

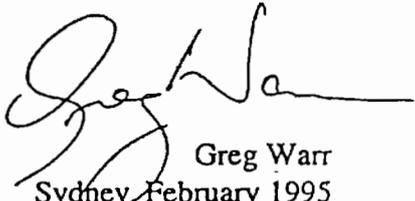
PREFACE

Who knows what Tom Healy and Bob Hunter had in mind when they got their postgraduate students together in Sydney for an informal meeting in 1967? Surely not this. Looking back on those meagre (but never humble) beginnings, one might say that these conferences have blossomed. One might also say that they have ballooned, expanded, exploded, even prolapsed. Conference organisers are now blessed, or cursed, with nearly 200 participants and 100 presentations. The introduction of a poster session at this meeting is an attempt to reclaim some time and informality, and to balance the aims of these meetings: to give students the opportunity to present their work to an expert and critical audience and to permit vigorous discussion of current research. We hope that the program leaves sufficient time for the latter without eroding the former.

It has become a tradition at student conferences that an eminent international scientist be invited as our Guests of Honour. At this meeting that role will be amply filled by Professor Henk Lekkerkerker from the Van 't Hoff Laboratory at the University of Utrecht. Also attending this meeting is Dr Geoff Barnes, retired but still of the University of Queensland. After so many years of contribution to the Australian colloid and surface chemistry community and to these conferences, we welcome you as a special guest of the conference.

These meetings have become increasingly international of late, and in addition to Professor Lekkerkerker's presence, we have several Dutch, English, and American participants presenting papers and posters.

The conference organisers would like to acknowledge the financial support provided by the Australian Centre for Water Quality Research, British Nuclear Fuels, Colloidal Dynamics, Fauldings, Comalco, ICI and ICI Dulux through the registration and attendance of their representatives at this meeting, and also the donation made by Tioxide Australia. The continuing support of the RACI Colloids Division is also gratefully acknowledged. Finally, thanks to Dr Peter Pieruschka of the ANU for providing the graphic on the cover of this booklet and the t-shirts.



Greg Warr
Sydney, February 1995

Dates and Locations of Australian Colloid and Surface Chemistry Student Conferences.

Location	Host	Year
Sydney	U of Sydney	1967
Melbourne	U of Melbourne	1969
U of Sydney	U of Sydney	1972
Melbourne/Blackwood	U of Melbourne	1973
Pretty Beach	U of Sydney	1974
ANU	ANU	1976
Blackwood	U of Melbourne	1977
Yarrawood	U of Sydney	1978
Kioloa	ANU	1980
Mt Eliza	U of Melbourne	1982
Yarrawood	U of Sydney	1983
Roseworthy	SAIT	1985
Kioloa	ANU	1987
Albury	U of Melbourne	1988
Camden	U of Sydney	1990
Roseworthy	U of SA	1991
Deakin U	U of Melbourne	1993
Fairy Meadow	U of Sydney	1995

18th Australian Colloid and Surface Chemistry Student Conference Programme

Monday, February 13th, 1995

Arrival and registration 11:00 a.m. - 1:00 p.m.

Lunch 12:00 - 1:00 p.m.

First Session Chair: Dr Michelle Gee

1:20 - 1:30 Opening Remarks: Dr Greg Warr

1:30 Preparation and Characterisation of Thin Films of the Trimethylamine Adducts of Alane and Gallane on Oxidised Silicon
Fiona Elms (Faculty of Science and Technology, Griffith University),

1:45 Fundamentals Of Red Mud Flocculation
Franca Jones (Curtin University)

2:00 Dynamic Microcalorimetric Gas Adsorption
Scott Buckingham (Chemical Engineering, UNSW)

2:15 Electrical Double Layer Interactions Between Two Unequal Spheres
Jim Stankovich (Mathematics, University of Melbourne)

2:30 Rheology Of Worm-Like Micelles
Chih-Ming Chen (Chemistry, University of Sydney)

2:45 The Effect Of Fluid Hydrodynamics On Droplet Coalescence
Trina Dreher (Chemical Engineering, University of Melbourne)

3:00 The Effect Of EDTA On The Surface Properties Of Skim Milk
Brent Ward (Chemistry, Monash)

3:15 - 3:45 Afternoon Tea

3:45 Structure And Biodegradability Of Surfactants Derived From Sugar Esters
Irene Baker (School of Chemistry, University of Melbourne/CSIRO)

4:00 Surface Phenomena of Conducting Membranes
Maria Chan (Chemical Engineering, UNSW)

4:15 Surface Forces Between Mercury And Mica Across A Thin Aqueous Film.
Darren J. Bachmann (Applied Physics, University of South Australia)

4:30 Flocculation And Its Downstream Effect On Bayer Process Residue Disposal
Nick Pashias (Chemical Engineering, University of Melbourne)

- 4:45 Nitrogen Occurrence in an Australian Bituminous Coal Studied by X-ray Photoelectron Spectroscopy (XPS) and Time-of-Flight Secondary Mass Spectrometer (TOFSIMS)
Bill Bin Gong (Chemistry, UNSW)
- 5:00 Adsorption Of Charged Latex Particles On Mica Studied With Atomic Force Microscopy
Christopher Johnson (Chemical Engineering, U of Delaware, USA)

Dinner 7:00 p.m.

Mixer 8:30

Tuesday, February 14th, 1995

Second Session

Chair: Dr Ian Gentle

- 9:00 Forces Between Heterogeneous Charged Surfaces
Warwick Holt (Mathematics, University of Melbourne)
- 9:15 Binding Of Salicylate To Cationic Surfactant Aggregates
Marta Cassidy (Chemistry, University of Sydney)
- 9:30 Guided Wave Resonance Modulators Using ZnO Thin Films
Michael Koch (Chemistry, UNSW)
- 9:45 Adsorption Of Polymers On To Mineral Surfaces
Rod Harris (La Trobe University, Bendigo)
- 10:00 The Influence Of Sodium Carbonate On Aluminosilicate Scale Formation And Silica Solubility In Sodium Aluminate Solutions
Kali Zheng (Ian Wark Research Institute, University of SA)
- 10:15-10:45 Morning Tea
- 10:45 Validation Of The Compression Model For Colloidal Suspensions
Matthew D. Green (Chemical Engineering, University of Melbourne)
- 11:00 The Study Of Orthophosphate Adsorption Onto Natural Colloidal Particles
Jason van Berkel (Chemistry, Monash)
- 11:15 Surfactant Templated Silica/Organic Composites
Karen Edler (Research School of Chemistry, ANU)
- 11:30 Conformations of Adsorbed Polyelectrolytes
David J. Neivandt (School of Chemistry, University of Melbourne)
- 11:45 Adsorption of Dissolved Humic Material onto Activated Carbon
Gayle Newcombe (Aust. Centre for Water Quality Control)

Lunch 12:30 - 1:30 p.m.

Third Session Chair: Dr Robert Hayes

- 1:30 Observation Of Elastic Effects Of Viscoelastic Fluids In Swirling Flow
Jason Stokes (Chemical Engineering, University of Melbourne)
- 1:45 The Effect Of Polymer Adsorption On Electroacoustic Signals
Melanie Carasso (Physical Chemistry, University of Sydney)
- 2:00 Interparticulate adhesion: The interaction between silica and iron oxide
Gary Toikka (Ian Wark Research Institute, University of SA)
- 2:15 Nanoparticles
David T. Atkins (Applied Maths, ANU)
- 2:30 Correlation Between Surface Speciation/Solution Speciation/Flotation
Response In Sphalerite Flotation
Angela Lange (Ian Wark Research Institute)
- 2:45 Direct Force Measurement of Dissimilar Metal Oxides
Ian Larson (School of Chemistry, University of Melbourne)
- 3:00 Aluminium Hydroxide Films And Their Effect On Surface Bond Durability
Andrew Rider (Chemistry, UNSW)
- 3:15 - 3:45 Afternoon Tea
- 3:45 Thin Film Drainage Between Solid And Fluid Surfaces
Jason Connor (Applied Physics, University of South Australia)
- 4:00 Solution And Adsorption Properties Of A Polymeric Talc Depressant
Gayle Morris (Ian Wark Research Institute, University of SA)
- 4:15 Dewatering of Australian Black Coals
Jamie Tudor (Swinburne)
- 4:30 Synergistic Effects of Dual Polymer Flocculation
Kristen Bremmell (University of Newcastle)
- 4:45 **Poster Presentations** Chair: Dr Greg Warr (3 min. per presentation)
- 1 The Adsorption Of Polyphosphates At The Titanium Dioxide-Water Interface
Karen Grieve (Chemistry, University of Melbourne)
- 2 The Influence of Colloidal Particles on the Inactivation of a Proteolytic Enzyme
Hilde Rinia (Wageningen Agricultural University)
- 3 Ion Specific Interactions in Lamellar Liquid Crystals
Heather Patrick (Chemistry, University of Sydney)
- 4 AFM Measurements Of Forces Due To Contact Electrification Between Particles
And Surfaces
Ben Francis (Applied Physics, University of South Australia)

- 5 Rheology of Waxy Crude Oil.
Cheng Chang (Chemical Engineering, University of Melbourne)
- 6 Continuous Separation Of Particles And Colloids By SPLITT
Frank Riet (Chemistry, Monash)
- 7 Lateral Mobility Of Surfactant Molecules Confined Between Solid Surfaces
Gerold Willing (Auburn)
- 8 Dewatering of Sludges
Deanne Labbett (Chemistry, Melbourne)
- 9 Tailored Zeolites
Greg Cusick (Chemistry, UNSW)
- 10 Influence of Electrolyte on Hydrogel Morphology
Anita Ip (Chemical Engineering, UNSW)

Dinner 7:00 p.m.

Poster Session 8:30 p.m.

Wednesday, February 15th, 1995

Fourth Session Chair: Dr Calum Drummond

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|-------------|---|
| 9:00 | Sonochemical Dissolution of MnO ₂ Colloids
Joe Sostaric (School of Chemistry, University of Melbourne) |
| 9:15 | Measurement of Interactions Between Colloidal Particles and an Air/Water Interface.
M. Fielden (Ian Wark Research Institute, University of SA) |
| 9:30 | Nucleation and Growth of Colloidal Crystals
Stuart Henderson (Applied Physics Department, R.M.I.T.) |
| 9:45 | Reductive Dissolution of Optically Transparent Colloidal CuFeS ₂
Kate Drummond (School of Chemistry, University of Melbourne) |
| 10:00 | The Interaction Of A Copper Selective Collector With Chalcopyrite
Gillian Fairthorne (Ian Wark Research Institute, University of SA) |
| 10:15-10:45 | Morning Tea |
| 10:45 | External Infrared Reflection-Absorption Spectrometry At The Air/Water Interface
Brendan Sinnamon (The University of Queensland) |
| 11:00 | Wettability Of Heterogeneous Surfaces.
Stephen Duplock (Ian Wark Research Institute, University of SA). |

- 11:15 Sonochemical Reduction of AuCl_4^- (aq)
Rachel Hobson (School of Chemistry, University of Melbourne)
- 11:30 Annealing Studies Of Sputtered Zinc Oxide Films
Martin Puchert (Chemistry, UNSW)
- 11:45 The Removal Of Nutrients By Precipitation Of Struvite Using Magnesia
Ian Fraser (Chemistry, Monash University)

Lunch 12:30 - 1:30 p.m.

Staff-Student Cricket Match 2:00

Dinner 7:00 p.m.

Thursday, February 16th, 1995

Fifth Session Chair: Dr Stephen Hyde

- 9:00 Measurement of Single Particle Motions in Concentrated Turbid Suspensions
Tim Mortensen (Applied Physics, RMIT)
- 9:15 Relationship Between Surface Chemistry and Flocculant Structure of
Asymmetric Particles
Stephen Johnson (School of Chemistry, University of Melbourne)
- 9:30 Mechanical Milling Of Zircon Sand
Tony Puclin (Applied Mathematics, ANU)
- 9:45 Electroacoustics Of Casein Micelles
Theresa Wade (University of Sydney)
- 10:00 Role of Surfactant Adsorption and Surface Charge in Flotation
Peter Sanciolo (Swinburne)
- 10:15-10:45 Morning Tea
- 10:45 Modelling Adsorption From Solution
Lorraine Staehr (La Trobe University, Bendigo)
- 11:00 A Study of The Removal of Oxidation Products from Sulfide Mineral
Surfaces.
Peter Clarke (Ian Wark Research Institute, University of SA)
- 11:15 Titania Hydrolysates From Carboxylic Acid Modified Alkoxides
Paul A. Venz (Chemistry, QUT)
- 11:30 Gibbsite Growth Mechanism Study
James Counter (Ian Wark Research Institute, University of SA)

11:45 A Study of the Surface and Biological Activity of a Trivalent Cage
Surfactant
Marilyn Karaman (Chemistry, ANU)

Lunch 12:30 - 1:30 p.m.

Sixth Session Chair: A/Prof Robert Lamb

1:30 Surface Properties Of Coal
Celesta Fong (The University of Queensland)

1:45 The Deposition of Colloidal Particles onto Surfaces under Stagnant-Point
Flow Conditions
Nigel Wright (Bristol)

2:00 High Intensity Conditioning of Mt Keith Ore
Chen Gang (Ian Wark Research Institute, University Of SA)

2:15 Novel Conducting Membranes Prepared From Polymer Blend By Phase-
Inversion Method
Anita Voros (Chemical Engineering, UNSW)

2:30 Mesoporous Solids - Templating With Liquid Crystals
Robert Corkery (Applied Mathematics, ANU)

2:45 A Study Of Colloidal Stability Of Gibbsite Dispersions
Jodieann Dawe (Ian Wark Research Institute, U.S.A.)

