strategy while attaching to the PET plastic surface, followed by the beginnings of biofilm formation and possibly plastic degradation.

These results are indicative that environmental marine bacteria are capable of developing a particular survival strategy to aid their interactions with unfavourable PET plastic surfaces. As a result of these interactions, environmental bacteria initiate biofilm formation potentially followed by plastic degradation as inferred from the bacterial recovery experiments. Some of the bacteria recovered may have potential as possible biodegraders of PET.

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PP040

## Dynamic Forces between Bubbles and Surfaces and Hydrodynamic Boundary Conditions

Ofer Manor<sup>1</sup>, Ivan Vakarelski<sup>1,4</sup>, Geoffrey Stevens<sup>1</sup>, Franz Grieser<sup>1</sup>, Raymond Dagastine<sup>1</sup>, Derek Chan<sup>1,2</sup>

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A bubble attached to the end of an atomic force microscope cantilever and driven towards or away from a flat mica surface across an aqueous film is used to characterize the dynamic force that arises from hydrodynamic drainage and electrical double layer interactions across the nanometer thick intervening aqueous film. The hydrodynamic response of the air/water interface can range from a classical fully immobile, no-slip surface in the presence of added surfactants to a partially mobile interface in an electrolyte solution without added surfactants. A model that includes the convection and diffusion of trace surface contaminants can account for the observed behavior presented. This model predicts quantitatively different interfacial dynamics to the Navier slip model that can also be used to fit dynamic force data with a *post hoc* choice of a slip length.

O. Manor, I. U. Vakarelski, G. W. Stevens, F. Grieser, R. R. Dagastine, D. Y. C. Chan, *Langmuir* 2008, 24, (20), 11533 - 11543

PP041

## Preparation of Poly(vinyl pivalate)/Gold Nanocomposite Microspheres using Suspension Polymerization of Vinyl Pivalate

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Metal nanoparticles have many unique chemical and physical properties that make them attractive for applications in catalysis, electronics, optics, and biomedics. If gold nanoparticles could be used as an embolic material, both advantages of curing and detectability, and improved material properties are attained at the same time.

In this study, we are reporting the in-situ synthesis of PVPi/gold nanocomposite microspheres using a suspension polymerization technique. Gold nanoparticles are the most stable metal nanoparticles, and they present fascinating aspects such as their assembly of multiple types involving materials science, size-related electronic, magnetic and optical properties (quantum size effect), and their applications to catalysis and biology.

The particles of poly(vinyl pivalate)/gold produced from polymerization of vinyl pivalate (VPI) with 2,2- azobis(2,4-dimethylvaleronitrile) (ADMVN) as an initiator have been characterized. By controlling various synthesis parameters, PVPi/gold microspheres were obtained that are expected to be precursors of syndiotactic poly(vinyl alcohol)/gold (PVA/gold) microspheres for biomedical embolic applications.

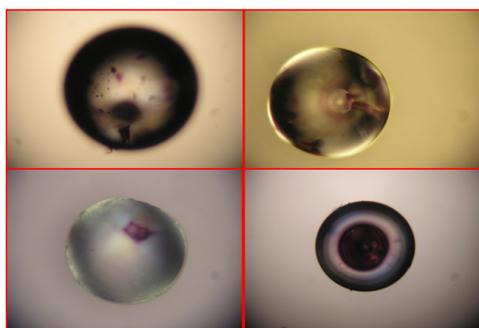


Figure 1. Optical microscope images of P(VPI)/Gold nanocomposite microspheres. ( No suspending agent,

Conc. of ADMVN :  $2.0 \times 10^{-4}$  at 50 °C )

Figure 1 shows the optical microscope images of the products from the *in situ* suspension polymerization of VPI in the presence of gold nano particles. The PVPi particle beads shows a wine color due to gold within the particles. The wine colour is

resulted from the gold nanoparticles due to their typical surface plasmon absorption in the wavelength range of 520~540 nm.

Acknowledgements: This work supported by grant No. RTI04-01-04 from Regional Technology Innovation Program of the Ministry of Knowledge Economy (MKE).

