

Adelaide

10/2/21

Adelaide – Keynote Abstracts

Flotation Puzzles- Encounters, Kinetics and Hydrophobicity

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Biography



John is a Physical and Colloid Chemist with complementary training in metallurgy, whose research interests embrace various aspects of interfacial science and engineering. In 1994, the Ian Wark Research Institute (1994 to 2015) was founded at the University of South Australia, with John as its Director, until his retirement in 2012. John's research deals with three main themes - how bubbles contact particles; why things stick together and how liquids spread

over surfaces. The problems addressed cross the boundaries from pure physical chemistry to materials science to chemical and minerals engineering, with many connections with, and knowledge transfer to, national and international industry. John has received numerous national and international awards and honours over the years. These include the Chemeca Medal in 2006 [Australia's highest honour in Chemical Engineering], the ATSE Clunies Ross Lifetime Contribution Award in 2009 and the Staudinger Durrer Lecture and Medal in 2012 from the Swiss Federal Institute of Technology, ETH Zurich, for influential contributions to the fields of colloid and surface science. In 2008 John was made an Officer of the Order of Australia. In 2007 he was awarded South Australian of the Year, the first scientist to be so honoured, as well as South Australian Scientist of the Year.

During his research career, John has been awarded over \$200M in competitive grant funding from the Australian Research Council, national and international granting agencies and private industry. His research efforts with his colleagues have returned over \$1.5BAUD to national and international industry with, in the case of minerals research, a verified ratio of 20 to 1 benefit to industry for each research dollar invested. John has actively supervised eighty-five PhD research students. These students have gone on to establish careers in universities, industry and other research institutions throughout the world.

Apart from mentoring research teams at UniSA, his present activities include strong interactions with universities, companies and research institutes internationally. John has an h-index of 72 and his publications have been cited more than 17000 times.

Abstract

The selective capture of specific particles by bubbles is fundamental in mineral flotation. For successful bubble-particle capture to take place the complementary steps of collision, attachment and stability of the three phase contact must be included in any description. How do we describe the selective interaction of single bubbles with specific particles in simple systems and then selective multiple bubble particle encounters or “coagulation” in a many-body heterogeneous environment? Fluid dynamics, physics, chemistry and engineering are all involved. What are the major issues and challenges?

Hydrophobicity is central to flotation, but can be interpreted in different ways, often incorrectly. Bubbles have surfaces which may be mobile, immobile or somewhere in between. Water structure at interfaces is very important. Particle surfaces may be rough at various length scales; are often patchy in terms of chemical and mineralogical composition; are frequently coated with tiny ‘particles’ to varying degrees; and rarely adsorb reagents uniformly. Many minerals comprise faces and edges whose structure and composition differ, along with their dielectric constants, and thus respond to chemical species differently. The aqueous phase may be highly saline. Determining particle separation and fluid mechanical behaviour in opaque, multiphase systems with complex interfaces is therefore challenging. Whilst great progress has been made, major puzzles remain to be solved.

Emulsions under Arrest!

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Patrick Spicer

Biography

Patrick Spicer is an Associate Professor in UNSW's School of Chemical Engineering where he leads the Complex Fluids group. The CFG combines microscopy and rheology studies to understand and design smart fluids with unique response and flow behaviour. Pat developed and teaches the core technology and design courses of UNSW's new Chemical Product Engineering stream in collaboration with industrial colleagues. Before UNSW, Pat ran a central engineering research department for the Procter & Gamble Company in the US for 15 years. His group developed new product and process technology there for all of P&G's billion-dollar brands.

Abstract

The combination of two or more emulsion droplets into a single volume is termed coalescence, a process with a strong impact on stability of diverse products like shampoos, explosives, and foods. In some cases, emulsion droplets contain solid or crystalline particles that alter their rheology and response to coalescence. Past observations of microstructure in milkfat emulsions identified structures formed by interrupted or arrested coalescence, resulting in droplet aggregates that are a critical part of food microstructure and texture. Using direct microscopic studies of arrest, we developed a physical model of the process that predicts its extent as a function of droplet rheology and interfacial tension. The experiments also identified a new mechanism of microstructure formation: a restructuring of colliding droplets into denser packings than would be achieved by random, fractal ordering. As this past work is based on studies of only a few droplets at a time, we are focused on validating the models for more realistic populations of emulsion droplets. Microscopy of thousands of droplets forming arrested coalesced structures shows unique structure formation that is consistent with a theoretical model of the restructuring mechanism. We build on this work to include three-dimensional imaging of arrested structures and consider the effects of shear stress and more complex crystalline species on the phenomenon. Droplet arrest and restructuring is then related to product performance measures like rheology and aesthetic texture.