3:00 Bubble Formation and Growth in Solution Supersaturated with Carbon
Dioxide
Sophie Lambert (University of Newcastle)

3:15 - 3:45 Afternoon Tea

3:45 The Effect Of Annealing On The Structures Of L-B Films Of Arachidates
Jian Bang Peng (The University of Queensland)

4:00 Synthesis And Action of Novel Organic Collectors for Zircon Flotation
Mick Bjelopavlic (Ian Wark Research Institute, University Of SA)

4:15 Zinc Carboxylates For The Chemical Vapour Deposition Of Oriented ZnO
Films
Leong Mar (Chemistry, UNSW)

4:30 Surface Modification of Kaolin by Covalently Bound Polyethylene oxide
Marylou Molphy

4:45 A Static Sims Study Of Hydroxylation Of Low Surface Area Silica
Barry Wood (Chemistry, UNSW)

5:00 The Hydrophobic Interaction. An Experimental Approach
Vince Craig (Chemistry, ANU)

Conference Dinner 7:30 p.m.

Friday, February 17th, 1995

Seventh Session

Chair: Dr Mark Rutland

- 9:00 **The Interactions of Colloidal Iron Oxide Particles with Quartz Surfaces**
Paula Bandini (Ian Wark Research Institute, University of SA)
- 9:15 **Measurement Of The Interactions Between Macroscopic Surfaces Inducing A**
First-Order Phase Transition: The Sponge-Lamellar Transformation
David Antelmi (Department of Applied Mathematics, ANU)
- 9:30 **Thin Film Polymer pH Sensors**
Tina Aquino-Binag (Chemistry, UNSW)
- 9:45 **Dielectric Response of Sulphonate Latices**
Adrian Russell (School of Chemistry, University of Melbourne)
- 10:00 **Direct Determination Of Bacterial Biomass Using Sedimentation Field-Flow**
Fractionation
Reshmi Sharma (Chemistry, Monash)
- 10:15-10:45 **Morning Tea**
- 10:45 **Halocarbon Etching Of III-V Semiconductors**
Adrian Bolzan (Chemistry, UNSW)
- 11:00 **Surfactant Solutions and Foams**
Ross Mair (Swinburne)
- 11:15 **Surface Treatments Of Wool And Wool Products**
Narelle Brack (Chemistry, UNSW)
- 11:30 **Light Scattering From Concentrated Dispersions: The Role Of Optical Fibers**
Rajesh Srivastva (Applied Physics, University of SA)
- 11:45 **Uranium Transport in Groundwaters**
Brett Fenton (Mechanical Engineering, UNSW)

12:00 Close Conference

Lunch 12:00 - 1:00 p.m.

18th Australian Colloid and Surface Chemistry Student Conference
List of Participants

Australian Centre for Water Quality Research			CSIRO Division of Chemicals and Polymers		
Ms	Gayle	Newcombe	Ms	Irene	Baker
Australian Defence Forces Academy			Dr	Frank	Caruso
Dr	Tim	Senden	Dr	Calum	Drummond
Dr	Erica	Wanless	Dr	Neil	Furlong
The Australian National University			Mr	George	Georgaklis
Mr	David	Antelmi	Mr	Asoka	Weerawardena
Mr	David	Atkins	Dr	Robert	Urquhart
Dr	Hugo	Christenson	Curtin University		
Mr	Rob	Corkery	Ms	Franca	Jones
Dr	Joan	Curry	Fauldings		
Dr	Eric	Freysingas	Dr	Belinda	Braggs
Dr	Stephen	Hyde	Griffith University		
Dr	Stjepan	Marcelja	Ms	Fiona	Elms
Prof	Barry	Ninham	LaTrobe University		
Mr	Anthony	Puclin	Mr	Rod	Harris
Dr	David	Williams	Dr	Bruce	Johnson
Dr	Vasily	Yaminsky	Ms	Lorraine	Staehr
Mr	Vincent	Craig	Dr	John	Wells
Ms	Marilyn	Karaman	Monash University		
Prof	Richard	Pashley	Ms	Winnie	Kwok
Ms	Karen	Edler	Mr	Frank	Riet
Dr	Phil	Attard	Ms	Reshmi	Sharma
Auburn University, USA			Mr	Jason	van Berkel
Mr	Gerold	Willing	Mr	Brent	Ward
Prof.	Ron	Neuman	Mr	Ian	Fraser
Bristol University, UK			Dr	Ron	Beckett
Mr	Nigel	Wright	Dr	Ian	McKinnon
British Nuclear Fuels			Queensland University of Technology		
Dr	Bob	Holmes	Mr	Paul	Venz
Colloidal Dynamics / University of Sydney			Royal Melbourne Institute of Technology		
Dr	Robert	Hunter	Mr	Stuart	Henderson
Comalco Australia			Mr	Tim	Mortensen
Dr	Karen	Burrows	Mr	Mark	Padgham
Mr	John	Cleaver	A/Prof	Bill	van Megen

Swinburne University

Mr Russell Crawford
 Dr Ian Harding
 Mr Ross Mair
 Ms Mary-Lou Molphy
 Mr Peter Sanciolo
 Mr Jamie Tudor
 Prof David Mainwaring

University of Melbourne

Mr Cheng Chang
 Ms Trina Dreher
 Dr David Dunstan
 Mr Matt Green
 Dr Y K Leong
 Mr Nick Pashias
 Dr Jilska Perera
 A/Prof Geoff Stevens
 Mr Jason Stokes
 Ms Kate Drummond
 Dr Michelle Gee
 Dr Michael Giersig
 Dr Franz Grieser
 Ms Karen Grieve
 Dr Patrick Hartley
 Prof Tom Healy
 Ms Rachel Hobson
 Mr Stephen Johnson
 Ms Deanne Labbett
 Mr Ian Larson
 Mr Richard Kuo
 Dr Andrew Milling
 Dr Paul Mulvaney
 Mr David Neivandt
 Mr Adrian Russell
 Dr Peter Scales
 Dr Ewen Silvester
 Mr Joe Sostaric
 Dr Suzie Steinberg
 Dr Steven Carnie
 Prof Derek Chan
 Dr Jonathan Ennis-King
 Mr James Gunning
 Mr Warwick Holt
 Ms Christine Mangelsdorf
 Dr John Sader

Mr Jim Stankovich
 Prof Lee White

University of Newcastle

Dr Simon Biggs
 Ms Kristen Bremmell
 Ms Sophie Lambert

University of Oklahoma

Prof Bruce Ackerson

University of Queensland

Dr Geoff Barnes
 Ms Janine Bryceon
 Ms Celesta Fong
 Dr Ian Gentle
 Dr Gwen Lawrie
 Mr Jian Bang Peng
 Mr Brendan Sinnamon
 Dr Roland Steitz

University of SA

Dr Gary Bryant
 Mr Ben Francis
 Prof Roger Horn
 Dr Stan Miklavic
 Ms Rajesh Srivastva
 Prof John Thomas
 Dr Jonas Addai-Mensah
 Mr Darren Bachmann
 Ms Paula Bandini
 Mr Mick Bjelopavlic
 Ms Monique Bremer
 Mr Gang Chen
 Mr Peter Clarke
 Ms Hilde Crossen
 Mr Jason Connor
 Mr James Counter
 Ms Jodieann Dawe
 Mr Stephen Duplock
 Ms Gillian Fairthorne
 Mr Matthew Fielden
 Dr Daniel Fornasiero
 Dr Andrea Gerson
 Ms Frances Hayes

Dr Robert Hayes

Dr Thomas Horr

Ms Angela Lange

Ms Gayle Morris

Dr Clive Prestidge

Prof John Ralston

Mr Andrew Robinson

Dr Bill Skinner

Prof Roger Smart

Mr Gary Toikka

Ms Kali Zheng

ICI Dulux

Ms Patty Fasoulopoulos

ICI Explosives Division

Ms Sarah Rodgers

Ms Andrea Goudy

Carnegie-Mellon University

Prof John Anderson

Wageningen Agricultural University

Ms Hilde Rinia

University of New South Wales

Ms Anita Ip

Mr Scott Buckingham

Ms Maria Chan

Dr Vicki Chen

Ms Anita Voros

Ms Tina Aquino-Binag

Mr Bill Bin Gong

Mr Adrian Bolzan

Ms Narelle Brack

Mr Greg Cusick

Dr Andreas Hartmann

Mr Michael Koch

A/Prof Robert Lamb

Mr Leong Mar

Dr Paul Pigram

Mr Martin Puchert

Mr Andrew Rider

Ms Natalie Szakacs

Mr Barry Wood

Mr Brett Fenton

University of Delaware

Mr Chris Johnson

Prof. Abraham Lenhoff

University of Sydney

A/Prof James Beattie

Ms Melanie Carasso

Ms Marta Cassidy

Mr Chih-Min Chen

Dr Richard O'Brien

Ms Feryal Ozbakan

Ms Heather Patrick

Dr Bill Rowlands

Dr Mark Rutland

Ms Theresa Wade

Dr Greg Warr

Mr Archie Carambassis

Utrecht University

Prof Henk Lekkerkerker

ABSTRACTS

**PREPARATION AND CHARACTERISATION OF THIN FILMS OF THE
TRIMETHYLAMINE ADDUCTS OF ALANE AND GALLANE ON
OXIDISED SILICON**

Fiona Elms (Faculty of Science and Technology, Griffith University),

The surface adsorption characteristics of trimethylamine alane, (TMAA, H_3AlNMe_3), and trimethylamine gallane, (TMAG, H_3GaNMe_3) on SiO_2 substrates have been investigated using X-ray photoelectron spectroscopy (XPS) and static secondary ion mass spectrometry (SSIMS). These compounds have been shown to be excellent precursors for fabricating ultrapure Al and Ga-containing semiconductor materials for device purposes.

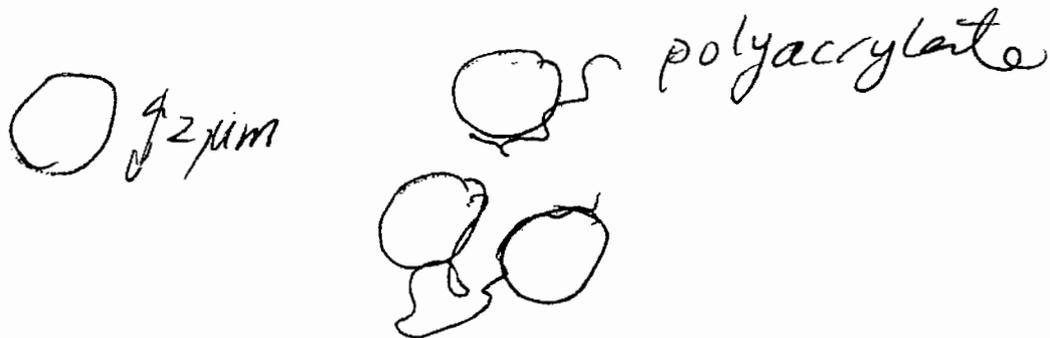
In the case of TMAA, molecular adsorption prevails at exposures of ~ 15 langmuirs (L) with the aluminium centres becoming five coordinate *via* binding to surface oxygen centres. High X-ray flux during XPS experiments (> 240 W) results in migration of NMe_3 to silicon centres, ascertained by comparison with the adsorption of NMe_3 gas. At exposures greater than ~ 30 L an aluminium rich species is formed, with the ratio of Al:N close to 2:1. Similar results are obtained for dosing of bistrimethylamine alane, $\text{H}_3\text{Al}(\text{NMe}_3)_2$.

Ab initio molecular orbital calculations (HF/D95*) on H_3AlNH_3 and H_2O and H_3AlOH_2 , as model systems for the interaction of H_3AlNMe_3 with surface oxygen centres, gave formation of $\text{H}_3\text{AlNH}_3(\text{OH}_2)$ as energetically favoured by 4.53 kcal mol $^{-1}$, and its fragmentation to H_3AlOH_2 and NH_3 requiring 13.16 kcal mol $^{-1}$; association of H_3AlOH_2 and H_3AlNH_3 to $\text{H}_2(\text{NH}_3)\text{Al}(\mu\text{-H})_2\text{Al}(\text{OH}_2)\text{H}_2$, as a model for the aluminium rich species, is also favoured, by 3.39 and 3.24 kcal mol $^{-1}$ for two isomers with different orientations of the H-atoms on sp^3 oxygen.

In contrast, TMAG forms a Ga rich species for a range of dosing conditions with a Ga:N ratio close to 3:1. XPS spectra for the Ga 2p and N 1s photoelectron peaks indicates that TMAG dissociates on adsorption with amine binding to silicon sites and H_3Ga binding to oxygen sites on the surface. The difference in the adsorption characteristics of TMAA and TMAG is in accordance with the weaker nature of both Ga-H and Ga-N bonds and with gallane preferentially forming stable four-co-ordinate species with Lewis bases whereas alane can form four- or five-co-ordinate species including hydride bridges or even cationic six-co-ordinate species.

FUNDAMENTALS OF RED MUD FLOCCULATION
Franca Jones (Curtin University)

Red mud is a waste product formed during the refining of bauxite to alumina using the Bayer process. Caustic solutions ~4M are used to dissolve the aluminous material from bauxite and solid/liquid separation is required to clarify the supersaturated liquor from the waste mud. Thus, removal of the red mud is an important step in the overall refining process. High molecular weight polymers are used to aggregate the fine mud particles so that they will settle faster, ie flocculation occurs. In addition to the high caustic levels, plant liquors are known to contain very high levels of inorganic salts (>100 g/L). Thus these solutions present the extremes in both pH and ionic strength. The red mud is then flocculated at 95-110 °C. While flocculation mechanisms are well understood in aqueous environments, high ionic strength and highly caustic solutions present some difficulties. Fundamental knowledge of this system is lacking and previous work on this topic has not been systematic. Important information is unavailable; for example, what is the interaction between the flocculant and the surface at such high ionic strengths? What are the surface groups present on the various minerals under these conditions? In an attempt to answer these questions and determine the flocculation characteristics of red mud, the approach taken has been to investigate the behaviour of the main red mud components separately in synthetic liquors. A review of the literature available on red mud flocculation is given, along with the aims for this project. Finally, some preliminary results will be discussed.