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## Continuous Flow Polymer Adsorption on Monodisperse Droplets for Microcapsule Synthesis in a Microfluidic Chip

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The stringent criteria applied to biomedical applications demand precise control over processing conditions and product, while the cost of bioactive materials, high-purity chemicals, and cleanliness drive commercial processing towards increasingly high efficiencies and reduced waste. Microfluidics is well-positioned to address these criteria and progress polymer multilayer technology to the next-generation of applications.[1] We have designed a microchip capable of handling consecutive adsorption of polymer layers on a droplet template, including intermediate rinse steps, under continuous flow conditions.[2]

Monodisperse liquid crystal (LC) droplets ( $44 \pm 1 \mu\text{m}$ ) are generated at a T-junction in a microfluidic network, Fig. 1(a), where they are stabilized against coalescence by sodium dodecyl sulphate and poly(methacrylic acid) containing pendant thiol moieties, PMA<sub>SH</sub>, *i.e.* the first polymer layer. After droplet generation and polymer adsorption ( $\sim 25$  s), the continuous phase is selectively removed through comb-like side channels, Fig. 1(b), aided by the Laplace pressure, which opposes droplet deformation through the narrow side channels. The rinse solution is then added, before removal (at another comb-like channel) and infusion of the alternate polymer layer, *i.e.* poly(*N*-vinyl pyrrolidone), PVP. This sequence is repeated in the microfluidic network to form a 3 layer multilayer within 2 min, compared with  $\sim 1$  h using conventional methods. The multilayer is then cross-linked (disulphide linkage) using chloramine T to strengthen the capsule, before removal of the LC core using ethanol.

The microcapsules were analysed by fluorescence microscopy, scanning electron microscopy, and atomic force microscopy. The capsules formed using this method did not differ from those prepared using conventional bench-scale synthesis.

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PP043

## Biomolecular surface interactions and cell adhesion studied using QCM-D

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Interface interactions between materials and the physiological environment where they are placed are of importance in many life science applications, such as biomaterial research. Better understanding of the dynamics of such processes is crucial for understanding host response for design of medical devices and biomaterials. Here we demonstrate how clever sensor design provides unique information on biomolecular interactions with each other, surfaces and cells which contribute with novel, real-time information not previously possible. The technology used, Quartz Crystal Microbalance with Dissipation monitoring (QCM-D), is a surface sensitive technique that enables evaluation of biomaterials and surface coatings. QCM-D is able to simultaneously analyze changes in mass and structural properties of proteins, cells, bacteria and biopolymers on different materials in real-time. Events such as cell adhesion, binding and conformational rearrangements of molecules can easily be tracked using QCM-D. Here we present three studies where QCM-D is used to interface reactions.

Microscopy is a common method used to study cell interactions and adhesions with surfaces. Here QCM-D was combined with fluorescence microscopy to monitor cell attachment and spreading on protein modified surfaces<sup>1</sup>. Depending on the surface coating, the optical image revealed different cell behavior, which was consistent with the QCM-D signal. Interestingly, QCM-D was able to sense events associated with changes in cell-surface contacts and cytoskeleton rearrangements, which were not detectable with microscopy. QCM-D was also used as a method to study and detect the formation of biofilms on surfaces. FDA's recent ruling that Medical Insurance Companies do not have to cover infections caused by implants and medical devices has created a new interest in this field. In this study QCM-D has been used to detect early biofilm formation of *Leuconostoc mesenteroides* on stainless steel surfaces<sup>2</sup>. The results show that the technique is sensitive to bacterial attachment and growth, a lag phase of about 4 hours, followed by rapid bacteria growth was detected. After about 6 hours the bacteria start producing slime, which changes the frequency/dissipation ratio, meaning that the biofilm becomes softer. Another potent attribute important in this context is the immunogenicity of different materials. Materials introduced into the body are known to cause surface associated complement activation in human sera, which triggers inflammation. By exposing different surfaces to human serum containing complement proteins, aspects of blood compatibility of the materials can be evaluated<sup>3</sup>. In this study blood compatibility of different biomaterials are quantified as amount of bound C3 convertase. Polyurethane urea (PUUR), Polystyrene (PS), Hydrophobic self-assembled monolayer (SAM) and Titanium dioxide (TiO<sub>2</sub>) surfaces were investigated. It was found that the degree of anti-C3 convertase binding on the TiO<sub>2</sub> surface was as low as on the negative control (heat-inactivated sera), indicating low immunogenicity of TiO<sub>2</sub>.

