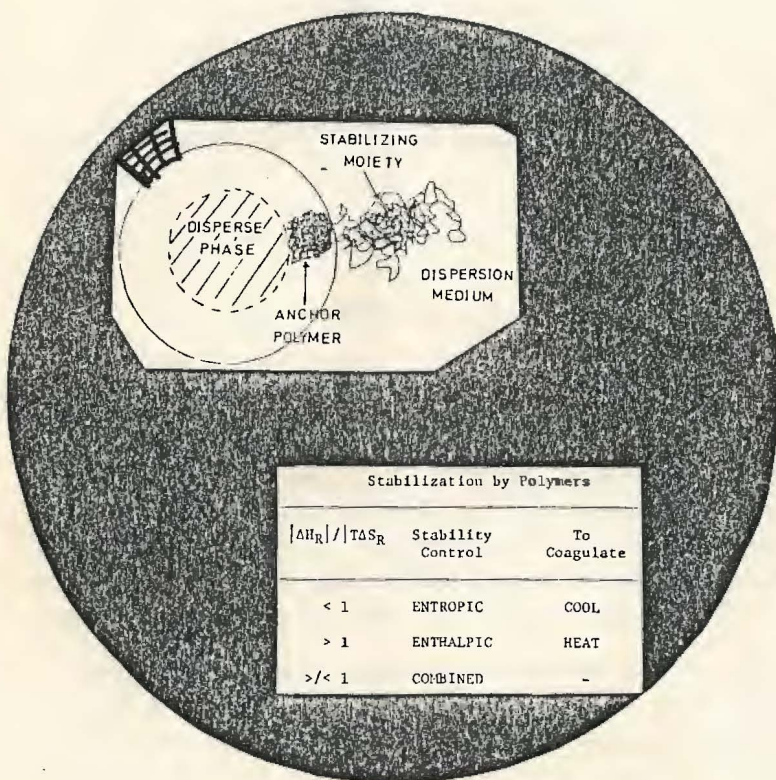EIGHTH

AUSTRALIAN COLLOID AND SURFACE CHEMISTRY
STUDENT CONFERENCE

UNIVERSITY OF SYDNEY

1978

PROCEEDINGS AND ABSTRACTS

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OF THE EIGHTH

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CONTENTS

ACKNOWLEDGEMENTS

PREFACE

Colloid and surface science is concerned with processes and systems in which the surface of the material exerts a controlling influence on the properties of the system. *Aerosols* - small droplets of liquid dispersed in air, *clays* - small solid particles dispersed in liquids, *emulsions* - small droplets of one liquid dispersed in another, *blood* - small biocolloid platelets dispersed in a fluid, *photographic film* - small silver halide particles dispersed in a gel matrix; these examples illustrate the wide range of material, biological and technological processes of concern to the colloid chemist.

Because of the diversity of disciplines involved in colloid and surface science, education and research training in the subject expose the student to theoretical and experimental skills, not only in chemistry but also in physics, biology and engineering. In order to foster these interdisciplinary aspects of colloid science, the Australian Colloid and Surface Chemistry Student Conference was begun in 1969; the present volume outlines the programme and contents of the eighth such conference.

The Conference is designed to allow students and their supervisors from Australian universities and colleges to exchange research ideas, to give students an opportunity to present technical papers on their research work to a critical audience, to learn new experimental and theoretical skills, and to meet and learn from visiting industrial and government scientists.

The eighth Student Conference was hosted by the Department of Physical Chemistry, University of Sydney, from November 11-14, 1978. Students and staff participating came from the Australian National University, the University of Sydney, the University of Melbourne, the University of New South Wales, the Royal Melbourne Institute of Technology, the South Australian Institute of Technology, and Bendigo College of Advanced Education. Some 25 student papers and two invited papers by research fellows were presented.

These Conferences began in the late sixties as very informal gatherings (usually over a weekend) of the research students of Dr Healy (Melbourne) and Dr Hunter (Sydney) respectively. Only student papers were permitted but

in successive meetings, the number of observers from other universities, the CSIRO and industry gradually increased and the organisation became a little more formal.

The format usually consists of a one-day meetings with fairly wide attendance, followed by a more secluded, residential arrangement for the weekend, during which the Conference Programme continues in an informal atmosphere with plenty of opportunity for small group discussions and social intercourse.