Adelaide – Oral Presentation Abstracts

Incorporation and antimicrobial activity of nisin Z within carrageenan/chitosan multilayers

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An antimicrobial peptide, nisin Z, was embedded within polyelectrolyte multilayers (PEMs) composed of natural polysaccharides in order to explore the potential of forming a multilayer with antimicrobial properties. Using attenuated total reflection Fourier transform infrared spectroscopy (ATR FTIR), the formation of carrageenan/chitosan multilayers and the inclusion of nisin Z in two different configurations was investigated. Approximately $0.92 \mu\text{g}\cdot\text{cm}^{-2}$ nisin Z was contained within a 4.5 bilayer film. The antimicrobial properties of these films were also investigated. The peptide containing films were able to kill over 90 % and 99 % of planktonic and biofilm cells, respectively, against *Staphylococcus aureus* and methicillin-resistant *Staphylococcus aureus* (MRSA) strains compared to control films. Additionally, surface topography and wettability studies using atomic force microscopy (AFM) and the captive bubble technique revealed that surface roughness and hydrophobicity was similar for both nisin containing multilayers. This suggests that the antimicrobial efficacy of the peptide is unaffected by its location within the multilayer. Overall, these results demonstrate the potential to embed and protect natural antimicrobials within a multilayer to create functionalised coatings that may be desired by industry, such as in the food, biomaterials, and pharmaceutical industry sectors.

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Anticancer efficacy of Cyclodextrin-based Nanoparticles containing Alpha-mangostin

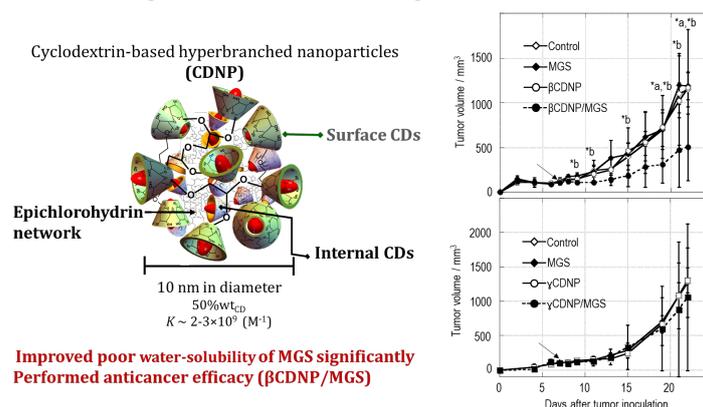
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Alpha mangostin (MGS) is a natural xanthone compound and extracted from mangosteen pericarps. Although MGS has great potential to be an excellent anticancer agent, its extremely low solubility in water seriously impedes its medical application. Previously, we found that cyclodextrin (CD)-based hyperbranched polymer nanoparticles (CDNPs) solubilizes MGS by encapsulating it into the CD cavity and their binding constants became almost 100 times higher than native CDs.^{1,2} Our finding suggested that CDNPs could become a good carrier of MGS.¹ In present study, we prepared three types of CDNPs from α -, β -, and γ - CDs and compared them in terms of the MGS release, and *in vivo* anticancer efficacy.

Firstly, drug release profile showed that all data points of CDNPs/MGS were fitted by bi-exponential first-order equation and performed two steps release: the initial rapid and second slow releases. It suggests a model in which slow and rapid modes are connected in series and, before release, MGS must shift from the slow to the rapid mode. We also assumed that the slow and rapid modes are related to the interior and surface CDs of CDNPs. Based on fitting result, MGS released more gradually from β CDNP/MGS than other CDNPs in the slow mode. Additionally, β CDNP/MGS demonstrated the greatest anticancer efficacy, while no efficacy was observed for the others *in vivo* experiment. On the connection between drug release behavior and anticancer efficacy, we proposed the releasing time in the slow mode is essential for MGS retention until reaching the cancerous region.