DYNAMIC MICROCALORIMETRIC GAS ADSORPTION

Scott Buckingham (Chemical Engineering, UNSW)

Many heterogeneous catalysts rely on their surface acid/base nature to promote reaction. Two common methods of identifying surface acidity are temperature programmed desorption (TPD) and static microcalorimetric gas adsorption. TPD is often complicated by the kinetics of desorption while static adsorption requires dedicated ultra-high vacuum technology. A new technique that combines the positive features of both TPD and static adsorption has been developed and will be discussed and compared to the other techniques. Dynamic microcalorimetric gas adsorption involves pulsing a probe molecule into a carrier gas stream that is passed over a sample in a microcalorimeter cell. The new technique measures the population and strength of surface acid sites on solid samples at atmospheric pressure. Other benefits such as the ability to perform insitu pretreatments aid the application of the technique. Surface acidity measurements performed on various silica, titania and chromia based catalysts with ammonia as the probe will be presented. Links between surface acidity and catalyst activity for the selective catalytic reduction of NO_x with ammonia will be discussed.

**ELECTRICAL DOUBLE LAYER INTERACTIONS BETWEEN TWO
UNEQUAL SPHERES**

Jim Stankovich (Mathematics, University of Melbourne)

The force and interaction free energy between two unequal spheres (or between a sphere and a plate) are calculated numerically using the nonlinear Poisson-Boltzmann theory. Results are compared with the linear theory, and with the Deryaguin construction applied to the nonlinear and linear theories. With most particle configurations at least one of these approximations provides accurate results.

RHEOLOGY OF WORM-LIKE MICELLES
Chih-Ming Chen (Chemistry, University of Sydney)

The rheology of worm-like ionic micelles formed by adding sodium salicylate into tetradecylammonium bromide solution has been studied. The elongational rheology infers pictures of microstructure of micelles with various degrees of elongational field. A microscopic approach, light scattering, will be used to detect the influence of elongational field on micelle microstructure. A new way to prepare anionic worm-like micelles by mixing with non-ionic surfactants has been found. Due to most of studies so far are concentrated on cationic micelles, we will also study rheology of anionic worm-like micelles.

**THE EFFECT OF FLUID HYDRODYNAMICS ON DROPLET
COALESCENCE**

Trina Dreher (Chemical Engineering, University of Melbourne)

Droplet motion is of interest in many fields including fermentation, polymer processes, waste treatment and food processing.

Droplet coalescence is considered to be a three step process consisting of droplet approach and contact, interfacial liquid film drainage and droplet rupture, which is very rapid in comparison to the first two steps. The drop approach time is controlled by the hydrodynamics of the bulk liquid phase. The interfacial drainage rate is controlled by the hydrodynamics of the liquid film and is the controlling factor in the coalescence time of a droplet at an interface.

A number of experimental investigations on the effects of fluid properties on droplet coalescence have been published, although little work has been conducted on the effects of interfacial rheological properties. The use of ideal elastic (Boger) fluids based on organic systems, has enabled the effect of fluid elasticity and viscosity on coalescence time to be studied independently. Preliminary results from these experiments will be presented.

THE EFFECT OF EDTA ON THE SURFACE PROPERTIES OF SKIM MILK

Brent Ward, Ian McKinnon, Mary Ann Augustin (Chemistry Department, Monash University, Clayton Vic. 3168 C.S.I.R.O. & Division Of Food Science And Technology, Highett Laboratory, Vic. 3190)

The proportion of milk salts and proteins present as aggregates in casein micelles and the proportion present in more solvated form in the serum phase affects many of the properties of skim milk. The aim of this project is to determine how changes in the protein distribution within milk, as induced by changes in the calcium ion equilibria, influence the surface and foaming properties of the milk.

It is known that EDTA causes transfer of both colloidal calcium and casein proteins from casein micelles, thus increasing the amounts of calcium and casein present in the milk serum phase. This increase in serum protein causes a marked change in the foaming properties of skim milk. The degree of change in both foam formation and foam stability depends only on the amount of EDTA added and not on the pH. The addition of EDTA has no effect either on the value of the equilibrium surface tension of droplets of skim milk or on the rate of decay of the surface tension freshly formed drops. Thus surface tension is not a major factor in determining the foaming properties of skim milk.

**STRUCTURE AND BIODEGRADABILITY OF SURFACTANTS DERIVED
FROM SUGAR ESTERS**

Irene Baker (Chemistry, University of Melbourne/CSIRO)

Since the 1950's sugar esters have attracted the attention of researchers looking for non-toxic and readily biodegradable surfactants. Nonionic surfactants are formed by esterification of sugar hydrophiles with fatty acid hydrophobes. The nature of the sugar and fatty acid components can be varied, mono or diesters can be formed and ethoxylate chains can be attached to the sugar. Anionic analogs can be formed by sulfonation. It is possible to produce surfactants with a wide range of properties.

This paper describes how sulfonation and variations in the type and number of alkyl chains, have been found to affect the biodegradability of sugar esters.

Biodegradabilities have been determined according to the ISO standard 7827. This involves measurement of ultimate biodegradation by decrease of dissolved organic carbon content of bacterial cultures containing the test substance as the sole source of organic carbon. The pathways by which selected materials are degraded have been elucidated using HPLC and NMR to determine the nature of intermediates. Mechanisms by which structural variations affect biodegradability are discussed.

In this way some understanding has been obtained about the modifications which can be made to the structure of sugar esters, in order to obtain desired chemical/physical characteristics, without compromising their ready biodegradability.

SURFACE PHENOMENA OF CONDUCTING MEMBRANES

Maria Chan (UNESCO Centre for Membrane Science and Technology, UNSW)

Electrical effects are known to be capable of modifying both polarization and solute-membrane interactions during filtration. In this research, these were investigated using conductive membranes. The conductive membranes were prepared by coating commercially available flat-sheet ultrafiltration (UF) or microfiltration (MF) membranes with a thin metal layer or with a conductive polymer to form a conductive surface.

The effective charge of a membrane was modified by application of various electrical potentials: varying from -1500mV to + 1500mV. Different types of feed solutions at various pH and pressures were studied. Experimental results showed that for conductive UF membranes, solute-membrane interaction is affected significantly by electrical field. On the other hand, electrical effects are minimal for MF membranes. Evidence from electron micrographs of the "fouled" conductive membranes supports these experimental results.

Future studies will focus on the characterization of the solute-membrane interaction through measurements of its capacitance and conduction properties by impedance spectrometer.

**SURFACE FORCES BETWEEN MERCURY AND MICA ACROSS A THIN
AQUEOUS FILM.**

Darren J. Bachmann (School of Applied Physics, University of South Australia)

The interactions between surfaces in close proximity are the key mechanism behind a range of interfacial phenomena including wetting behaviour, adhesion and colloid stability. Many direct measurements of these surface forces have been made over the last twenty years or so, and these have generally been concerned with the interactions between two solid surfaces. The approach presented here is an extension of this work, in which a solid interacting with a fluid surface across an intervening aqueous film is considered. Mercury is used as a model fluid because (a) its reflectivity allows accurate measurements of the solid-fluid separation to be made by using a variation of the optical interference technique that is commonly used in surface force measurements (FEKO), and (b) its electrical conductivity allows control of the surface potential and hence of double-layer interactions with the solid (mica) surface. In addition to probing the double layer, the experimental arrangement will also enable detailed observations of wetting and dewetting processes, and will serve as a useful analogy for the study of bubble-particle attachment.

**FLOCCULATION AND ITS DOWNSTREAM EFFECT ON BAYER
PROCESS RESIDUE DISPOSAL**

Nick Pashias (Chemical Engineering, University of Melbourne)

During the past Alumina producers have utilised specialty chemical treatment programs to overcome processing bottlenecks and achieve increased levels of efficiency. Although these programs often achieve their aim there is often a lack of understanding and forethought as to the effect of these chemicals on downstream processing. This study aims to identify the consequences of these chemicals as well as identifying new additives which may be better suited.

**NITROGEN OCCURRENCE IN AN AUSTRALIAN BITUMINOUS COAL
STUDIED BY X-RAY PHOTOELECTRON SPECTROSCOPY (XPS) AND
TIME-OF-FLIGHT SECONDARY MASS SPECTROMETER (TOFSIMS)**

Bin Gong (School of Chemistry, University of NSW)

The surface chemistry of cleaved coal and coal dust is an important factor in many aspects of coal utilisation and mining occupational health. Surface sensitive analytical techniques including X-ray photoelectron spectroscopy (XPS) and time-of-flight secondary ion mass spectrometry (TOFSIMS) were used to provide direct chemical information about coal surfaces and in particular, the chemical mode of occurrence of nitrogen in NSW coals.

Nitrogen occurrence in coal is of great importance because combustion of nitrogen-containing fuels is believed to be a major source of NO_x emissions. Pyrrole and pyridine forms of nitrogen are predominant in all coals. In this paper, a previously unreported quaternary nitrogen species, most probably NH_4 -bearing illite, is identified in the dull bands of Young Wallsend bituminous coal from the Hunter region, NSW. XPS shows a high binding energy nitrogen component comprising 13% of total nitrogen content occurring only in the dull portion of the coal. This component was found have similar differential charging behaviour to other mineral elements, such as silicon, aluminium and potassium indicating possible nitrogen association with potassium-containing clays. High mass resolution TOFSIMS shows an intense peak at mass, 130.150 - 130.165 daltons from the dull bands of the coal. This peak is assigned to quaternary nitrogen containing molecular ions of the form $(\text{C}_2\text{H}_5)_4\text{N}^+$ and the corresponding isomers. Other quaternary nitrogen-containing ions were also recorded from dull coal. These ion peaks are, however, significantly lower from bright coal samples. In contrast, pyrrole or pyridine-like ion peaks have similar relative intensities in both bright and dull bands of the coal.

**ADSORPTION OF CHARGED LATEX PARTICLES ON MICA STUDIED
WITH ATOMIC FORCE MICROSCOPY**

Christopher Johnson (Department of Chemical Engineering, University of
Delaware, USA)

Atomic force microscopy (AFM) is used in this work to observe the formation of adsorbed layers of colloidal particles. A model system for particle adsorption is provided by an aqueous suspension of charged latex microspheres in contact with a mica surface. Tapping mode AFM is used to image the adsorbed particles at the solid-liquid interface and, after drying, at the solid-air interface. Variations in the ionic strength of the latex suspension reveal the effects of double-layer screening on the rate of growth of the adsorbed layer and on the ordering of particles at the surface. Results are to be applied to study of the adsorption of more complicated colloidal particles, including proteins.

BINDING OF SALICYLATE TO CATIONIC SURFACTANT AGGREGATES

Marta Cassidy (Chemistry, University of Sydney)

Systems composed of acrylamide based copolymers and tetradecyltrimethylammonium salicylate show unusual rheological properties. In an effort to elucidate the structure of this system studies of the surfactant have been undertaken. Of particular importance in this system is the surfactant packing parameter, v/al . In order to vary v/al surfactants with varying sized headgroups were synthesised. Thus, the phase behaviour of surfactants of the tetradecyltrialkylammonium type has been examined. The alkyl derivatives studied were methyl, ethyl and propyl. The counterions used were bromide and salicylate. The increase in headgroup size has a marked effect on the phase behaviour of these surfactants. Surface potential studies of tetradecyltrimethylammonium bromide and salicylate will also be reported.

FORCES BETWEEN HETEROGENEOUS CHARGED SURFACES

Warwick Holt (Mathematics, University of Melbourne)

Experimental work has shown that there exists an attractive force (the "hydrophobic force") between like-charged particles and surfaces which is of much longer range than the va der Waals interaction. Additional recent work has shown that adsorbed surfactant monolayers are made up of aggregate structures of variable size - i.e. charge is distributed in a heterogeneous "patchy" manner. We propose that by modelling such charge distributions, forces can be found which are of longer range than van der Waals forces. Analysis and simulations on surfaces with regular square patches has shown that such forces can be found, using various combinations of constant charge and constant potential boundary conditions for the linearized Poisson-Boltzmann equation, in both net neutral and net charged systems. We will also investigate the case of patches of random shape and size.

GUIDED WAVE RESONANCE MODULATORS USING ZnO THIN FILMS

M. Koch (School of Chemistry, University of New South Wales)

Electro optic (EO) materials such as Zinc oxide provide the possibility to design light modulators based on the resonant excitation of modes (i.e. energy transfer) from an incident light beam into a waveguide. As the resonance condition is a function of the refractive index of the waveguide, EO materials can be used to modulate the reflected intensity of an incident beam by changing the refractive index in an applied electric field (Pockels effect).

A novel electro-optic (EO) modulator was constructed using sub- μm thickness, c-axis oriented Zinc oxide films. The ZnO films were deposited using rf magnetron sputtering of a pressed ZnO target (99.99%). These films were characterised using X-ray Photoelectron Spectroscopy (XPS), X-ray Diffraction (XRD) and Scanning Electron Microscopy (SEM) to investigate their chemical (i.e. Zn to O ratio, contaminations) and physical (i.e. orientation, grain size, length of the c-axis lattice constant) properties.