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**PP044**

## **Surface Dilational Viscosity of Nonionic Polypropylene Glycol Surfactants and their influence on Foam Behaviour**

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Foam is used in various industrial applications, such as froth flotation, food processing and oil recovery. The control of foam stability is critical for enhancement of process efficiency. Surfactant is often introduced to reduce the free energy and improve the foam stability by lowering the interfacial tension. From an engineering point of view, it is necessary to understand the relationship between surfactant molecular structure and the foam behaviour in order to select the most suitable surfactant that can optimize the process efficiency.

The aim of this work is to establish a surfactant structure-interfacial properties-foam behaviour correlation. The model system used in this work is a homologous series of polypropylene glycol surfactants (192-2000 g/mol) whereby the surfactant interfacial conformation changes from linear to coiled structure with increasing PPG molecular weight. The surface dilational viscosity of the PPGs were quantified using the overflowing weir technique. Their static and dynamic surface tension were measured. These interfacial properties were correlated to their foam behaviour.

PP045

## Surface Chemical Modification of Porous Silicon to Control Molecular Interactions and Adsorption

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Porous silicon (pSi) particles are under investigation as a drug delivery system for small molecules, peptide/proteins and various hydrophobic drugs. The native pSi surface is SiH<sub>x</sub> terminated, which makes it highly reactive and may have a detrimental effect on the bioactivity of some loaded molecules. Passivation modifies surface chemistry and hence influences pSi/molecule interactions, dissolution, molecular loading and release. The aim of this project is to investigate the effect of thermal oxidation as a passivation method on the porous structure and chemical speciation of pSi. The adsorption of probe molecules was also investigated to observe the changes in molecular interactions, particularly the influence of oxidation temperature.

pSi was oxidized at various temperatures (200-800°C) producing temperature dependent surface chemistry. Transitions in the surface chemistry were from native SiSiH<sub>x</sub> to O<sub>y</sub>SiH<sub>x</sub> then O<sub>y</sub>SiOH. Thermal oxidation increased wettability and surface roughness while decreasing the BET surface area<sup>1</sup> and zeta potential<sup>2</sup>. Dye adsorption was dependent of surface chemistry with increased cationic dye adsorption for higher oxidation temperatures. In contrast negligible adsorption of an anionic dye occurred at higher oxidation temperatures due to electrostatic repulsion. Higher oxidation temperatures decreased protein adsorption due to reductions in surface reactivity and area but also retained bioactivity. The size and charge of proteins had an impact on adsorption, with higher adsorption for positively charged proteins.

Thermal oxidation has been used to passivate the pSi surface, modifying the surface chemistry and therefore also the molecular interactions. Studying the adsorption of probe molecules we can observe the interactions of these molecules with different pSi surface species. This information can then be used to ascertain the types of interactions between pSi and drugs/proteins that possess similar functionalities. Using a range of probe molecules allows us to obtain extensive information about molecular interactions with pSi and by controlling these interactions we can influence adsorption and subsequent release, advancing the development of pSi as a drug delivery vehicle.

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PP046

## The Influence of Shear Responsive Polyethylene Oxide Adsorption behaviour on the Dewatering Behaviour of Talc

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Dewatering of colloidal clay mineral tailings produced as a result of hydrometallurgical activities is a common problem faced by mining and mineral processing industries world-wide. These dilute clay tailings show poor dewatering behaviour over several days or weeks without dewatering aids such as flocculants and coagulants. Conventional polyacrylamide (PAM) flocculants are commonly used to enhance dewaterability of mineral suspension in gravity thickeners. However, the consolidation of PAM flocculated sediments is considerably less than desirable. In recent years, the use of non-conventional stimulus responsive polymers as flocculants leading to dramatic enhancement in sediment consolidation, has received significant attention. Recent studies reported that a marked increase (~15 wt%) in clay (i.e. kaolinite and smectite) sediment solid loading has been achieved upon shear following flocculation with non-conventional, non-ionic and high molecular weight polyethylene oxide (PEO) [1, 2].