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Evaporation-Driven Flow in Micropillar Arrays: Transport Dynamics and Chemical Analysis under Varied Sample and Ambient Conditions

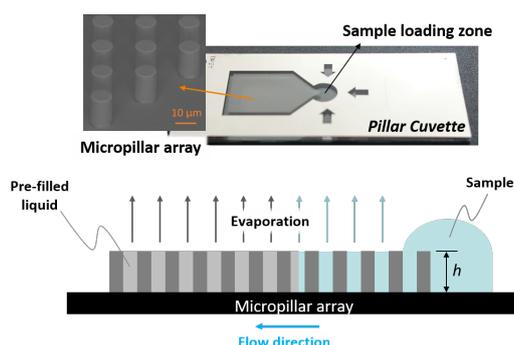
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Microfluidic flow in lab-on-a-chip devices is typically very sensitive to the variable physical properties of complex samples, e.g., biological fluids. In this study, we report evaporation-driven fluid transport (transpiration) in a micropillar array configuration that is insensitive to interfacial tension, salinity, and viscosity over a wide range. The micropillar array (“pillar cuvette”¹) was preloaded by wicking a known volatile fluid (water) and then adding a microliter sample of salt, surfactant, sugar, or saliva solution to the loading zone. As the preloaded fluid evaporates, the sample is reliably drawn from a reservoir through the pillar array at a rate defined by the evaporation of the preloaded fluid (typically nL/s). Including a reagent in the preloaded fluid allows photometric reactions to take place at the boundary between the two fluids. In this configuration, a photometric signal enhancement is observed and chemical analysis is independent of both humidity and temperature.² The ability to reliably transport and sense an analyte in microliter volumes without concern over salt, surfactant, viscosity (in part), humidity, and temperature is a remarkable advantage for analytical purposes.



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Characterisation of the properties and structure of Poly(N-isopropylacrylamide) layers on silica in alcohols and binary solvents

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Poly(N-isopropylacrylamide) (PNIPAM), a typical thermoresponsive polymer, is not only responsive to temperature but also to the conditions of solutions, such as the presence of salts. Therefore, solids onto which PNIPAM chains have been grafted could be applicable to a wide variety of industrial fields that utilise these properties. In this study, the structural changes of PNIPAM chains grafted onto solid plates were investigated in alcohols and their mixtures with water, using an atomic force microscope (AFM).

AFM imaging (Fig. 1) of the PNIPAM-grafted silica substrate in ethanol-water mixtures showed that the grafted PNIPAM chains exhibited a mushroom-like morphology in mixtures with 20–40 vol.% of ethanol, whereas they exhibited a brush-like morphology in both water and ethanol. Interaction force measurements conducted between the AFM tip and the substrate indicated that the PNIPAM chains exhibited complex expanding-shrinking behaviour, depending on the concentration of ethanol. The grafted PNIPAM chains also expanded with the increase in the carbon number of the alcohol used. Such structural changes are likely to have been caused by the balance of the interchain repulsion, due to the hydration of amides, and the hydrophobic attraction between hydrocarbons in the chains.

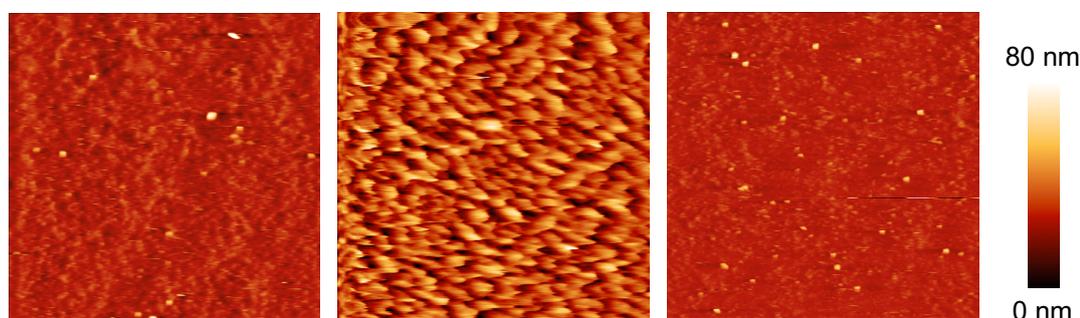


Fig. 1 AFM images ($5.0 \times 5.0 \mu\text{m}^2$) of a PNIPAM layer grafted on a silicon wafer obtained in water (left), water 80 vol% - ethanol 20 vol% mixture (centre) and ethanol (right).