In a prism coupler experiment the optical properties and coupling efficiency (defined as ratio of excited intensity to intensity without coupling) can be investigated. It was found that the coupling efficiency is correlated to both film thickness and grain size of the ZnO films.

Modulation of the reflected intensity could be obtained applying a square wave driving voltage of variable frequency and amplitude across the film. From the intensity change obtained and the coupling resonance angle the electro optic tensor element in the direction of the c-axis of the ZnO films and the refractive index in the plane of the film have been calculated for four prototype devices. The values were found to be in the order of magnitude expected for bulk ZnO indicating the excellent crystallinity of our films.

ADSORPTION OF POLYMERS ON TO MINERAL SURFACES

Rod Harris (La Trobe University, Bendigo)

The adsorption of selected polymers on to mineral surfaces is being investigated under a range of conditions. Initial results have shown that the adsorption of certain dye-modified polymers on to alumina depends strongly on pH. Further investigations will have the aim of elucidating the effects of different parameters. Some preliminary findings will be discussed.

**THE INFLUENCE OF SODIUM CARBONATE ON ALUMINOSILICATE
SCALE FORMATION AND SILICA SOLUBILITY IN SODIUM
ALUMINATE SOLUTIONS**

Kali Zheng (Ian Wark Research Institute, University of SA)

Silica is an impurity in bauxite and is present as kaolin and quartz. Alumina is refined from bauxite by the Bayer process. Most of the silica is removed prior to the Bayer process however the residue stays in the Bayer circuit and can form aluminosilicate scale on the pipes, tanks and heat exchangers. There is a large cost associated with the removal of this scale. The mechanism of scale formation is being investigated. It may be possible to reduce silica concentration within the Bayer process by appropriate seeding thereby reducing the scaling problem.

Isothermal batch precipitation experiments have been carried out to investigate the effects of sodium carbonate concentration on both equilibrium silica concentration and the formation of sodium aluminosilicate, in synthetic spent Bayer liquors. The two main phases of the sodium aluminosilicate scale formed are sodalite (cubic) and cancrinite (hexagonal). Cancrinite has been shown to be more thermodynamically stable than sodalite although sodalite is favoured kinetically. Solutions seeded with sodalite give rise to a crystalline product of sodalite at 90 °C and cancrinite at 160 °C. Solutions seeded with sulphate cancrinite at both these temperatures give rise only to cancrinite. Cancrinite has lower solubility than sodalite. The presence of sodium carbonate in synthetic spent liquor reduces silica solubility in sodium aluminate solutions. The concentration of carbonate trapped in the crystal structures decreases with time for both cancrinite and sodalite.

**VALIDATION OF THE COMPRESSION MODEL FOR COLLOIDAL
SUSPENSIONS**

Matthew D. Green (Chemical Engineering, University of Melbourne)

The compressibility of concentrated, colloidal suspensions is extremely important in many mineral processing industries. The degree of suspension compression, given the same applied force, is determined by the nature of the forces between the individual particles. These forces range from electrostatic and Van der Waals interactions, through to various polymer interactions introduced into the system such as steric repulsion, bridging attraction and depletion attraction.

In this work, fundamental research is being undertaken utilising several 'ideal' spherical, mono-disperse particle systems in order to investigate the validity of the currently used compression model. The effect of these various inter-particulate forces on the compressibility of the suspensions is being examined. These results are applicable to more 'real' systems that have previously been studied.

**THE STUDY OF ORTHOPHOSPHATE ADSORPTION ONTO NATURAL
COLLOIDAL PARTICLES**

Jason van Berkel (Water Studies Centre, Monash University)

The adsorption behaviour of contaminants to natural colloids is important in determining their fate and effect in the aquatic environment. A surface adsorption density distribution (SADD) gives the amount adsorbed per unit area of particle surface as a function of particle size. This informative plot can be determined using sedimentation field-flow fractionation. For homogeneous particle samples the SADD should be constant, however, with natural colloidal samples considerable changes occur across the size distribution. These trends can be due to changes in the particle mineralogy, surface coating composition or particle shape. This paper will report on a study of the causes of non-uniform SADD curves for orthophosphate onto some soil and riverborne colloids.

Reference:

Beckett, R., D. M. Hotchin and B. T. Hart. 1990. Use of Field-Flow Fractionation to Study Pollutant-Colloid Interactions. *J. Chromatography*. 517:435-447.

SURFACTANT TEMPLATED SILICA/ORGANIC COMPOSITES

Karen Edler (Research School of Chemistry, ANU)

In the past, molecular sieves and zeolites have been prepared by using a single molecule as a template around which the porous crystal forms. The channels in these systems are however limited by the size of the template molecules and the structure of the crystal itself. The largest channel structures achieved in these systems have had diameters of 14 Å. The recent synthesis of MCM-41 has extended the range of available pore sizes from 13 Å to beyond 100 Å by using a self-assembled liquid crystal array as the templating agent. These materials show the same ordered and well-defined pore structure as in microporous zeolites but have pore sizes easily adjustable by changing the chain length and composition of the surfactant forming the liquid crystal. We have found optimised conditions for the alkaline synthesis of the large pore molecular sieve, MCM-41, by determining small angle X-ray scattering and adsorption isotherms from materials at various stages of the preparation. Highly curved surfaces, sealed structures, quasicrystalline hexagonal products coexisting with true MCM-41 can all be detected in this system by transmission electron microscopy, raising interesting questions as to the action of the liquid crystal template.

CONFORMATIONS OF ADSORBED POLYELECTROLYTES

David J. Neivandt (Chemistry, University of Melbourne)

The new technique of Variable angle of Incidence Evanescent Wave Spectroscopy (VIEWS) has been applied to the adsorption of quaternarised poly 2-vinyl pyridine (P2VP) polyelectrolytes onto silica from aqueous solution. The kinetics of adsorption and adsorbed conformations were measured as a function of solution pH for both the iodide and chloride salts of low molecular weight, high charge density, quaternarised P2VP. The polyelectrolyte was found to adsorb readily above the iep of silica in comparatively flat conformations with little extended polymer structure, increasing surface excesses and decreasing centres of mass of the polyelectrolyte from the interface were observed as solution pH was raised. These results were attributed to the increasingly favourable electrostatic interactions between the positively charged polyelectrolyte and the increasingly negatively charged silica surface. The chloride salt of P2VP was found to have smaller surface excesses and larger centres of mass from the interface than the iodide salt at the same pH value. This is believed to be an effect of counterion binding to the polyelectrolyte, altering its hydrophobicity.

18th Australian Colloid and Surface Chemistry Student Conference

**ADSORPTION OF DISSOLVED HUMIC MATERIAL ONTO ACTIVATED
CARBON**

Gayle Newcombe (ACWQR)

NO ABSTRACT RECEIVED

**OBSERVATION OF ELASTIC EFFECTS OF VISCOELASTIC FLUIDS IN
SWIRLING FLOW**

Jason Stokes (Chemical Engineering, University of Melbourne)

Swirling motion of viscoelastic fluids is observed in many industrial flows and a fundamental understanding of this behaviour is desired. It is envisaged that this research into a complex flow field will also provide a crucial test of the ability of constitutive equations to describe the flow of viscoelastic fluids.

The effect of elasticity on the secondary motion of viscoelastic fluids due to swirl was analysed using flow visualisation. A closed cylinder containing a rotating base is used to induce the swirling motion. The major polymer solutions used during experimentation were constant viscosity elastic liquids that are commonly referred to as Boger fluids. The addition of fluorescent dye to the system allowed the visualisation of the secondary motion of the fluid by passing a sheet of laser light through the cross section of the cylinder.

Various phenomena were observed due to the elasticity of the fluid. At low rotation rates the secondary motion of the fluid was inwards along the base, against centrifugal forces, and then up the central axis away from the rotating disk. This is in the opposite direction to that produced when using a Newtonian fluid. At higher rotation rates an instability was also observed where the vortex core is seen to spiral with the primary motion of the fluid.

THE EFFECT OF POLYMER ADSORPTION ON ELECTROACOUSTIC SIGNALS

Melanie Carasso (Physical Chemistry, The University of Sydney)

The electroacoustic behaviour of silica particles in the presence of added polymer has been studied using the AcoustoSizer. The adsorption of the surfactants CTAB and SDS and a polyelectrolyte, poly(acrylic acid), resulted in no unusual effects on the dynamic mobility spectrum of the particles. However, neutral polymers including poly(vinyl alcohol) and nonyl phenyl ethoxylate caused abnormal behaviour which has been shown theoretically to be consistent with the formation of an elastic gel layer of adsorbed polymer on the surface of the particles.

**INTERPARTICULATE ADHESION: THE INTERACTION BETWEEN
SILICA AND IRON OXIDE**

Gary Toikka (Ian Wark Research Institute, University of SA)

Adhesion between two surfaces can be modified by the adsorption of polymers. A reduction in the force of adhesion can lead to an increased removal efficiency of attached particles subjected to shear. This talk will focus on the effect of the triblock copolymer polyethyleneoxide/polypropyleneoxide/polyethyleneoxide (PEO/PPO/PEO) on the interaction, particularly adhesion, between silica and iron oxide in an aqueous environment. Measurements of interaction forces (including the pull-off force) by Atomic Force Microscopy (AFM) allow calculation of the interaction energy via the Derjaguin approximation. Complementary adsorption isotherms for PEO/PPO/PEO will be presented allowing qualitative assessment of polymer configuration at the liquid/solid interface and correlated with interaction force measured with the AFM. Elektrokinetic data for iron oxide and silica, supporting the hypothesis of an electrostatically induced adhesion mechanism for this system prior to the addition of PEO/PPO/PEO will be included.

NANOPARTICLES

David T. Atkins and Rosalie J. Atkins

Nanoparticles refers to dispersions of nanometric particles, the surface chemistry of which can be both fascinating and frustrating.

THE RE-USE OF SINGLE USE ITEMS

The re-use of single use medical items is a topic of some concern and interest at present. the major factor which speaks strongly in favour of such re-use is cost effectiveness in a time of decreasing unit budgets and increasing patient demand. However this attractiveness must be tempered by medical and scientific factors, as well as ethical and legal questions concerning the re-use of such items.

In this context we have performed experiments to evaluate the effectiveness of cleaning procedures for single use endoscopic items, with a mind to evaluating the potential for re-use of endoscopic single use items.

**CORRELATION BETWEEN SURFACE SPECIATION/SOLUTION
SPECIATION/FLOTATION REPOSE IN SPHALERITE FLOTATION**

Angela Lange (Ian Wark Research Institute)

The products of sphalerite (ZnS) activation have been the centre of much controversy when relating to sphalerite flotation. Each avenue of sphalerite activation by copper (II) ions has been studied, relating to surface speciation solution speciation and flotation reponse. However, despite the vast amount of research undertaken, the correlation between these three avenues has not been fully explored.

By using techniques such as XPS and SAM, surface species can be identified for a range of activating conditions. Similarly, analysis of the metal ions in the pulp is performed by AAS, with the total metal ions including oxidation products on the surface such as; hydroxides, sulphates and other physically adsorbed species, being extracted with EDTA. Experimental results are compared with computer modelled results from Geochem-PC or EQ3/6. These results are predicted based on concentration, pH, Eh and solubilities.

Once these aspects of sphalerite activation have been examined, flotation results can be correlated to the predicted mechanism, thus allowing a full relationship between flotation, surface speciation and solution speciation to be established. Preliminary results and correlations will be discussed.

DIRECT FORCE MEASUREMENT OF DISSIMILAR METAL OXIDES

Ian Larson (School of Chemistry, University of Melbourne)

An Atomic Force Microscope has been used to measure the force of interaction between a SiO₂ glass sphere (~5µm diameter) and a TiO₂ crystal, in an aqueous medium over the pH range 3 to 9. The force-separation profiles obtained were compared with DLVO theory, which was found to adequately account for the experimental results up to separations of *ca.* 2nm. At distances below this point repulsive interactions in excess of DLVO may be present under certain conditions. To complement the diffuse layer potential results extracted from the force-separation data for dissimilar materials, force-separation interactions were also measured between two SiO₂ glass spheres. For both sets of surfaces, modelling of the experimental force-separation curves was best achieved using constant charge rather than constant potential boundary conditions.

**ALUMINIUM HYDROXIDE FILMS AND THEIR EFFECT ON SURFACE
BOND DURABILITY**

Andrew Rider (School of Chemistry, University of NSW/AMRL (Melb))

Adhesive bonding is used extensively in the Aerospace Industry, particularly in the application of fibre re-inforced composite patches to the fatigue susceptible areas of the aircraft structure. This technology relies critically on the methods used to prepare the metal substrate prior to adhesive application. The adhesive bond will degrade under humid conditions at a rate dependent on the pretreatment applied to the surface.

Research to date has involved studying the factors affecting the rate at which the metal oxide degrades in humid environments. The effect of bond durability on the formation of different metal hydroxides prior to adhesive application has also been investigated. X-ray photoelectron spectroscopy, Secondary Ion Mass Spectroscopy and FT-IR have been used to characterize the metal oxide/hydroxide surfaces.

THIN FILM DRAINAGE BETWEEN SOLID AND FLUID SURFACES

Jason Connor (School of Applied Physics, University of South Australia)

As a fluid surface approaches a solid surface any intervening liquid (a thin film) must be removed to the bulk liquid. Film thinning and drainage of the intervening liquid is important from both fundamental and commercial points of view. Typical commercial applications of film thinning and drainage include: bubble/particle attachment in mineral flotation processes, stability of foams, lubrication and wetting dynamics. The process of squeezing the liquid film out is complicated and involves both hydrodynamic and thermodynamic surface forces. A notable feature of this process is the possible formation of a dimple profile observed at the fluid/liquid interface. In this talk I will give the outline of an experimental project in which we aim to make detailed measurements of aqueous film profiles between a mercury drop and a mica surface. Measurements of the film deformation under various conditions will provide a useful insight into the mechanisms driving film formation and collapse.