In this study, the influence of PEO molecular weight (4 vs. 8 MDa), suspension conditioning time (1 h vs. 18 h) and Mg(II) ion concentration (0 - 10<sup>-2</sup> M) on the dewatering behaviour of 8 wt% talc dispersion at pH 7.5 and 22 °C has been investigated. Adsorption isotherms, kinetics and adsorbed layer conformation of PEO on talc particles were also examined. Significantly improved settling behaviour was achieved at higher rather than at lower polymer MW during flocculation. The affinity and plateau values of PEO adsorption onto talc particles increased with higher Mg(II) ion concentration in solution but decreased with longer suspension conditioning time. An inverse correlation between PEO adsorption affinity/density and settling behaviour of talc dispersion was observed. Conditions which lead to lower adsorption affinity and plateau density result in higher settling rate of talc suspensions. Upon moderate agitation, PEO flocculated sediments led to a dramatic increase of 12-16 wt% in solid content, from 38 to 52 ± 2 wt%. However, polymer molecular weight, suspension conditioning time and Mg(II) ions concentration had no noticeable effect on the extent of sediment consolidation. The results demonstrate that PEO adsorption behaviour and interfacial conformation plays an important role in clarification but not on consolidation behaviour of talc dispersion.

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## Synchrotron XPS Study of Fractured, Solution Exposed Heterogeneous Chalcopyrite Surfaces

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Successful separation of metal sulfide minerals from other minerals present in an ore using flotation is highly dependant on surface chemistry. The heterogeneous nature of mineral sulfides influences their flotation response in many ways as wettability is determined by both the physical texture and the chemistry of a surface. Surface chemical changes due to the presence of other ore constituents or their dissolution products during flotation can both depress or activate minerals[1]. In addition, the semiconducting nature of metal sulfides enables galvanic mineral-mineral interactions which alter the oxidation and dissolution processes [2]. Knowing what effect a certain combination of minerals will have on mineral surface chemistry in a heterogeneous sample can help to predict how such a sample will behave during processing or indicate better treatments for that mineral

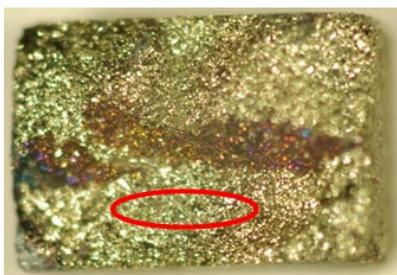
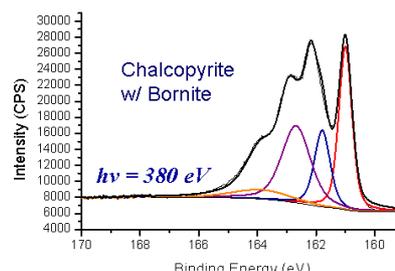


Fig A (Left): Heterogeneous sample of bornite (middle band) and chalcopyrite. Fig B (Right): S 2p spectrum from chalcopyrite in Fig A after pH 9 solution exposure



In this study natural samples of homogeneous chalcopyrite and heterogeneous samples containing both chalcopyrite and bornite (Fig. A) have been studied using Synchrotron Radiation X-ray Photoelectron Spectroscopy (SR-XPS) at the Australian Synchrotron's Soft X-ray beamline. Bulk samples were freshly fractured in the N<sub>2</sub> atmosphere of a glove box attached directly to the endstation's vacuum introduction chamber. The resulting surfaces were exposed to either pH 9 KOH for 30 minutes (to oxidise the surface) or were leached in pH 1 HCl for 2 hours before being transferred to vacuum without leaving the glove box. Analysis of the chalcopyrite region on each sample indicates that exposure to pH 9 for 30 minutes when bornite is present results in a reduction of the production of hydrophobic polysulfide species. In addition to this reduction in hydrophobic species generation, there is an increase in the amount of hydrophilic sulfate species on the surface. For those samples leached at pH 1 there was also a reduction in polysulfide species but also a slight increase in disulfide species. The surface chemical differences will be discussed with reference to their potential effect on mineral processing.