Adsorption of Inorganic Ions at Liquid Surfaces – Ion Specific Effects

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Adsorption or desorption of inorganic ions at solvent surfaces has relevance in complex biological process, physiochemical systems and as a model system for atmospheric chemistry studies i.e., ionic presence in aerosol droplets influences Cl₂ and Br₂ uptakes. Since the recent developments in surface-sensitive experimental techniques, many investigations have shown that adsorption or desorption of ions in aqueous solution follows specific ion series (direct or indirect Hofmeister series) and this behaviour is believed to be originated from ion-solvent interaction^[1]. The recent discovery of specific ion effect in non-aqueous solutions suggests that water is not a special liquid in the matter of specific ion effects^[2]. But, consensus for adsorption or desorption of inorganic ions in liquids other than water is limited hence a clear origination of specific ion effect is not understood. Therefore, to further unravel the origination of specific ion effect at liquid surfaces, we have employed neutral impact collision ion scattering spectroscopy^[3] (NICISS) to obtain concentration depth profiles of various ions in glycerol and formamide solutions.

Overall, 12 inorganic salts (LiCl, LiBr, LiI, NaCl, NaBr, NaI, KF, KBr, KI, CsF, CsCl & CsBr) dissolved in glycerol and formamide are investigated to compare the depth profile onsets of 3 different ionic subsets: i) anionic depth profiles without varying the cation, ii) anionic depth profiles when paired with varying cation & iii) cationic depth profiles while varying the counter anions. Preliminary results show that ions are driven towards air-liquid interface not only based on their ionic sizes and polarizability but also depending upon the solvent's polarizability. These implications are made from the findings that smaller anions in glycerol are adsorbed closer to the solvent surface in comparison to bigger anions and that cation specific effect is absent from glycerol solution surfaces which is opposite of the results reported so far for ions at aqueous solution surfaces^[4].

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The Effect of Stabilisers on the Interfacial Crystallisation of Lipids

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Crystallisation of lipids at the oil-water interface has a significant effect on the stability of emulsion systems [1, 2]. Interfacial crystallisation is of particular importance to the dairy industry, as interfacial crystals also play an important role in the structure and texture of dairy products. The presence of either included or indigenous stabilisers are also vital to ensure the stability of emulsions during product formation. The effect of these stabilisers on the formation and structure of lipid crystals at the oil-water interface is an area which is of great importance; however, isolating the interface is difficult to achieve by studying emulsion systems.

In this study, a different approach has been taken to study interfacial crystallisation, whereby a single oil-water interface was examined using Synchrotron Small and Wide-Angle X-ray Scattering (SAXS/WAXS) and Profile Analysis Tensiometry (PAT) in the presence and absence of emulsion stabilisers. X-ray scattering provided insights on the influence of stabilisers regarding crystal concentration and structure at the oil-water interface compared to the bulk oil phase, while PAT was used to monitor of the kinetics of interfacial tension in response to surface-active lipid crystal formation. The combination of these two techniques allows for a more detailed study of the oil-water interface and the effect of stabilisers on interfacial crystallisation compared to emulsion systems.

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high loaded Gold cluster deposited onto the functionalized mesoporous TiO₂: Efficient photocatalytic methyl orange degradation

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Since water splitting photo catalytically on the electrodes made of TiO₂ single crystals was discovered by Fujishima and Honda¹, use of TiO₂ semiconductors has been strongly emphasized in various practical applications owing to its unique electronic and optical features; good chemical and thermal stability; and low toxicity and cost^{2,3}. However, a wide range of approaches has been ever conducted to increase the TiO₂ photocatalytic activity. It can be achieved by two kinds of modification; 1- Morphological ones included increasing the porosity and surface area; as a result, mesoporous TiO₂ (MTiO₂) have attracted much attention in versatile fields such as solar fuels and water treatment process, 2- Chemical ones; such as incorporating additional components in the structure of TiO₂ to enhance the sensitivity of TiO₂ towards the visible light region, inhibit the recombination of the photogenerated electron-hole pairs or/and increase the active sites enhancing the photocatalytic activity. In the case of noble metals loaded onto the semiconductor particles, if the size is reduced, it leads to a remarkable improvement in the catalytic efficiency due to two effects: scalable effects and quantum confinement effects.

Gold nanoclusters (NCs) are smaller in size than Au nanoparticles used to modify surface properties. For this reason, the number of atoms forming an Au NC strongly influences the catalytic properties of cluster-modified surfaces. Agglomeration of NCs leads to an increase in NC size, eventually forming NPs, and should be avoided.