**SOLUTION AND ADSORPTION PROPERTIES OF A POLYMERIC TALC
DEPRESSANT**

Gayle Morris (Ian Wark Research Institute, University of SA)

During the separation of sulphide minerals by flotation, polymers are added as depressants, dispersants or flocculants to improve the concentrate grade of valuable sulphide minerals. Polymeric depressants are essential to reducing the natural floatability of hydrophobic undesirables whilst permitting the flotation of valuable minerals. Depressants selectively adsorb onto naturally hydrophobic gangue minerals such as talc, rendering the surface hydrophilic and reducing talc flotation. Commonly used depressants include polysaccharides such as carboxymethyl cellulose (CMC) and guar gum.

The surface properties of a CMC depressant at the talc-water interface were investigated using adsorption isotherms, infrared studies and microflotation. Solution conditions were varied in both ionic strength and pH. The adsorption of CMC onto the talc surface was greatly influenced by both the solution ionic strength and pH. Limited adsorption, and therefore depression, occurred at high pH and low ionic strength with the depressant. Adsorption, and thus talc depression, improved greatly with either increased ionic strength or reduced pH.

DEWATERING OF AUSTRALIAN BLACK COALS

Jamie Tudor (Swinburne)

Excess water associated with Australian black coal is an expensive problem for the Australian coal industry. A one percent reduction in coal water content would reduce transportation costs by millions of dollars annually. Current dewatering relies on energy intensive mechanical methods; filtration, centrifugation and thermal drying being the most commonly employed. Chemical dewatering, utilising the surface properties of Australian black coal, could significantly reduce the intrinsic water content, yet little research has been performed in this area to date. Coal is a very heterogeneous substance and its absolute structure remains unclear, consequently its surface properties must be carefully characterised before chemical dewatering is attempted. Several coal samples were characterised by contact angle, surfactant adsorption, surface area and electrophoretic mobility measurement. The results of this work will be presented.

18th Australian Colloid and Surface Chemistry Student Conference

SYNERGISTIC EFFECTS OF DUAL POLYMER FLOCCULATION

Kristen Bremmell (Chemical Engineering, Newcastle)

NO ABSTRACT RECEIVED

POSTER PRESENTATIONS

THE ADSORPTION OF POLYPHOSPHATES AT THE TITANIUM DIOXIDE-WATER INTERFACE

Karen Grieve (Chemistry, University of Melbourne)

An application of polyphosphates is as dispersants, whereby they are adsorbed onto the surface of colloidal particles in solution and act to prevent coagulation. In spite of extensive use of polyphosphate dispersants in industry and manufacturing, there has been little investigation of the mechanism of polyphosphate adsorption. As preliminary research, the isotherms for the adsorption of various oligomeric polyphosphates onto titanium dioxide were determined for a range of pH values. Subsequently, the polydisperse nature of polyphosphates was utilized as the relative adsorption of the components was investigated. These experiments used HPLC separation techniques and were conducted at various pH conditions. Analyses of both sets of results highlighted the importance of coulombic interactions in the adsorption mechanism.

18th Australian Colloid and Surface Chemistry Student Conference

**THE INFLUENCE OF COLLOIDAL PARTICLES ON THE INACTIVATION
OF A PROTEOLYTIC ENZYME**

Hilde Rinia (Wageningen Agricultural University)

NO ABSTRACT RECEIVED

ION SPECIFIC INTERACTIONS IN LAMELLAR LIQUID CRYSTALS

Heather N. Patrick (Chemistry, University of Sydney)

Lamellar liquid crystal bilayers of the surfactants didodecyldimethylammonium bromide and chloride were osmotically stressed. Compression of the chloride system could be modelled by theories of electrostatic double-layer repulsion and van der Waals attraction. The bromide system exhibited a discontinuous compression curve corresponding to a phase transition to a second, more concentrated lamellar phase. This could not be modelled by theory. Compression of a mixed 1:1 bromide and chloride system showed the phase transition found in the bromide system. However, the phase behaviour of the bromide-chloride-water system showed no phase transition at a 1:1 bromide to chloride ratio.

**AFM MEASUREMENTS OF FORCES DUE TO CONTACT
ELECTRIFICATION BETWEEN PARTICLES AND SURFACES**
Ben Francis (School of Applied Physics, University of South Australia)

Evidence for contact electrification is as common as combing your hair on a dry day, but the familiarity of this phenomenon belies the fact that it has yet to be adequately explained from a fundamental physical viewpoint. Despite this, contact electrification has many applications in industry and science, and it is a major factor in determining the behaviour of powders. In particular, contact between a particle and a surface of a different material in a dry environment results in electrical charge transferring from one material to the other, and as a consequence there is a strong attractive force, and adhesion, between the two. This poster describes measurements made using an Atomic Force Microscope (AFM) to detect the adhesion and the electrostatic force between a model particle (silica glass sphere) and a flat surface (mica) after they touch. Most researchers in the field consider the transfer of charge to be an instantaneous process; however, the present study has shown that charging of the materials in the AFM experiment occurs with a characteristic time scale of between two and four seconds.

RHEOLOGY OF WAXY CRUDE OILS

Cheng Chang (Dept of Chemical Engineering, University of Melbourne)

Yield stress is an important characteristic of waxy crude oils. It is highly dependent on both the shear and thermal history experienced by the oil sample. Several methods for the measurement of the yield stress will be compared. The most suitable technique will be determined such that the 'true yield stress' of waxy crude oils can be obtained.

CONTINUOUS SEPARATION OF PARTICLES AND COLLOIDS BY SPLITT

Frank Riet (Water Studies Centre, Monash University)

The split-flow thin (SPLITT) separation cell is a thin field-flow fractionation like channel which is capable of continuous particle fractionation. An external applied field acting on the SPLITT cell influences the differential transport of the particles. These forces can be gravitational, electrical, centrifugal or hydrodynamic lift forces. In our case the driving force is gravitational, limiting the particle cut-off diameter to greater than 2 μm . Depending on the ratios of the flowrates entering into and exiting out of the SPLITT channel, different binary splits of the suspended particle sample can be achieved. One fraction has the particles smaller than the cut-off diameter and the other fraction has the particles greater than the cut-off diameter. The poster will outline the basic concepts of the SPLITT system and its potential application to environmental and mineral processing studies.

**LATERAL MOBILITY OF SURFACTANT MOLECULES CONFINED
BETWEEN SOLID SURFACES**

S. Park, Gerold Willing and R.D. Neuman, (Department of Chemical Engineering,
Auburn University)

The lateral mobility at the contact region of two surfactant monolayer-coated solid surfaces was investigated as a function of relative humidity (RH) by employing the fluorescence recovery after photobleaching (FRAP) technique. At $\leq 45\%$ RH, fluorescence probe molecules in myristic acid monolayers confined between silica surfaces are completely mobile. With increasing RH from 0 to 45%, the measured lateral diffusion coefficient, D_s , within the apparent contact area increases by more than 1 order of magnitude due to the adsorption of water vapor at the monolayer headgroup/silica interface. At higher RH values, however, a significant portion of the probe molecules within the apparent contact area become immobile presumably due to interdigitation of hydrocarbon chains of monolayer molecules between the contacting surface microasperities. In addition, nonuniform fluorescence distribution was observed within the apparent contact area in the RH range. The complex dependence of D_s on RH is explained by applying an effective medium model. The fluid phase fraction of relatively high mobility in the heterogeneous film decreases in proportion to the growth of surfactant-enriched domains of relatively low mobility around the contacting surface microasperities due to capillary condensation of water vapor.

DEWATERING OF SLUDGES

Deanne Labbett (School of Chemistry, University of Melbourne)

The dewatering of alum based potable sludges has been examined using electrokinetic and rheological measuring techniques. Good agreement was observed between particle surface properties and yield stress measurements of concentrated sludges. The effect of the amount of alum added and its corresponding effect on dewatering properties will be presented.

18th Australian Colloid and Surface Chemistry Student Conference

TAILORED ZEOLITES
Greg Cusick (Chemistry, UNSW)

NO ABSTRACT RECEIVED

INFLUENCE OF ELECTROLYTE ON HYDROGEL

Anita Ip (Chemical Engineering, UNSW)

NO ABSTRACT RECEIVED

SONOCHEMICAL DISSOLUTION OF MnO₂ COLLOIDS

Joe Sostaric (School of Chemistry, University of Melbourne)

The passage of ultrasound through water leads to chemical activity arising from the formation of highly reactive hydrogen and hydroxyl radicals, which are produced in high temperature and pressure regions formed due to the collapse of vapour filled cavities in solution during sonication. In the presence of certain solutes, these primary radicals can be scavenged to produce secondary radicals which in turn may react with a particular solute in solution, hence leading to further redox processes. We have shown that colloidal manganese dioxide can be sonochemically reduced in aqueous solution and this process has been attributed to the reaction of the colloid with hydrogen peroxide, which is produced due to certain recombination reactions of the primary radicals. The reduction process has been shown to increase in the presence of certain alcohols in solution and we have found that at low alcohol concentrations (< 0.1 M) the amount of colloid dissolved seemed to be highly dependant on the hydrophobicity of the alcohol. It is concluded that the amount of alcohol at the interface of the collapsing cavity is the determining factor in the increase in dissolution of the colloid and this observation is quantitatively explained in terms of the Gibbs surface excess (Γ_{ROH}) of the alcohol.

**MEASUREMENT OF INTERACTIONS BETWEEN COLLOIDAL
PARTICLES AND AN AIR/WATER INTERFACE**

M. Fielden (Ian Wark Research Institute, University of SA)

The interaction between a 3 μ m silica particle and an air/water interface (air bubble) has been measured using an atomic force microscope. The interaction is reversible in the AFM environment, i.e. the adhesion encountered is surmountable within the range of the piezo-electric crystal. Experiments are planned to study the interaction in salt solutions of varying ionic strength.

Qualitative results have been obtained for the interaction of hydrophobised glass particles ($\theta = 110^\circ$) and an air bubble. The interaction between the two hydrophobic interfaces was purely attractive, and the adhesion was much greater than could be overcome with the piezo-electric crystal. For this reason, the time-course of the particle as it 'snapped' into the bubble was followed using a digital oscilloscope, providing a cantilever deflection versus time output. Polymethylmethacrylate (PMMA) particles, which have an intermediate contact angle ($\theta = 50^\circ$), were also studied. A significant difference in the time-course of the interaction between the two types of particles was observed.

NUCLEATION AND GROWTH OF COLLOIDAL CRYSTALS

Stuart Henderson (Applied Physics Department, R.M.I.T.)

Spherical particles of polymethylmethacrylate (PMMA) sterically stabilized by a thin macromolecular layer behave like hard spheres when suspended in an organic solvent and exhibit phase behaviour similar to that of simple atomic fluids. Fluid, crystalline and glassy phases may be produced by varying the concentration of particles in the suspension. For these non-interacting hard spheres, the transition from disordered fluid to ordered crystal is driven by entropy alone.

Such systems are important for exploring the kinetics of crystallization for several reasons. Firstly, these processes occur on time scales slow enough to permit experimental access. Also, the suspending medium acts as a thermal bath, allowing large supersaturations to be achieved without the problems associated with heats of fusion upon crystallization from the melt as encountered in atomic systems. Finally, heterogeneous nucleation by impurities and surfaces can be avoided, allowing large sample volumes and spontaneous homogeneous nucleation to be investigated.

Laser light scattering experiments will be described in which the progress of crystallization is monitored in real time by observing the evolution of Bragg reflections as the crystals form. Such reflections give information about the structure of crystals within the bulk of the suspension.

**REDUCTIVE DISSOLUTION OF OPTICALLY TRANSPARENT
COLLOIDAL CuFeS₂**

Kate Drummond (School of Chemistry, University of Melbourne)

The kinetics for the reductive dissolution of optically transparent colloidal chalcopyrite (CuFeS₂) by the one electron reductant radical, zwitterionic viologen (ZV⁻) has been studied using pulse radiolytic techniques. The reaction of ZV⁻ with CuFeS₂ was monitored using a UV-visible spectrophotometric detection system. The timescale for this reaction was observed to be deciseconds. The kinetic decay process was shown to be pH dependant. The pH at which electron transfer ceases was identified and the conduction band of CuFeS₂ calculated. Using literature values of electrophoretic ζ potential data for sulphide minerals, a simplified Butler-Volmer equation was used to obtain a theoretical plot of $\log(k_{et} / k_{pzc})$ versus ΔpH ($pH - pH_{pzc}$). By comparing this theoretical plot with the experimental data, β (the transfer coefficient) has been assigned.

**THE INTERACTION OF A COPPER SELECTIVE COLLECTOR WITH
CHALCOPYRITE**

Gillian Fairthorne (Ian Wark Research Institute, University of SA)

Collectors are reagents used in sulfide mineral flotation to enhance mineral beneficiation. They adsorb on the mineral surface and render the particles hydrophobic, promoting bubble-particle attachment and hence flotation. The increasing economic pressure on the minerals processing industry has led to the development of new, more efficient collectors for sulfide mineral flotation.