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PP048

## Enzyme Assisted Self Assembly

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The self assembly (SA) of peptides as an approach to produce complex architectures is commonplace in biology. Researchers are increasingly seeking to mimic these natural processes by utilising the natural portfolio of amino acids provided by nature. Despite significant advances in the field, the complexity which can be achieved in the laboratory is limited in comparison. Defect free, reproducible and thermodynamically stable structures are desirable for applications such as 3D cell culture, biosensing, organoelectronics and nanodevices.

We describe here the use of a fully reversibly enzymatic reaction to initiate and control the formation of SA aromatic short peptide derivatives. The use of enzymes in the SA process has a number of advantages, as functionality is optimal under mild, physiological conditions (aqueous, pH 5-8, 37°C).

The SA building blocks are formed by the reversed hydrolysis of hydrophobic N-(fluorenyl-9-methoxycarbonyl) (Fmoc)-amino acids and dipeptides [1]. Coupling the formation and SA of these peptide derivatives places the system under thermodynamic control; the SA process provides a thermodynamic “pull”, driving the reaction towards synthesis.

This approach provides three unique features; (i) Spatiotemporal control: the protease reversibly supplies building blocks on demand, limiting the SA process to the site of enzyme synthesis in a spatially constrained manner, (ii) Self-correction: the SA under thermodynamic control allows the fully reversible enzyme reaction to “proof-read” less favourable assemblies, allowing for the formation of defect free structures, and (iii) Component selection: the ability to amplify and accumulate components which from the most stable assemblies are comprised.

Enzyme-assisted SA with its inherent functionality, selectivity and ability to control SA under constant conditions therefore provides an important new tool in molecular SA and nanomaterials discovery, ultimately paving the way to functional nanostructures with enhanced complexities.

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PP049

## Phospholipid-based Cubic phases for Improved Drug Delivery Applications

Hsin-Hui Shen, Florian Huber, Guoliang Zhen, Durga Acharya, Simon Saubern, Patrick Hartley, Keith McLean

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Biocontinuous cubic liquid crystalline phase has found useful applications in pharmaceutical drug delivery. It presents a higher area of contact with the skin, which could improve the skin/cubosome-based drug interactions <sup>(a)</sup> with drugs such as cubic-based vitamin K, cyclosporine A and doxorubicin. In particular for a parenteral drug delivery system, it would be of substantial value to construct cubic phase composed of lipids because a high concentration of unsaturated monoglycerides could increase toxicity when injected in-vivo. Here we present a phospholipid-based cubosomes which is mixed with 2-20% of drug in the cubosomes. We also investigate the interaction of cubosome-based drugs with cell-mimicking lipid bilayers.

The phase behaviours are compared with different systems, Pophatidylcholine/monoolein (MO)/water and phosphatidylserine /MO/water with/without any targeting drug. The cubic phases are characterized by Cryo-TEM and small angle x-ray scattering techniques. It has been found that the phospholipid-based cubic phase was formed with high percentage of MO and details of phase behaviours are discussed. The cubic phase drugs are selected for the further investigation when the phospholipid-based cubosomes can load a larger amount of targeting drugs in individual lipid/MO/water cubic systems.

Next, the cell-mimicking lipid bilayers are produced from small unilamellar vesicles self-assembly on a modified polymer [poly(ethyleneglycol) (PEG) brush/glass surface<sup>(b)</sup> incorporated with dyes. The lipid bilayer microarray is from direct robotic spotting of vesicles solutions forming stable supported lipid bilayers on the hydrophilic polymer PEG brush surface. The fluorescence microscopy images were used to screen the targeting drug on the phospholipid bilayer surface and amount of drug release on to the bilayer. The results have established the fluidic stable lipid bilayer platform for generating content microarrays in high-throughput studies. The use of stable lipid bilayers microarrayers with different target drugs is an easy-to-use and efficient method for fast screening in pharmaceutical drug delivery applications and might help decrease the number of animal tests.