MTiO₂ semiconductor application with remarkable surface defects, high surface area, and extensive 3D pore network can help prevent agglomeration of gold clusters. Also, to have stronger interaction between Au NCs and semiconductor surface leading to decreased agglomeration and increasing the loading of the Au NCs, the functionalizing reagent is used to make a system with a high number of active sites to obtain highly active photocatalytic systems.

Keywords: Gold nanoclusters, Mesoporous TiO₂, Photocatalytic activity

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Thermoresponsive polysaccharides with tunable thermoresponsive properties

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Over the last few decades, there has been a growing interest in polysaccharides (PS) that exhibit thermoresponsive properties and their applications. Whilst some PS are naturally thermoresponsive, their transition temperatures are often too high and not easily tuned. Thus, polymers with a lower critical solution temperature (LCST) are favoured over those with an upper-critical solution temperature (UCST), as they are a solution at ambient temperature and phase transition upon heating¹ (**Figure 1a**). PS with a LCST can only be achieved via synthetic modification of PS, and whilst this has been previously studied, many modified PS have a LCST that is either too high or cannot be tuned. Therefore, in this study we aimed to develop a thermoresponsive PS with a tunable LCST via the functionalisation of dextran with alkylamide groups. We prepared a library of alkylamide functionalised PS using a series of four different amic acids at a range of degrees of substitution (DS). UV-Vis spectroscopy was used to determine the LCST and it was found that the LCST could be tuned by altering the DS, with a higher DS resulting in a lower LCST, and vice versa. It was observed that when heated above the LCST, the functionalised PS transitioned from a solution to a colloidal suspension of aggregated PS globules (**Figure 1a and b**). An *in vivo* toxicity study in mice using one of the thermoresponsive alkylamide functionalised dextrans found no observable difference between the control and formulation treated groups, suggesting that the polymer is biocompatible. Furthermore, preliminary studies on the potential of these PS for use as biodegradable drug delivery systems was investigated through enzymatic degradation and *in vitro* drug release studies.

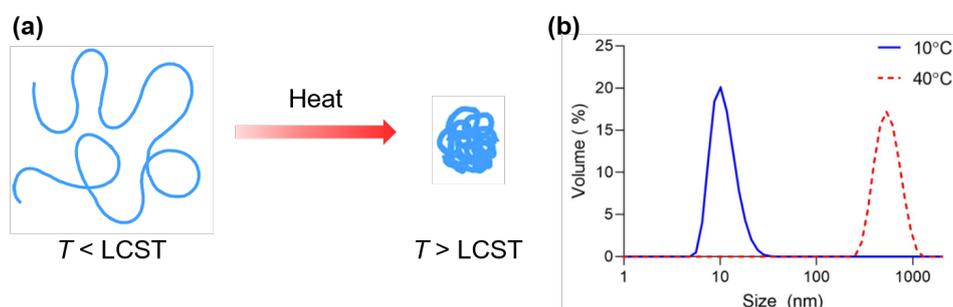


Figure 1: (a) The coil-to-globule transition resulting in the formation of a colloidal suspension. (b) The particle size distribution of functionalised dextrans above and below the LCST.

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Impact of bubble size on terminal velocity in water and frother solutions as indicator of surface mobility

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The bubble rise velocity in liquids is determined by the liquid-air interface boundary conditions. Bubbles having fully mobile surface rise with highest velocity, while tangential immobility at bubble surface cause decrease in the rise velocity. The bubble surface immobilization occurs in the presence of trace amounts of surface active molecules¹.

The available literature data on air bubble rise in high purity water does not provide unambiguous conclusions regarding mobility of the bubble surface. The biggest discrepancies concern very small bubbles, which may exhibit completely immobile boundary conditions according to Stokes law or have fully mobile water-air interface in accordance with Hadamard-Rybczynski model^{2,3}. Results present the systematic investigation on air bubble rise velocity in high purity water for a wide range of bubbles diameters (50 μm – 1.5mm) corresponding to three Reynolds numbers regions such as: low, intermediate, high. Rear stagnant cap model was used to estimate the required amount of surface active molecules that, cause retardation and full immobilization of bubble surface, which explains the reason of high sensitivity of small bubbles for even trace amount of surface active impurities.

The existing literature on the rise velocities of air bubbles in aqueous surfactant solutions adsorbing at the water-air interface focusses mainly on large bubbles ($D > 1.2 \text{ mm}$). In our study smaller air bubbles ($D < 505 \mu\text{m}$) were employed to investigate the effect of the bubble size on the detection of two flotation frothers of different adsorption kinetics via bubble rise velocity measurement. The influence of the bulk concentration of flotation frothers on the bubble rise velocity and the degree of tangential mobility was discussed. Additionally, the tangential mobility at the bubble surface was compared with the equilibrium interfacial tension and correlated with the surface coverage determined from the adsorption isotherms.