The 3rd Conference was in February 1972 in Sydney, just before the 3rd Australian Electrochemistry Conference in Terrigal; most students also attended the latter meeting and some presented papers. The 4th meeting was in Melbourne in May 1973, at the time of a one-day meeting of the Electrochemistry Division of the Royal Australian Chemical Institute, and was continued over the weekend at the University's field station at Blackwood near Ballarat, Victoria. The 5th meeting was held in Sydney in November 1974 at the University, and then over the weekend at the University's field station, Warrah House, Woy Woy, on the central coast. The 6th meeting was held at the Department of Applied Mathematics, Research School of Physical Sciences, Australian National University, Canberra in May 1976. The 7th meeting was held at the University of Melbourne and the Blackwood residential centre in September 1977.

These last five meetings have involved a significant number of observers (especially in the preliminary session) and have also involved participation by some additional, very active research groups, in particular the Applied Mathematicians from ANU, Dr Napper's polymer colloids group (Sydney), some from Flinders University (Professor Bockris), and from the University of Western Australia (formerly Professor Quirk), as well as from the Royal Melbourne Institute of Technology, Swinburne College of Technology (Melbourne), CSIRO, Bendigo CAE, and from Dr Barnes' group at the University of Queensland.

Special note

Information on the Australian Colloid and Surface Chemistry
Student Conference may be obtained from :-

        Associate Professor R J Hunter
        Department of Physical Chemistry
        University of Sydney
        SYDNEY
        N S W   2006

or

        Professor T W Healy
        Department of Physical Chemistry
        University of Melbourne
        PARKVILLE
        Victoria   3052

4.

From the University of Melbourne, Department of Physical Chemistry

Dr T W Healy, Professor of Physical Chemistry

Dr D N Furlong, Research Fellow

Luis Kolarik, PhD Candidate

Ian Harding, MSc Candidate

Ron Hurst, MSc Candidate

Brendan Lovelock, MSc Candidate

John Lyons, MSc Candidate

Fedir Woskoboenko, BSc (Honours) Candidate

Pam Freeman, Technical Assistant

From The Australian National University, Department of Applied Mathematics

Dr B W Ninham, Professor of Applied Mathematics

Dr D Chan, Research Fellow

Dr R G Horn, Research Fellow

Dr J Israelachvili, Research Fellow

Dr D J Marcelja, Research Fellow

Dr D J Mitchell, Research Fellow

Dr B A Pailthorpe, Research Fellow

Dr R M Pashley, Research Fellow

Dr L R White, Research Fellow

Jos Beunen, PhD Candidate

Steven Carnie, PhD Candidate

Barry Hughes, PhD Candidate

Michael Sculley, PhD Candidate

Joe Wolfe, PhD Candidate

From the University of Sydney, Department of Physical Chemistry

Dr R J Hunter, Associate Professor of Physical Chemistry

Dr D H Napper, Associate Professor of Physical Chemistry

Col Bensley, PhD Candidate

Robert Feigin, PhD Candidate

Brian Hawkett, PhD Candidate

Max Keniry, PhD Candidate

Gottfried Lichti, PhD Candidate

John Frayne, Research Assistant

Hashim Durrani, Professional Officer

From the University of Sydney, Department of Theoretical Chemistry

>Dr R G Gilbert, Senior Lecturer in Theoretical Chemistry
>Dr K S J Nordholm, Lecturer in Theoretical Chemistry
>Mark Johnson, BSc (Honours) Candidate
>Steve Lansdowne, BSc (Honours) Candidate

From the University of Sydney, Department of Pharmacy

>Dr K Brown, Lecturer in Pharmacy

From the University of Bristol, Department of Physical Chemistry

>Dr R H Ottewill, Professor of Colloid Science

From the University of Newcastle, Department of Chemical Engineering

>Dr G J Jameson, Professor of Chemical Engineering
>Peter Cooper, ME Candidate

From the University of New South Wales, Department of Microbiology

>Steve Lupton, MSc Candidate

From the University of New South Wales, Department of Mechanics

>Dr R W O'Brien, Lecturer in Mechanics

From the Royal Melbourne Institute of Technology, Department of Applied Physics

>Dr I Snook, Lecturer
>Kevin Gaylor, MAppSc Candidate
>Tony Hughes, MAppSc Candidate

From the South Australian Institute of Technology

>Keith Quast, MSc Candidate

From Bendigo College of Advanced Education

>John McClelland, MSc Candidate

From BHP Co. Ltd, Central Research Laboratories

>Dr J Day

6.