The adsorption of a new copper selective sulfide mineral collector, butyl ethoxycarbonyl thiourea (BECTU), on the copper sulfide, chalcopyrite, has been studied as a function of pH. Microflotation of chalcopyrite in the absence and presence of BECTU confirm the strong flotation of chalcopyrite in the presence of the collector in basic and neutral pH conditions. Adsorption isotherms and surface sensitive techniques such as zeta potential measurements and XPS were used to probe the mechanism of attachment of the modified thiol collector to the mineral surface. In addition, the solution reaction between BECTU and cupric ions was investigated and the results correlated with mineral studies. A 1:1 cuprous-BECTU complex is formed and in both cases, complexation is more favourable in alkaline pH. Time of Flight SIMS was also used to study the surface of chalcopyrite after the adsorption of BECTU. The molecular ion for a 1:1 complex was detected on the mineral surface, supporting the findings of the solution studies.

**EXTERNAL INFRARED REFLECTION-ABSORPTION SPECTROMETRY
AT THE AIR/WATER INTERFACE**

Brendan Sinnamon (The University of Queensland)

Spectroscopic examination of monolayers has usually been restricted to films deposited by the Langmuir-Blodgett technique onto solid substrates. Such films are not necessarily representative of the monolayer structure at the air/water interface because of the different substrate and possible distortions during deposition. Dluhy and co-workers have recently applied the technique of external reflectance infrared spectroscopy to the study of monolayers *in situ* at the air/water interface. The method does not require specialised laboratories and does not need additional molecules to be added to the host monolayer. The method is highly surface sensitive as vibrational spectroscopy measures changes in the dipole moments of specific chemical groups in the molecule. Furthermore it gives direct information on the structure of the monolayer, such as the conformation of the alkyl chains of the amphiphile and the orientation of vibrational dipole moments based on polarised reflectance spectra. The procedure can also be used to compare directly the IR spectra of monolayers at the air/water interface with films transferred to solid substrates.

External reflectance IR spectra have been obtained for pentadecanoic acid and poly(vinyl stearate) at defined surface pressures using polarised and unpolarised radiation. The results will be discussed in terms of the hydrocarbon chain conformation and the orientation of the molecules at the air/water interface.

WETTABILITY OF HETEROGENEOUS SURFACES

Stephen Duplock (Ian Wark Research Institute, University of SA)

Synthesis of self assembled monolayers (SAM's) of alkanethiolates on gold is a developing area of chemistry with excellent potential for creating model heterogeneous surfaces. The talk will describe a novel synthetic route to obtain a chemically heterogeneous surface over a large geometric area. One of the main objectives of the project is to elucidate the relationship between size of the heterogeneities and the dynamic wetting characteristics of the surface as a whole. Using the route described surfaces with heterogeneities varying in size from 0.5 μ m to >100 μ m can be easily fabricated. The Wilhelmy method will be employed to assess dynamic wetting characteristics of the surfaces. Preliminary results obtained for SAM's of the thiols (1)undecanethiol and (2) 11-mercapto undecanoic acid on gold will be presented.

SONOCHEMICAL REDUCTION OF AuCl_4^- (aq)

Rachel Hobson (School of Chemistry, University of Melbourne)

The absorption of high intensity ultrasound by water is known to produce $\text{H}\cdot$ and $\cdot\text{OH}$ radicals in solution¹. This is due to a phenomenon known as acoustic cavitation; the formation, growth and collapse of small bubbles in the sonicated solution. These primary radicals can then be scavenged by other chemical species in solution to produce secondary radicals and subsequently further chemical reactions may occur. The scavengers used in this study are alcohols and surfactants, molecules known to have a preference for the interfacial phase rather than the bulk solution. Hence these scavenging molecules should be at the bubble interface. The water soluble metal ion, AuCl_4^- , when sonicated in the presence of these surfactants is reduced generating colloidal gold particles². It has been found that by altering the type and quantity of the surfactant in solution the yield of the gold particles also changes. The efficiency of gold formation is dependent on the air/water surface activity of the surfactant used, implying that the scavenging of the primary radicals occurs at the cavitation bubble liquid interface.

1. K. S. Suslick, *Scientific American*, 1989, 260, 80.
2. S. Au Yeung, R. Hobson, S. Biggs and F. Grieser, *J. Chem. Soc., Chem. Commun.*, 1993, 378.

ANNEALING STUDIES OF SPUTTERED ZINC OXIDE FILMS
Martin Puchert (School of Chemistry, University of New South Wales)

Zinc oxide is a versatile wide bandgap semiconductor, suitable for thin film applications in piezoelectric and electrooptic devices. The usefulness of ZnO films in these applications is increased by maximising the film crystallinity, electrical resistivity, and smoothness, and minimising the compressive film stresses. In sputter deposition, this is conventionally achieved by depositing the film onto a heated substrate (~300-500_C), thereby increasing the adatom mobility. An alternative method is employed here, involving sputter-deposition of ZnO onto a room temperature substrate, and using post-deposition annealing to provide atomic mobility. This technique is advantageous in cases where the sample geometry (such as an optical fibre) is difficult to heat uniformly under vacuum, but easier to heat in air. Films were deposited by rf magnetron sputtering using 100% oxygen sputtering gas (~0.08 mbar). Properties of annealed ZnO films are presented as a function of temperature (up to 800_C) and time. Post-deposition annealing in air is found to increase the average grain size up to five-fold, reduce the compressive biaxial stress by an order of magnitude, and increase the ZnO film resistivity by up to 3 orders of magnitude (~10¹² W.cm). XPS measurements of the film composition indicate that annealing reduces the O:Zn ratio to that of bulk ZnO. SEM images show the surface topography becomes smoother as the annealing temperature increases, and these surface area changes are quantified using atomic force microscopy.

**THE REMOVAL OF NUTRIENTS BY PRECIPITATION OF STRUVITE
USING MAGNESIA**

Ian Fraser (CSIRO Division of Chemicals and Polymers and Deakin University
Current address: Water Studies Centre, Dept. of Chemistry, Monash University)

The discharge of N & P to natural water is causing serious environmental degradation resulting in algal blooms and subsequent water toxicity. Solutions containing soluble N & P species (specifically ammonia and orthophosphate) can be treated to deposit ammonium phosphate salts, particularly Struvite - $MgNH_4PO_4 \cdot 6H_2O$. Struvite has potential value as a slow release fertiliser but its formation is also of interest in formation of urinary stones, coastal landforms and scaling in pipe networks of wastewater treatment systems.

The precipitation of Struvite from wastewater is a complex reaction because of the equilibria involved. In addition, ions such as Ca^{2+} , Fe^{3+} and Al^{3+} can also interfere thus reducing the yield of Struvite and the effective removal of NH_3 .

A method has been developed using MgO as the source of Mg (a cheaper source of Mg than previous methods). This combined with careful pH control has produced up to 94% NH_3 removal from wastewater containing high NH_3 levels.

**MEASUREMENT OF SINGLE PARTICLE MOTIONS IN CONCENTRATED
TURBID SUSPENSIONS**

Tim Mortensen (Applied Physics, RMIT)

Colloidal suspensions of spherical particles exhibit similar phase and other behaviour to atomic fluids and solids. Hence, suspensions provide a convenient and powerful experimental model system for explaining fundamental dynamical processes in fluids and solids. Dynamic light scattering, the technique where intensity fluctuations of light scattered from particles is correlated to obtain information about the dynamics of the particles, is used on concentrated colloidal suspensions. To avoid the difficulties associated with multiply scattered light from turbid suspensions, a dual colour dynamic light scattering spectrometer is used to isolate singly scattered light.

We report on the study of single particle motions of tracer particles in colloidal suspensions at concentrations approaching the glass transition. The host suspension consists of polymer particles, dispersed in a mixture of organic liquids, with a trace of silica particles of identical size and different refractive index. Both particle types are stabilised with the same polymer coating. By matching the refractive index of the polymer particles to the solvent, only the single particle motions of the tracer particles are detected.

**RELATIONSHIP BETWEEN SURFACE CHEMISTRY AND FLOCCULANT
STRUCTURE OF ASYMMETRIC PARTICLES**

Stephen Johnson (School of Chemistry, University of Melbourne)

The relationship between flocculation, ease of extraction (filterability) and subsequent dewatering of asymmetric particle aggregates in an aqueous medium has been studied extensively using rheological techniques. The fundamental surface chemistry underlying such processes is, however, not fully understood. This project has examined the relationship between surface chemistry and flocculant structure using a model asymmetric kaolin particle system, with a view to better understanding the mechanisms of extraction and dewatering. Results are compared with concurrent studies on model monodisperse spherical silica and alumina particle systems. Findings are of relevance to industries producing potable and waste water sludges, minerals tailing suspensions, and other water-based environmental wastes.

MECHANICAL MILLING OF ZIRCON SAND

Tony Puclin (Applied Mathematics, ANU)

The natural mineral zircon (ZrSiO_4) is a highly stable material which is only decomposed in extreme chemical or physical conditions.

Mechanical milling is a novel way of achieving altered surface chemistry and chemical activation. The products of milling are often disordered, high energy metastable materials. In this study a mixture of alumina (A1203) and zircon was subjected to mechanical milling. The presence of alumina was found to greatly enhance the disordering of zircon, and acid leaching of the milled oxide mixtures resulted in complete dissolution of the zirconium, along with a proportion of the alumina and only traces of silica. Zirconium leaching was not possible with zircon milled alone. The milling and leaching processes were investigated using X-ray diffraction, electron microscopy, and Rutherford backscattering. Quantitative results of the leaching process will be shown.

ELECTROACOUSTICS OF CASEIN MICELLES

T. Wade; J. K. Beattie; R. O'Brien; M. Augustin (Chemistry, University of Sydney)

The zeta potential and size of casein micelles has been investigated using electroacoustics. Electroacoustics involves the application of an alternating electric field to a colloidal suspension. The particles in the suspension oscillate back and forth and generate sound waves from which the zeta potential and mean size can be determined. These measurements can be made on concentrated suspensions.

Reproducible electroacoustic signals were obtained on various skim milk suspensions at natural and lower pH values. The zeta potential obtained at natural pH for a commercial skim milk suspension was -3.3 mV which is lower than values reported in the literature. As the pH was decreased the zeta potential decreased. The size obtained at natural pH for a commercial skim milk suspension compared well with literature. As the pH was decreased the size increased, which has not been observed previously.

**ROLE OF SURFACTANT ADSORPTION AND SURFACE CHARGE IN
FLOTATION**

Peter Sanciuolo (Swinburne)

The application of adsorbing colloid flotation to the removal of heavy metals from industrial waste can be fraught with problems. Many substances which are present in industrial wastewater can interfere with the adsorption of surfactant onto hydrous metal oxides by either competing with the surfactant for surface sites, or by altering the surface charge of the hydrous oxides such that adsorption of the ionic surfactant is not favoured. In this talk, the flotation response of hydrous metal oxides using sodium dodecylsulfate (SDS) is discussed in the light of surface charge measurements made on bubbles and flocs, and adsorption measurements. This data is compared to that obtained with a dodecanoic acid/SDS mixture, which was found to overcome many of the interferences observed in flotation with SDS alone. Particular reference will be made to the mechanism of adsorption of the two surfactants.

MODELLING ADSORPTION FROM SOLUTION

Lorraine Staehr (La Trobe University, Bendigo)

Adsorption of solute from solution at the liquid-solid interface has not previously been modelled. The literature suggests that the first layer of adsorption at a solid-liquid interface can be approximated by a hard disc model. The liquid layer adjacent to the surface has been modelled in two dimensions as a dense fluid composed of solute and solvent molecules, using a grand canonical Monte Carlo method with a hard disc potential. The method used, the problems encountered and the results to date will be discussed.

**A STUDY OF THE REMOVAL OF OXIDATION PRODUCTS FROM
SULFIDE MINERAL SURFACES.**

Peter Clarke (Ian Wark Research Institute, University of SA)

The flotation and separation of sulfide minerals can be detrimentally affected by the oxidation of the surface of these minerals. The surface oxidation products consist mainly of metal hydroxides and sulfur-oxy species, either adsorbed in thin layers or precipitated from solution as colloidal particles. The amount of surface oxidation will reduce the hydrophobicity of the mineral and make the adsorption of collectors less selective. The interaction between these oxidation layers is usually weak, electrostatic and/or hydrophobic in nature.

In this study, various methods were used to remove oxidation products from the surface of various sulphide minerals. The effects of mineral treatment by mechanical (sonication or abrasion by quartz) or chemical (pH change or use of complexant) methods on mineral flotation were investigated and correlated to the amount of oxidation product removed from the mineral surface. It was also shown that these 'cleaning' methods were selective in removing oxidation products in mixed mineral systems.

**TITANIA HYDROLYSATES FROM CARBOXYLIC ACID MODIFIED
ALKOXIDES**

Paul A. Venz¹, John R. Bartlett², Ray L. Frost¹ and James L. Woolfrey²

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²Advanced Materials Program, Australian Nuclear Science and Technology Organisation, Private Mail Bag 1, Menai N.S.W. 2234.

In sol-gel processing, metal alkoxides are frequently modified with complexing agents, such as carboxylic acids, to control the rate of hydrolysis. FT-Raman studies of titanium isopropoxide modified with acetic, propanoic and butyric acids suggest that the isopropoxy groups bonded to the titanium are partially substituted by bidentate carboxylate species. Colloidal titania aggregates produced by hydrolysing the modified alkoxides with water, have a structure similar to that of rutile, as determined by FT-Raman spectroscopy. During peptisation of the hydrolysate with nitric acid at 60 °C, an apparent phase change was observed; vibrational modes consistent with anatase appeared, and bands associated with rutile decreased or disappeared. Hydrolysate produced from acetic-acid-modified alkoxide underwent a similar phase change when agitated in water at 60 °C, in the absence of the peptising agent. A longer heating period was required to induce the phase change, compared to an identical hydrolysate undergoing peptisation. Carboxylic acid chain length had a significant influence on the induction time of the phase change, with the transformation occurring more rapidly with decreasing carboxylate chain length.