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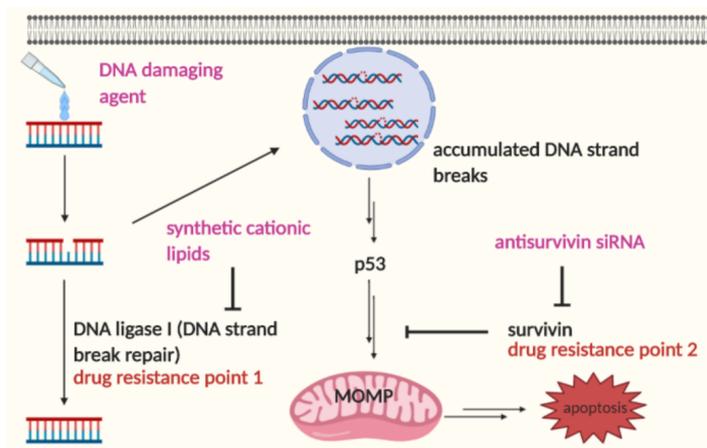
Novel antitumor cationic cubosomes deployed for the combination therapy of drug-resistant cancers

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Lipid-based nanocarrier systems have gained enormous attention in the medical field due to their high biocompatibility and ability to improve the therapeutic efficacy of encapsulated drugs. However, the therapeutic efficacy of the latter is compromised in certain diseases (like cancer), due to highly complex pathways associated with the disease development, demanding multiple pharmacological interventions. Hence, herein we aim to address this challenge by co-delivering the traditional chemotherapeutic agent and survivin siRNA using cubosomes constituted of novel synthetic antitumor cationic lipids (anti hLigI inhibitors)¹ wherein the siRNA and cationic lipid act independently on different complimentary targets to sensitize the drug-resistant cancers to the chemotherapeutic agent (paclitaxel/doxorubicin) employed.



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The importance of diffusiophoresis in promoting small-on-top stratification in drying films

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Stratification in drying films – how a mixture of differently-sized particles arranges itself upon drying – is examined. It is seen experimentally that smaller particles preferentially accumulate at the top surface, but it is not understood why.¹ Understanding this could allow the design of formulations that self-assemble during drying to give a desired structure. Potential applications are across a wide range of industries, from a self-layering paint for cars, to a biocidal coating in which the biocide stratifies to the top surface, where it is required.

On the basis of diffusional arguments alone, it would be expected that larger particles stratify to the top surface. However, other physical processes, including diffusiophoresis, may also be important. By deriving transport equations, the magnitude of different contributions can be compared, and numerical solutions for the film profile are produced.

This work probes the significance of diffusiophoresis: to the diffusional model, a diffusiophoresis term is added that can be varied in strength. For hard spheres, it is predicted that diffusiophoresis counteracts the effect of diffusion, resulting in approximately uniform films. When the diffusiophoresis strength is increased, the small particles are predicted to stratify to the top surface. This suggests that diffusiophoresis does contribute to experimental observations of small-on-top stratification, but it might not be the only promoting factor.

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An Open Microfluidic Chip for Continuous Sampling of Solute from A Turbulent Particle Suspension

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High solids content complicates in situ analysis of chemical processing, biological suspensions, and environmental streams. In most cases, analytical methods require at least one pre-treatment step of a small volume of sample before a particle-free fluid can be analyzed. We have developed a continuous in situ sampler that can “sip” particle-free solution from a turbulent high solids content stream (a slurry).¹ An open microfluidic chip with an extended slit opening shields the internal laminar flow from the turbulence outside. Unlike other open chips, our chip does not require close proximity to a solid surface and operates in turbulent environments for hours without maintenance. Two applications are demonstrated: monitoring iron(III) in a stirred slurry of mixed ore particles at high solids loading (4%wt) and paracetamol tablet dissolution profiles for two different formulations.