From Tioxide (Australia) Pty Ltd

     David Rundle

From CSIRO Division of Textile Physics

     Dr R O James

From CSIRO Division of Food Research

     Mr J Algie
     Dr L Fisher
     Dr N Parker

AUSTRALIAN COLLOID AND SURFACE CHEMISTRY

STUDENT CONFERENCE - 1978

PROGRAMME

Saturday, November 11 - School of Chemistry, University of Sydney

2.30-3.00 PM	Assembly and Registration
3.00	By bus to Yarrawood Conference Centre
7.00	Evening barbecue

Sunday, November 12 - Yarrawood

9.00 AM	Opening Remarks - Professor R J Hunter (Sydney)	
9.15	Photon Correlation Studies of Polystyrene Latex Colloids	Ron Hurst (Melbourne)
9.45	Photon Correlation - A method of colloidal analysis	Tony Hughes (RMIT)
10.15	*Adsorption of Cd(II) at the Latex-Water Interface	Ian Harding (Melbourne)
10.45	Morning tea	
11.15	Oil Agglomeration of flue dusts in the Lead-Zinc Industry	Peter Cooper (Newcastle)
11.45	*Flow Behaviour of Coagulated Sols	John Frayne (Sydney)
12.15 PM	*Adsorption of Transition Metal Cations on Hydrous Metal Oxides	John McLelland (Bendigo)
12.45	Lunch	
2.00	*Low Temperature Adsorption Micro-calorimetry	Neil Furlong (Melbourne)
2.30	*Colloid Science in Biology - an overview	Joe Wolfe (ANU)
3.00	*Surfactant-Microbe Interactions in Microbial Oil Degradation	Steve Lupton (NSW)
3.30	Afternoon tea	
4.00	*The Effect of Free, Non-interacting Polymer on Colloidal Stability	Robert Feigin (Sydney)
4.30	*Anomalous Forces in Colloid Science - fact or artifact?	Barry Hughes (ANU)
5.00	*Coagulation of Concentrated Sols	Col Bensley (Sydney)

8.

Monday, November 13 - Yarrawood

9.15 AM	*The Effect of Monovalent and Divalent Cations on Lipid Membrane Interactions	Michael Sculley (ANU)
9.45	*Changes in the Internal Fluidity of Lipid Bilayers caused by the Introduction of Proteins, as measured by Nuclear Magnetic Relaxation Times	Max Keniry (Sydney)
10.15	*Trans-Bilayer Distributions in Mixed Lipid Vesicles	Steven Carnie (ANU)
10.45	Morning tea	
11.15	The Generalised Van der Waals Equation and its Application to Interfaces and Adsorption	Mark Johnson (Sydney)
11.45	Dynamic Simulation of Colloidal Systems	Kevin Gaylor (RMIT)
12.15 PM	*Osmotic Pressure in Dense Colloidal Systems	Jos Beunen (ANU)
12.45	Lunch	
2.00	Zeta-Potentials at the Mica-Electrolyte Interface	John Lyons (Melbourne)
2.30	*Studies on the Surface Chemistry of Hematite	Keith Quast (SAIT)
3.00	Colloidal Magnetic Iron Oxide	Luis Kolarik (Melbourne)
3.30	Afternoon tea	
4.00	*Evidence for Exit in the Seeded Emulsion Polymerisation of Styrene	Brian Hawkett (Sydney)
4.30	*Rate Decay in Emulsion Polymerisation	Steve Lansdowne (Sydney)
5.00	The Growth of Polymer Colloids	Gottfried Lichti (Sydney)
7.00	CONFERENCE DINNER - Guest Speaker : Prof. R H Ottewill (Bristol)	

Tuesday, November 14 - Yarrawood

9.15 AM	Wettability of Hydrophobic Glass induced by Non-ionic Surfactants	Fedir Woskoboenko (Melbourne)
9.45	*Surface Forces in Adsorbed Multi-layers of Water on Quartz	Richard Pashley (ANU)
10.15	The Synthetic Fibre-Water Interface	Brendan Lovelock (Melbourne)
10.45	Closing Remarks - Professor T W Healy (Melbourne)	

SELECTED ABSTRACTS

In order to give a general view of the content of the Conference, abstracts of papers indicated with an asterisk on the Programme, pages 7 and 8, are reproduced below.