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## Analysis of Osteoblast Cell Behaviour on Nanostructured Porous Silicon Functionalised with Chemical Gradients of Plasma Polymerised Films

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The majority of bone graft procedures use allograft or autograft bone tissues.<sup>1</sup> These procedures can be painful and costly and also have limitations with incompatibility and disease transmission. An alternative approach is the use of bone engineered tissue scaffolds.<sup>2</sup> Ideally the scaffold should mimic the physical and chemical environment of natural bone tissue, which is mainly composed of a porous hydroxyapatite (HA) and collagen I matrix, to promote optimal osteoblast (bone producing cell) activity leading to bone mineral synthesis/precipitation and integration with the surrounding bone tissue. Nanotextured surfaces have been shown to regulate osteoblast cell growth structure and function.<sup>3</sup> These surfaces typically mimic the structure of extracellular matrix proteins and the basement membrane (10-300 nm) and hydroxyapatite crystals (4 nm).<sup>4</sup> Surface chemistry also plays an important role in regulating osteoblast cellular activity. For example, attachment of osteoblast cells can be controlled by negatively charged surface functional groups.<sup>5</sup> However, the analysis of both nanotopography and surface chemistry in the development of bone engineered tissue scaffolds is both costly and time consuming, limiting the combinations of topography/chemistry that can be analysed without a suitable screening method. In this presentation we describe a high-throughput screening device for analysing cell response to surface chemistry on nanoporous silicon. Gradients of carboxylic acid functional groups were plasma polymerised onto flat and anodised silicon with controlled pore geometries from < 10 nm to > 100 nm. Following surface characterisation with both XPS and AFM we examined the growth of MG63 osteoblasts on the functionalised nanostructured surfaces and provide evidence that both the pore size and the surface concentration of carboxylic acid groups influenced cell attachment and spreading. Therefore, plasma polymerised functional chemical gradients on porous silicon substrates can be used as high-throughput tools for developing improved bone engineered tissue scaffolds.

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## Lamellar to Cubic Phase Transitions Intermediates in Colloidal Dispersions of Self-Assembled Systems.

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Self-assembled systems have recently come to prominence in the field of drug delivery as potential carriers for therapeutic agents<sup>1,2</sup>. One of their primary advantages is their versatility as they can be adapted to different agents and targets sites. This behaviour arises from the diverse properties of the collection of molecules present within the aggregate. For example one could imagine the formation of particles with a multitude of properties, all contributing towards the therapeutic treatment of disease. This includes chemotherapy, targeting, imaging, radiotherapy targeting, and protection from immune system response. As targets and therapies are being developed the need for improved drug delivery capabilities to overcome obstacles such as the blood brain barrier becomes more important.

During the preparation of cubic phase dispersions with novel materials we observed the presence of new intermediates between the transition from the fluid lamellar lyotropic crystalline phase to the cubic phase. This phase transition is regarded as a model to membrane-fusion processes that occur *in-vivo*<sup>3</sup>. From our small angle X-ray scattering and transmission electron microscopy observations we are able to formulate a novel model of phase transition behaviour. Our model allows us to rationalise previous observations during such transitions and provides information as to how novel amphiphilic systems may interact with cell membranes.

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PP052

## **The Effect of Architecture on the Crystallization of Oxyethylene/Oxybutylene Block Copolymers from Micelles in n-Octane**

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Crystallization of Oxyethylene/oxybutylene diblock copolymers from micelles in n-octane was studied by simultaneous small-angle and wide angle X-ray scattering (SAXS/WAXS), dynamic light scattering (DLS) and differential scanning calorimetry (DSC). The effect of architecture on the crystallization was investigated on polymers with different molecular weight and composition.

It is observed that the block copolymers form spherical micelles at higher temperature and the oxyethylene blocks in the core of the micelles were amorphous. On lowering the temperature, two types of crystallization are identified: breakout crystallization in the core of the micelles from block copolymers with lower molecular weight regardless of the composition of block copolymers; and confined crystallization which happened when the length of each block in the block copolymer has reached a certain size.

In block copolymers having a shorter block length, as the temperature is lowered, the E chains in the core crystallise and the micelle shape is transformed. There are hairs on the upper and lower surface but not around the edges. These exposed hydrophilic crystal faces have attractive potentials and the parallelepiped micelles agglomerate to form rafts and precipitate out from the solution. By contrast, in block copolymers with longer block lengths, the amorphous block is densely packed rather than highly stretched. The densely packed amorphous block protects the lateral interface and hinders the aggregation of different block copolymers. As a result, the longer block copolymer always forms micelles. The crystallisation of the oxyethylene blocks within most micelles has to proceed through homogeneous nucleation which requires very deep undercooling, leading to very low crystallization temperatures.