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Pure water-air interface is mobile and bounces bubbles stronger

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The question of water-air interface mobility has been long debated. Modelling of free-rising bubbles bouncing from water-air interfaces has concluded that the water-air interface is always immobile in practical situations due to trace amounts of contamination¹. Recently we conducted experiments using extra pure perfluorocarbon liquid, which demonstrated that a free-rising bubble would bounce more strongly from mobile than an immobile liquid interface². To examine this effect in the case of pure water, we compared the bounce of millimetre-sized free-rising bubbles from a pure water-air interface with the bounce from a water-air interface on which a Langmuir monolayer of arachidic acid was deposited³. The monolayer concentration is low enough not to change the surface tension but high enough to immobilize the interface due to Marangoni stress effects. Bubbles were found to bounce stronger (by a factor of up to 2.0, Fig. 1) from the pure water interface compared to the Langmuir monolayer deposited interface. These experiments demonstrate that a pure water-air interface behaves like a mobile liquid interface in our systems. Numerical simulations support these experimental findings.

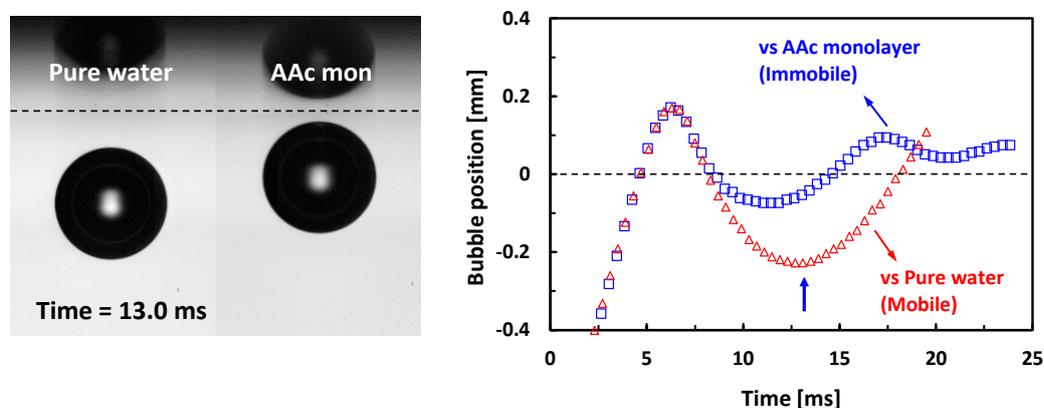


Fig. 1. Comparison of a 0.78 mm free-rising bubble bouncing from the pure water-air interface and arachidic acid (AAC) deposited on the water-air interface.

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Microfluidic Screening to Study Acid Mine Drainage

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Acid mine drainage (AMD) is the most significant environmental pollution problem associated with the mining industry. Case-specific testing is widely applied and established in the mining and consulting businesses for AMD prediction, and any improvements in its efficiency, while reducing its environmental impact, are of utmost societal importance. Our group has successfully developed microfluidic platforms for screening mineral dissolution (leaching) chemistry.^{1,2} In this study, we develop a microfluidic screening method as a useful tool in the prediction and, potentially, prevention and remediation of AMD.³ The new approach offers key advantages including high throughput screening of reaction conditions, better spatiotemporal control over the process, and ability to conduct field-based measurements, which will account for specific interactions between mineral ores and their environment. Reagent and sample consumptions are greatly reduced to mL and mg levels, compared with those in conventional bulk-scale screening. Parallel (multichip) screening of ferric ion concentration gradients (0–40 mM) and temperature (23–75 °C) is demonstrated here, showing that the dissolution rate of pyrite significantly changes with the pH, temperature, and the ferric ion concentration, consistent with previous bulk-scale studies. To verify the robustness of the method, a mine waste rock was also tested in the microchip with natural waters. This study demonstrates the application of microfluidic screening to the challenging issue of AMD and, more generally, forecasting and optimization of mineral leaching in industry.

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Extended electrostatic decay lengths at very high salt concentrations: Examples and Implications

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Many colloidal properties are strongly dependent on the range and strength of Coulomb interactions. In the presence of other ions, the Coulomb interactions between ions are screened such that the interaction energy between charges is exponentially dependent on the separation, this is often expressed in terms of the Debye length.

The surprising observation of long-range electrostatic forces between surfaces immersed in ionic liquids and concentrated salt solutions¹⁻⁵, has recently shown that at high electrolyte concentrations the electrostatic decay length is clearly *not* described by the Debye length and that the electrostatic decay length shows a minimum beyond which the range of electrostatic interactions *increases* with increasing electrolyte concentration.

Several examples of systems that exhibit long-range interactions at high salt concentrations will be presented and the implications discussed.