GIBBSITE GROWTH MECHANISM STUDY

James Counter (Ian Wark Research Institute, University of SA.)

The aim of the project is to investigate the mechanism of gibbsite nucleation and growth in the Bayer process. Gibbsite nucleation and growth in these super saturated caustic aluminate liquors is very slow even when seeding is used. The time involved in crystallisation causes problems in alumina plant situations as it can lead to a percentage of fine materials as well as a loss in production. This talk will describe the results obtained from the two complimentary techniques used in the investigation of the mechanism, Light Scattering and Quartz Crystal Microbalance. LS is a sensitive technique and provides information on particles in the nanometre size range, it can also determine whether the size and/or the number of particles is increasing with time. By measuring the frequency change of an oscillating quartz crystal between two gold electrodes the QCM can measure mass change of tiny nuclei deposited on a substrate. A combined experiment involving both techniques can gauge whether the mechanism is essentially homogeneous or heterogeneous. The dependencies of the growth characteristics can be assessed by varying the conditions of nucleation. The data will provide an indication of more favourable nucleation conditions.

18th Australian Colloid and Surface Chemistry Student Conference

**A STUDY OF THE SURFACE AND BIOLOGICAL ACTIVITY OF A
TRIVALENT CAGE SURFACTANT**

Marilyn Karaman (Chemistry, ANU)

NO ABSTRACT RECEIVED

SURFACE PROPERTIES OF COAL
Celesta Fong (The University of Queensland)

The pore structure of coal plays a key role in dictating the diffusion of seam gases. Methane resides primarily in coal as an adsorbed monomolecular layer (~ 4 Å thick) on the internal surface of pore walls or as a free gas in pores and microfractures. The total gas capacity is therefore a function of the ability of these pores to store methane. For methane flow through a coal seam, the adsorbed gas must diffuse through the matrix until it reaches a natural fracture or cleat, whereupon the methane flows from the coal to the well in response to a pressure gradient dictated by Darcy's law. This rate of flow is dependent on the diffusion characteristics as determined by the natural permeability of the coal.

The current research endeavours to resolve some of the questions pertaining to the mechanism of gas diffusion on a microstructural level. In particular, correlations between various coal parameters are sought, namely those of rank, maceral and moisture content and most importantly, porosity. In addition, other factors such as pore wall geometry, functionality and the interaction of methane with other hydrocarbons in the system will be examined. It is expected that these will all have a significant impact upon the gas transport properties of coal on the macroscopic scale.

To this end then, studies have already commenced to characterise coal cores obtained from different coal seams of the Bowen Basin. Magnetic resonance techniques, namely NMR and EPR will supplement information about pore size distribution and the functionality of the pore walls will be obtained by classical spectroscopic (FTIR) and gas absorption isotherm methods. XPS, AFM, and microanalytical techniques have been utilised to characterise surface and bulk properties of coal.

**THE DEPOSITION OF COLLOIDAL PARTICLES ONTO SURFACES
UNDER STAGNANT-POINT FLOW CONDITIONS**

Nigel Wright (Bristol)

In this work the rate of deposition of paint-grade rutile titanium dioxide particles (i.e. $\sim 0.3\mu\text{m}$ diameter) onto model substrates, under a variety of conditions, has been monitored. The model substrates used were optically flat glass plates whose surfaces were made cationic by reaction with aminopropyltrimethylsiloxane, APTMS. The flow geometry was arranged such that the particles impinged, through a jet, normally onto the substrate. This creates a stagnation point region near the substrate surface, opposite the mouth of the jet. In this region it is supposed that particles reach the surface by a diffusion process. The deposition (rate) of the particles was monitored visually using a microscope, and using a CCD camera linked to an image analysis system. This allowed the distribution of particles, as well as the number per unit area to be monitored.

Deposition rates, and maximum coverages, have been obtained at various particle concentrations and various background electrolyte (NaCl) concentrations. However, under certain conditions, when adsorbed poly(vinyl alcohol) layers were present, two dimensional raft formation on the surface was observed.

The results obtained in this way agreed well with some relatively simple experiments in which APTMS coated glass plates were simply immersed ("vertically") in a suspension of titania particles, and particles allowed to deposit, under brownian motion conditions.

The deposition of the particles has been modelled using standard theories for the particle/surface and particle/particle interactions. Good agreement with the experiment results was obtained.

HIGH INTENSITY CONDITIONING OF MT KEITH ORE

Chen Gang (Ian Wark Research Institute, University of SA)

A method has been established to investigate the particle aggregation state of a pentlandite suspension during High Intensity Conditioning (HIC) by using laser particle size analysis *in-situ*. Great care was taken to prevent air entrainment into the system during the tests. Fresh dry ground samples were tested. The presence of collector induced immediate flocculation. Shear flocculation (ie. particle size distribution of the suspension shifting to significantly large size particles after collector addition under high shear) occurred only for ultrafine particles ($d_{50} = 5 \mu\text{m}$) in deionised water. High ionic strength of Mt. Keith water had detrimental effect on pentlandite shear flocculation. Pentlandite particles naturally flocculated before HIC. Floc destruction for different initial particle sizes occurred during HIC in the presence and absence of collector in both deionised water and Mt. Keith water, except for ultrafine particles in the presence of collector in deionised water. The increase in the portion of the ultrafine fraction ($\sim 3 \mu\text{m}$), in all cases using Mt. Keith water and in some cases using deionised water during HIC, shows that ultrafine particle removal from large particle surface (surface cleaning) and/or destruction of aggregates, formed by ultrafine particles, apparently occurred.

MESOPOROUS SOLIDS - TEMPLATING WITH LIQUID CRYSTALS

Robert Corkery (Applied Mathematics, ANU)

Much excitement has been generated in the various fields that deal with mesoporous solids, especially with the recent development of large pore zeolites and MCM-41 materials. Synthesis of designer mesoporous solids with regular channel networks now looks within reach using liquid crystal templates; analogous to the use of quaternary ammonium ions in zeolite synthesis. Mesoporous solids with regular channel networks will become highly useful in the oil industry for cracking long chain hydrocarbons; for storage of gases and many other applications.

The problem with the current mesoporous solids is that they are hydrophilic, are stable only at low-temperature, are prone to chemical attack and have irregular pore size distribution and geometry.

In this talk, I will discuss the idea of templating low surface energy 2:1 clays with thermotropic liquid crystals to obtain a mesoporous solid with regular channel networks and a hydrophobic surface. This method is possible, as some clays have a natural tunable curvature in their sheets. The sheets, which are hydrophobic in some cases maybe intercalated into the hydrophobic interface that is present in a meso structure thermotropic liquid crystals.

I will present results for templating experiments using single component thermotropic liquid crystals on natural 2:1 low surface energy clays.

**NOVEL CONDUCTING MEMBRANES PREPARED FROM POLYMER
BLEND BY PHASE-INVERSION METHOD**

Anita Voros (Chemical Engineering, UNSW)

The objective of this work is to investigate the possibility of fabricating environmentally stable and mechanically strong conductive membranes. This work focuses on the fabrication methods of phase-inversion membranes from a blend of conducting polymer and polysulfone, as polysulfone is extensively used for membrane manufacture because the membranes made from it are chemically resistant and thermally stable. In addition to being commonly used for ultrafiltration membrane, this material serves as a selective layer in membrane gas separations, as a support layer for thin film composite membranes and as a substrate for enzyme attachment.

Polypyrrole is one conducting polymer that is known to be highly stable over long periods of time in air without considerable degradation in electrical properties however it is difficult to dissolve. To overcome this solubility problem 3-Octadecyl-pyrrole and the electrochemically polymerised poly-3-octadecyl-pyrrole (PODP) and Poly-Octyl-pyrrole (POP), which is more readily dissolved, was used in this work.

Following extensive experiments it was found that a miscible blend of PS and PODP, POP was observed in carefully selected solvents, such as N-Methyl-pyrrolidone (NMP).

A STUDY OF COLLOIDAL STABILITY OF GIBBSITE DISPERSIONS

Jodieann Dawe (Ian Wark Research Institute, U. of S.A.)

One of the puzzles in the gibbsite precipitation process has been the unknown causes of poor nucleation and crystal growth kinetics under Bayer conditions. In addition to crystal growth by solute, gibbsite particles of colloidal size, formed during precipitation from supersaturated sodium aluminate solution may coagulate, resulting in the formation of gibbsite clusters, which may inhibit the precipitation process. The stability of these ultrafine gibbsite particles is governed by the balance of various interparticulate forces of repulsion and van der Waal's attraction. The rate at which a sol coagulates can be used to measure the degree of stability of a dispersion.

The stability of the sol, resulting from the interactions of finely ground gibbsite crystals dispersed in an aqueous medium, has been investigated by monitoring the change in the absorbance of light over time under various conditions. Two peculiar trends in the stability of gibbsite dispersions have been observed - an induction time prior to the commencement of detectable coagulation and an increased stability at $\text{pH} > 13$. The interaction potential of the mean interparticulate force involved in a gibbsite sol can then be correlated with the coagulation behavior of the sol through the estimation of the stability ratio, W .

By probing the underlying reasons for the observed unusual stability effects and hence coagulation kinetics of gibbsite dispersions in aqueous media, a clearer understanding of the mechanisms in the gibbsite crystal growth in the Bayer process will be achieved.

18th Australian Colloid and Surface Chemistry Student Conference

**BUBBLE FORMATION AND GROWTH IN SOLUTION SUPERSATURATED
WITH CARBON DIOXIDE**

Sophie Lambert (University of Newcastle)

NO ABSTRACT RECEIVED

**THE EFFECT OF ANNEALING ON THE STRUCTURES OF LB FILMS OF
ARACHIDATES**

Jian Bang Peng (The University of Queensland)

By using both AFM and synchrotron Grazing Incidence X-ray Diffraction, we have observed changes in the structures of arachidate LB films on annealing by heating the films to 80°C then cooling to room temperature.

For barium arachidate, the films prior to annealing showed mainly a short range positional order structure. However, after annealing a long range order superlattice structure formed, and a polycrystalline feature was observed.

For lead arachidate the annealing led to an obvious improvement in correlation length, both in-plane and between the layers.

For cadmium arachidate there was no appreciable effect of annealing on the structure of the films. The annealing resulted in more disorder in the films of calcium arachidate.

The data analysis is being performed and the changes in the structures of the films are being further investigated.

**SYNTHESIS AND ACTION OF NOVEL ORGANIC COLLECTORS FOR
ZIRCON FLOTATION**

Mick Bjelopavlic (Ian Wark Research Institute, University of SA)

The froth flotation of zircon mineral sands is of considerable importance to the Australian heavy minerals industry. Compared to current physical separation techniques, froth flotation promises to meet escalating demands for higher productivity, better selectivity, lower costs and increased safety. However, flotation technology for zircon is currently in its infancy and the available literature is negligible, and that which does exist is often empirical and sketchy in detail. Despite this, certain classes of organic compounds have been identified as potentially selective collectors. This talk will describe the synthesis of these collectors (hydroxamic acids, malonic acids, glucosides, maleic acid esters, monoalkyl phosphates and N-alkyl glycines) as well as give details on their performance in the flotation of zircon.

**ZINC CARBOXYLATES FOR THE CHEMICAL VAPOUR DEPOSITION OF
ORIENTED ZnO FILMS**

Leong Mar (School of Chemistry, University of NSW)

The viability of zinc carboxylates as a class of compounds for use as solid phase single source precursors for the chemical vapor deposition of oriented ZnO films was investigated. Single source chemical vapor deposition offers a simple method for the uniform growth of II-VI semiconductor materials onto non planar structures suitable for micromechanical device applications.

The chemistry that occurs during the sublimation and vapor phase transport as well as the pyrolysis of the zinc carboxylates to form ZnO films on silicon substrates was studied using X-ray Photoelectron Spectroscopy (XPS) and Fourier Transform Infrared Spectroscopy. The presence of oxidising or reducing gases during deposition can enhance the thermal decomposition to produce ZnO films with minimal contamination from the organic components of the metal-organic precursor. The influence of substrate temperature and a gas ambient (eg O₂, H₂ or H₂O) during deposition on the extent of thermal decomposition of the precursor and the physical properties of the resultant ZnO films was systematically examined.

XPS was used to estimate the Zn/O stoichiometry and amount of carbon incorporation. The preferred orientation, crystallite size, morphology and was characterised by X-ray diffraction (XRD) and Scanning Electron Spectroscopy (SEM). The effect on the optical bandgap of the films was determined by UV-visible absorption.

**SURFACE MODIFICATION OF KAOLIN BY COVALENTLY BOUND
POLY(ETHYLENE OXIDE)
Marylou Molphy (Swinburne)**

The colloidal behaviour of particles can be improved through the attachment of polymer chains onto the surface as stabilising moieties. The polymer chains must be chosen so that compatibility of the solid with the dispersion medium is optimised and the point of anchorage onto the particle surface must also be resistant to desorption and hence destabilisation. The availability of the surface hydroxyl groups on kaolin provides an avenue for tailoring such particle surfaces. Incorporating different molecules onto the surface through covalent bonding instead of conventional adsorption improves the colloidal stability due to greater resistance to desorption.

The modified surface of kaolin was studied to determine the effect of changing the molecular weight of the polymer chain grafted onto the surface. The particles were modified by attaching poly(ethylene oxide), PEO, to the surface using a urethane linkage. A particle series of 1000, 6000, 15000, 20000 & 35000 g/mol PEO modified kaolins were produced and evaluated. The grafting density of the chains on the kaolin surface was calculated and the likely conformation of the polymer on the surface determined through contact angles and therefore change in surface hydrophilicity.