PP053

## Forces between $\alpha$ -Al<sub>2</sub>O<sub>3</sub> probe and air bubble measured by AFM

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Surface forces between an air bubble and an alumina particle have been studied by colloidal probe atomic force microscopy (CP AFM). In our study particular attention was paid to the effect of the electrostatic component of the force acting between an air bubble and an alumina probe. Since the surface potentials of both interacting interfaces depend on solution composition; electrolyte concentration and pH of the solution was varied. It is well-known that the bubble surface bears a negative charge. The isoelectric point of  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> used in our study was found to be around pH=8.5. Therefore, we were able to use a wide pH range (3-7) to investigate interaction between oppositely charged surfaces (negatively charged solution/air interface and positively charged alumina/solution interface). It was found that for a slightly hydrophobic alumina probe interacting with a bubble, the film pH of the solution plays a significant role. We always observed small adhesion on approach part of the force curve followed by much greater adhesion on retraction. The magnitude of the adhesion increased as pH of the solution was decreased (i.e. surface potential of the alumina surface become more positive).

**PP054**

## **Characterization of amino functional groups on the surface of silica colloids**

Khoa Pham, Damian Fullston, Kwesi Sagoe-Crentsil

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The surface of colloidal silica in the size range of 30-500 nm was modified by grafting with amino silanes. The effects of pH, solvent and temperature on grafting efficiency are investigated. UV-visible spectroscopy, used with the Kaiser test, allows quantitative characterization of the amino density on the surface of silica colloids. In addition, measurement of the surface charge and zeta potential helps elucidate the reaction mechanism.

**PP055**

## **Gelation kinetics of silica colloids in the presence of Ca<sup>2+</sup> ion**

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Stable silica nanoparticles in a colloidal suspension form a solid network upon addition of calcium cations. The kinetics of this gelation is studied in detail as the effects of particle and calcium concentrations are measured quantitatively. Rheological measurements and dynamic light scattering were used to follow the characteristics of the suspension during the transition from liquid to solid. This study provides necessary understanding so that optimal control of the gelation time and final gel strength can be achieved for various applications.

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Boecking, Till	KN006	Dermis, Terry	<u>PP032</u>
Bonaccorso, Elmar	<u>OC109</u>	Dietrich, Siegfried	OC094
Borkovec, Michal	<u>OC092</u>	Dimitrov, Nikolay	OC081
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Brichter, Leanne	OC010	Duke, Mikel	<u>OC106</u>
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Caldwell, Karin	OC006	Endres, Frank	OC085
Carpenter, John	OC119	Evans, Drew	<u>OC071</u>
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Evrard, Mathilde	OC086	Hamza, Hassan A.	OC021
Fairclough, Patrick	<u>OC075</u> , <u>PP011</u> , PP038	Han, Jingtian	<u>PP015</u>
Fairgrieve, Craig	PP011	Hanley, Tracey	OC068
Feiler, Adam	<u>OC006</u> , <u>OC097</u>	Hansen, Ryan	OC024
Fernyhough, Christine	OC075, <u>PP009</u> , PP011 PP038	Han, Sung Soo	PP031
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Finch, James	<u>KN004</u>	Hao, Fuping P.	OC020
FitzGerald, Paul	PP025	Harmer, Sarah	<u>OC034</u> , PP047
Follink, Bart	OC019, OC080	Harper, Jason	KN006
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Gautam, Lekh Nath	PP002	Horikoshi, Koki	OC055
Gengenbach, Thomas	OC005, OC093	Horne, Mike	OC080
Ghouchi Eskandar, Nasrin	<u>PP037</u>	Horn, Roger	<u>OC030</u> , PP044
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Gotoh, Kuniaki	OC033	Ivanova, Elena	<u>OC009</u> , PP039
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Graf, Karlheinz	OC056	Iwama, Takashi	PP004
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Gray-Weale, Angus	OC077	James, Michael	KN006
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Szili, Endre	<u>PP050</u>	Wright, Phillip	<u>OC007</u>
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**The biennial Australian Colloid and Interface Symposium and the 10th Australia-Japan Colloid and Interface Science Symposium, Glenelg, Adelaide, South Australia – 1 to 5 February 2009**