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Adelaide – Poster Abstracts

Investigating the Structure of Tethered Bilayer Lipid Membrane (tBLM) in the Presence of Liquid by Ion Scattering Spectroscopy

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Tethered bilayer lipid membranes (tBLMs) are solid supported membranes, where the solid supported substrate is separated from the artificial lipid bilayer by an anchorlipid such as 2, 3-di-O-phytanyl-glycerol-1-tetraethylene glycol-D,L-lipoic acid ester lipid (DPhyTL). Tethered bilayer lipid membranes are based on self-assembled monolayers (SAMs) of anchorlipids. The chemical structure of the tether-segment of the anchorlipids has a significant effect on the properties of the artificial tethered bilayer lipid membranes such as its fluidity. Therefore, this study focuses on investigating the structure of tBLM based on DPhyTL anchorlipid in the presence of liquid e.g. formamide and water by ion scattering spectroscopy (ISS). Neutral impact collision ion scattering spectroscopy NICISS is one of the ion scattering techniques. It is a vacuum-based technique that employed for investigating the composition and structure of soft matter surfaces. NICISS measures the concentration depth profiles of elements present in the sample. Other surface analytical techniques will be applied such as X-ray photoelectron spectroscopy (XPS). XPS is applicable to determine the elemental composition and chemical state of elements present in the sample. Electrochemical impedance spectroscopy (EIS) is a commonly used technique to confirm the presence of lipid bilayers and the quality of it through the presence of electrochemical properties before applying NICISS and XPS techniques. The main purpose of understanding the structure of tBLM will help in further development and adjustment of the structure of the membrane to mimic a real membrane, thus, using them as sensor devices.

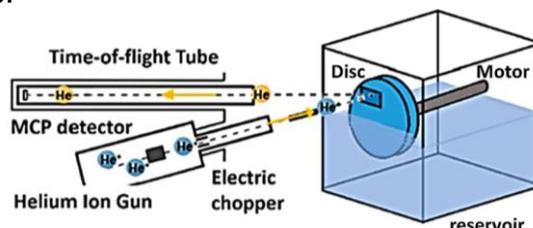


Figure 1: A schematic illustration of the design used for liquid sample target in NICISS. This figure is adapted from (1)

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Interfacial Study of Aged Dye Sensitised Solar Cell to Investigate the Degradation Phenomena Introduced Under Different Stress Factors

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Dye Sensitised Solar Cells (DSSCs) are a strong candidate among the third-generation thin films solar cells with a simple and inexpensive manufacturing process, eco-friendly nature, and good cost-to-performance ratio which uses low-cost materials. The commercialization of DSSCs demands high efficiency with good stability and hence, the understanding of aging and instability is very crucial. Though aging studies is not a new topic to investigate, it still lacks an effective methodology to clarify the aging and instability caused by the degradation of individual cell component. This research focuses on setting up a procedure to understand ageing and the cause of instability in high performing DSSCs. To approach the aim, it is intended to reproduce efficient cells with easily and commercially available resources, considering the cost-effective property of DSSCs. Thus, reproduced cells are further exposed to different stress factors. The influence of the applied stress on the cell performance is tracked using Solar Simulator and further investigated using the surface analysis techniques, XPS (X-ray photoelectron spectroscopy), MIES (Metastable induced electron spectroscopy), UPS (Ultraviolet photoelectron spectroscopy), and FTIR (Fourier transform infrared) to understand the surface and interfacial change introduced due to ageing. NICISS (Neutral impact collision ion scattering spectroscopy) is involved to investigate the concentration depth profile for heavy elements like Ruthenium and Iodine the representative of dye and the electrolyte respectively. Additionally, the study aims to include ARXPS (Angle-resolved x-ray photoelectron spectroscopy) an effective depth-profiling technique complimenting FTIR spectroscopy for a better understanding of dye adsorption modes.

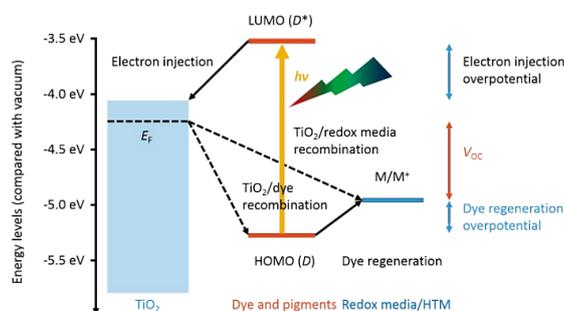


Fig: The schematic energy diagram and operating principle of a DSSC

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