Grafting of the poly(ethylene oxide) polymer onto the surface of the particle enabled control over the chain density and also the degree of surface coverage. For the system described, increasing the molecular weight of the polymer chain resulted in a lower density of chains being grafted onto the surface. The hydrophilic character decreased across the molecular weight series, correlating with the change from a comb-like, high grafting density state for the lower molecular weight PEO chains to a loop and train state for the higher molecular weight chains.

**A STATIC SIMS STUDY OF HYDROXYLATION OF LOW SURFACE AREA
SILICA**

Barry Wood (School of Chemistry, University of NSW/University of Queensland)

Relative surface silanol (SiOH) concentration levels on low surface area crystalline silica (synthetic quartz crystal) have been determined using the static Secondary Ion Mass Spectroscopy (SSIMS) technique. Various sample pretreatments including water plasma (maximum silanols), heating in vacuum to ~550 °C, heating in air to >1000 °C (minimum silanols) and inert gas ion bombardment in ultra high vacuum (UHV) were examined. Both positive ion ratios (SiOH⁺/SiO⁺, SiOH⁺/Si⁺) and negative ion ratios, (OH⁻/O⁻) were monitored as a function of temperature as the pretreated surface dehydroxylated (increasing temperature) and rehydroxylated (decreasing temperature) in the UHV analysis chamber. Plots of positive ion versus negative ion ratios for all data at the various stages of hydroxylation indicated a linear relationship. Deviations from this were attributed to the presence of physisorbed water and/or surface hydrocarbon contamination.

18th Australian Colloid and Surface Chemistry Student Conference

THE HYDROPHOBIC INTERACTION. AN EXPERIMENTAL APPROACH
Vince Craig (Chemistry, ANU)

No Abstract Received

**THE INTERACTIONS OF COLLOIDAL IRON OXIDE PARTICLES WITH
QUARTZ SURFACES**

Paula Bandini (Ian Wark Research Institute, University of SA)

Iron oxide/hydroxide gangue particles are ubiquitous in sulphide mineral systems forming as oxidation products of iron sulphides and from steel grinding media wear. It is well established that they heteroaggregate with sulphide minerals and detrimentally affect flotation performance. Heteroaggregation studies of colloidal iron oxide with sulphide mineral surfaces (e.g. galena) and model quartz surfaces are in progress. (The latter system is discussed here). A scattering technique has been developed to accurately determine the solution concentration of Fe_2O_3 particles, therefore enabling the extent and kinetics of heteroaggregation to be studied. Strong heteroaggregation of Fe_2O_3 and quartz occurred at pH values below the i.e.p. of Fe_2O_3 , where surfaces are oppositely charged. The rate of heteroaggregation was shown to be pseudo-first order with respect to the Fe_2O_3 concentration and directly proportional to the stirring rate. Colloidal particle desorption studies were performed and the role of pH, sonication and chemical dispersants investigated. Effective desorption of iron oxide particles from quartz surfaces was observed when a combination of sonication with pH control was employed. Anionic dispersants also proved effective iron oxide desorbers; the dispersant action enhanced by sonication. A non-ionic PEO-PPO copolymer, however, showed no such dispersant behaviour. These findings enabled the mechanisms of heteroaggregation and colloidal particle removal to be discussed.

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MEASUREMENT OF THE INTERACTIONS BETWEEN MACROSCOPIC SURFACES INDUCING A FIRST-ORDER PHASE TRANSITION: THE SPONGE-LAMELLAR TRANSFORMATION

David Antelmi (Applied Mathematics. ANU)

The interactions between two macroscopic walls immersed in an isotropic symmetric sponge phase (L_3) at different volume fractions, Φ , were studied with the surface force apparatus. At temperatures well below the lamellar (L_α)/ L_3 bulk transition, the force-distance profile is weakly oscillatory with a period that is twice the correlation length (ξ) of the L_3 phase measured from SAXS. The oscillations are superimposed on an exponentially attractive background with an order correlation length of 2-4 cell sizes of the sponge structure. When the temperature is raised, a first order phase transition to a lamellar structure can be induced for separations below a threshold. Another oscillatory interaction results which has a period that is twice the reticular distance for an L_α phase of similar Φ . In addition, the thickness of the induced lamellar film increases (reversibly) with temperature. The compressibility modulus extracted from the oscillatory interaction is consistent with that expected for lamellae stabilised by undulation forces.

THIN FILM POLYMER pH SENSORS

Christina Aquino-Binag (School of Chemistry, University of New South Wales)

In previous work, quinhydrone (a combination of hydroquinone and quinone) supported in an inert polymer (PVC) was fabricated as a thin film at the end of a carbon electrode and determined to be a satisfactory, simple H⁺ sensor. In this study the active functionality, quinhydrone, was chemically incorporated into polypyrrole with the aim of constructing a self-supporting thin film sensor. Pyrrole was derivatised in the 3-position with benzene, dimethoxybenzene, hydroquinone and quinone functionalities. A series of polymers were fabricated using the derivatised monomers. The physical and chemical properties of resulting thin films were evaluated to determine suitability for application as pH sensors.

Electrochemical polymerisation of the monomers on Pt and C electrodes using different electrolyte salts, such as tetraethylammonium *p*-toluene sulfonate, tetraethylammonium tetrafluoroborate and lithium perchlorate was initially investigated. The polymer films were examined by X-ray photoelectron spectroscopy (XPS) and time-of-flight secondary ion mass spectrometry (TOFSIMS). The latter has shown to yield reproducible fragmentation patterns of the polymeric materials and was used to establish the extent of the derivitization within the thin film.

The electrochemical response of the resulting thin film sensor was assessed by relative pH response, electrode drift, hysteresis and reproducibility. This information was correlated with the surface characterization of the film.

DIELECTRIC RESPONSE OF SULPHONATE LATICES

Adrian Russell (Chemistry, University of Melbourne)

Electrokinetic measurements such as electrophoretic mobility and dielectric response are widely used to determine the zeta potential of colloidal particles. Some studies have raised doubts about the classical theories used to interpret these measurements due to discrepancies in the zeta potentials measured using the two techniques. The zeta potential of highly charged sulphonate/polystyrene latices was measured by both techniques and interpreted using full numeric classical theories. The potentials from the two techniques agreed. The use of a Stern layer conduction model ruled out surface conduction as a significant phenomenon in these latices.

**DIRECT DETERMINATION OF BACTERIAL BIOMASS USING
SEDIMENTATION FIELD-FLOW FRACTIONATION**

Reshmi Sharma (Water Studies Centre, Monash University)

Studies in microbial ecology require accurate measures of cell numbers and biomass, but the techniques currently used are often tedious and time consuming. Most bacteria can be treated as colloidal particles. Sedimentation field-flow fractionation (SdFFF) offers a rapid method for characterizing the physical properties (size, density and mass) of bacteria. The technique described can separate and detect DAPI stained cells and generate a fractogram¹.

Standard methods for estimating cell biomass involve tedious estimation of total cell numbers and cell volume from microscopy measurements and a rather uncertain conversion factor to convert this to dry cell mass. The errors are estimated to be up to $\pm 600\%$. SdFFF enables a more direct calculation of cell biomass (dry organic matter content) using only literature values for average density of dried bacteria biomass and an experimentally determined calibration factor between the detector signal and cell number concentration. This direct method for estimating bacterial biomass offers distinct advantages over present methods. The errors are estimated to be less than $\pm 100\%$ at present with some possibilities for reducing this being suggested.

Reference:

Sharma, R. V., R. T. Edwards and R. Beckett. 1993. Physical characterisation and quantification of bacteria by sedimentation field-flow fractionation. *Appl. Environ. Microbiol.* 59:1864-1875.

HALOCARBON ETCHING OF III-V SEMICONDUCTORS

Adrian Bolzan (School of Chemistry, University of New South Wales)

Dry etching of compound semiconductors, such as gallium arsenide (GaAs), has received increasing interest in recent years due to the technological importance of these materials, especially in the optoelectronics industry. Although halogens, hydrogen halides, and halocarbons are routinely used as etchants, surface mechanistic studies aimed at deriving a molecular level picture of the interaction between semiconductor surfaces and the halocarbon molecules has received little attention. Results will be presented on the adsorption of one halocarbon, iodoethane, on the GaAs(100) surface, which was studied with the techniques of Temperature Programmed Desorption (TPD), Low Energy Electron Diffraction (LEED) and Auger Electron Spectroscopy (AES). Adsorption of iodoethane at room temperature leads to complete dissociation to form surface-bound ethyl species and iodine atoms. These iodine atoms selectively etch surface gallium, resulting in an arsenic-rich surface. The adsorbed ethyl species were found to undergo the competing reactions of β -hydride elimination and reductive elimination to give ethene, ethane and molecular hydrogen as major products. Desorption of the adsorbed ethyl moieties also occurs by recombination with the iodide to form the molecular species, iodoethane.

SURFACTANT SOLUTIONS AND FOAMS

Ross Mair (Swinburne)

Nuclear Magnetic Resonance (NMR) spectroscopy has, over the past fifteen years, become a very useful tool for the study of surfactant systems. The measurement of NMR relaxation times provides a qualitative indication of the immediate environment of various regions of the surfactant molecule. When a number of relaxation times, often acquired at different magnetic field strengths, are available, they can be interpreted according to models for molecular dynamics, thus yielding accurate optimised times for molecular reorientation. In addition to this, newer NMR techniques allow the direct measurement of diffusion coefficients without the need to "tag" the molecule in any fashion.

These techniques have been widely applied to surfactant systems such as micellar solutions, emulsions and liquid crystalline phases. They have allowed the determination of proportions of aggregated and monomer surfactant, and have allowed the description of surfactant motion as the function of two correlation times, one describing total, overall motion of the molecule, and the other describing internal rotation of an alkyl chain unit. The application of these techniques to a surfactant stabilised aqueous foam system was a new challenge, however extensive detail of surfactant behaviour on the foam as been obtained.

SURFACE TREATMENTS OF WOOL AND WOOL PRODUCTS

Narelle Brack (School of Chemistry, University of New South Wales)

A thorough understanding of the surface chemistry of wool is of critical importance for subsequent processing such as shrinkproofing and dyeing. The surface chemistry of untreated and treated wool fabric has been investigated using time of flight secondary ion mass spectrometry (TOFSIMS) and X-ray Photoelectron Spectroscopy (XPS). These techniques provide detailed information concerning the concentration and distribution of elemental and chemical species present on the surface of wool.

It has been suggested that the wool fibre is covered by a thin covalently bound lipid layer. By stabilising the surface of the fabric with a thin coating of chromium, a C-20 fatty acid has been identified using TOFSIMS. This lipid layer can be partially removed by treatment with potassium hydroxide in ethanol or potassium t-butoxide in t-butanol. These treatments are confined to the outer surface thus preventing whole fibre degradation. XPS results will be presented that indicate that lipid removal is incomplete and that there is some oxidation of the underlying cystine residues to form cysteic acid and other intermediate oxidised sulphur species. TOFSIMS data show an increase in the relative intensity of protein peaks to hydrocarbon peaks. The removal of this lipid layer generates a more polar and hydrophilic surface thus enhancing dye uptake and the adhesion of shrinkproofing polymers.

**LIGHT SCATTERING FROM CONCENTRATED DISPERSIONS: THE
ROLE OF OPTICAL FIBERS**

Rajesh Srivastva (School of Applied Physics, University of South Australia)

Dynamic Light Scattering (DLS) allows the Brownian motion (diffusion) of colloidal dispersions to be characterised by monitoring the intensity fluctuations in the laser light scattered from these dispersions. DLS is an absolute, fast and reproducible technique for determining particle diffusion coefficients which, in turn, provides a measure of the particle size for submicron dispersions. Typically measurements can only be made at low concentrations ($\sim 10^{-4}$ wt %). This greatly restricts the applications of DLS. Certain concentrated dispersions lose their interesting properties if diluted, and hence can not be studied by conventional DLS. There is a paucity of techniques available for the study of concentrates. The advent of optical fibers has enabled extension of DLS techniques to concentrated solutions. Optical fibers, if used in the correct configuration, can reduce the multiple scattering and can be used as reliable DLS probes in concentrated dispersions. Currently efforts are being made to develop robust, portable, small and remote commercial systems using optical fibers.

URANIUM TRANSPORT IN GROUNDWATERS

Brett Fenton (Mechanical Engineering, UNSW)

NO ABSTRACT RECEIVED

$$\int_0^L dx \quad u_z^2 - \epsilon u_x^2 + \lambda^2 u_{xx}^2$$

$$\int_0^L dx \quad 2u_z \delta z - 2\epsilon u_x \delta x + 2\lambda^2 u_{xx} \delta_{xx}$$

$$\rightarrow -\int_0^L dx \quad (2u_z z - 2u_{xx} \epsilon - 2\lambda^2 u_{xxxx}) \delta$$

$$u_{zz} \frac{\partial^2 u}{\partial z^2} - \epsilon \frac{\partial^2 u}{\partial x^2} - \lambda^2 \frac{\partial^4 u}{\partial x^4} = 0$$

$$u = u_0 \cos(k_x x) \sin(k_z z)$$

$$f'' = -\alpha f$$

$$-k_z^2 + \epsilon k_x^2 - \lambda^2 k_x^4 = 0$$

$$k_z = \frac{\pi}{2L}$$

$$u = u_0 f(z) \cos(k_x x) \quad f(L) = u_0$$

$$-\int_0^L dx \Rightarrow -\frac{\epsilon}{2\lambda^2}$$

$$k_x^2 = \frac{\epsilon}{\lambda^2}$$

$$f'' = -\alpha f$$

$$f'' = -\frac{\epsilon}{\lambda^2} f + k_x^4 f \lambda^2$$