Adsorption of Cd(II) at the Latex-Water Interface

Ian Harding (Melbourne)

The adsorption of hydrolysable metal ions on hydrous metal oxides is fairly well characterized in the literature as involving the following:-

1. Narrow pH range of uptake from 0 to 100%.
2. Modified electrokinetic behaviour exhibiting three distinct charge reversals under suitable conditions.
3. Very dependent on the chemistry of the adsorbing metal ion, especially its first hydrolysis product.
4. Not dependent, apart from surface area effects, on the nature of the solid oxide.
5. Able to predict behaviour of any system, given the appropriate equilibrium constants.
6. Maximum of one monolayer coverage.

    a polystyrene amphoteric latex has shown that cadmium adsorption (i) did exhibit a narrow pH range of uptake; (ii) did not appear to show charge reversals, although this may have been obscured due to heterocoagulation; (iii) was dependent on the nature of the solid, particularly its iep; (v) was not able to predict behaviour from equilibrium constants, perhaps due to oozing of the latex; (vi) more than one monolayer coverage, again possibly due to oozing of the latex;

A recent study, by comparison, on a polystyrene amphoteric latex has shown that cadmium adsorption:-

1. Did exhbibit a narrow pH range of uptake.
2. Did not appear to show charge reversals, although this may have been obscured due to heterocoagulation.
3. Yet to be done.
4. Was dependent on the nature of the solid, particularly its iep.
5. Was not able to predict behaviour from equilibrium constants, perhaps due to oozing of the latex.
6. More than one monolayer coverage, again possibly due to oozing of the latex.

Flow Behaviour of Coagulated Sols ·
John Frayne (Sydney)

A model has previously been described which relates the flow parameters
of coagulated sols (the plastic viscosity, η_{pl}, the critical rate, D_o,
and the Bingham yield value, τ_B) to their colloidal properties (particle
size, r, particle volume fraction, ϕ_p, and interaction energy). Experi-
mental results are presented to test a number of the relationships between
flow parameters and colloidal properties at different medium viscosities.
The results show very good agreement with theoretical predictions for up
to a four-fold increase in medium viscosity.

The model predicts that for shear rates above D_o, the average floc size
is a function of the applied shear rate, D. A Coulter Counter Model ZB
was used to measure the size of these flocs as a function of the applied
shear rate and the results show that the floc radius, $a \propto D^{-.43 \pm .03}$.
The theoretical prediction was $a \propto D^{-.41}$.

Adsorption of Transition Metal Cations on Hydrous Metal Oxides
John McLelland (Bendigo)

Preliminary studies of cation/oxide adsorption systems have demonstrated
the difficulties involved in designing an experimental technique in which
the results produced can be related to the equilibrium reactions involved.
There would appear to be at least two equilibria occurring simultaneously:
the cation-surface reaction and the surface-PDI reaction. Because the
cation-surface reaction releases hydrogen ions, and hydrogen ions
together with hydroxyl ions are the potential-determining ions, these
reactions are interdependent. A further complication arises from the
fact that the oxide-PDI reaction appears to be slow coming to equilibrium
compared with the cation-surface reaction.

As a result of these difficulties, it is now proposed to study cation/
oxide adsorption using a number of different experimental approaches.

Low Temperature Adsorption Microcalorimetry
Neil Furlong (Melbourne)

Measurement of the energy of adsorption of nitrogen and argon on oxide
surfaces provides a means of determining the nature of mixed oxide
surfaces, as well as understanding gas-solid interactions.

A recently developed adsorption technique based on continuous slow addition of gas to a sample housed in a Tian-Calvet calorimeter was used to concurrently obtain adsorption isotherms and differential energies of adsorption on rutile and silica-coated rutile surfaces.

Outgassing of rutile surfaces between 150 and 250°C results in removal of ligand water and exposure of Ti cations. Subsequent adsorption of nitrogen shows strong interactions with exposed cation sites. Such sites represent approximately 40% of rutile surfaces. Silica surfaces do not contain exposed cations when outgassed at high temperature but "dehydrate" to form bridged siloxane bonds. Subsequent adsorption of nitrogen and argon shows these surfaces to interact much less strongly than similarly heat-treated rutile surfaces. Rutile coated with a uniform 5 mm thick coating of silica gave isotherms and adsorption energies consistent with a silica surface. Rutile coated with approximately half a monolayer of silica also gave silica-like behaviour. This is interpreted in terms of preferential adsorption of aqueous silica species from solution onto cation sites on rutile surfaces.

Colloid Science in Biology - An Overview
Joe Wolfe (ANU)

Recent studies, both experimental and theoretical, have indicated the importance in membrane biology and physical biochemistry of concepts from colloid science such as clathrate "cages", electric double layers, phase separations, amphiphile surfactant action, and vicinal water-ordering. These are reviewed[*], particularly in regard to the author's work on the temperature dependence of reaction rates, growth rates and survival of plants. As a specific example, it is demonstrated how membrane lipid lateral phase separations affect transmembrane electrolyte ions, a key symptom in cold-temperature damage.

*A more complex review is given in 'Chilling Injury in Plants - The Role of Membrane Lipid Fluidity' by the author. In Plant, Cell and Environment, 1978, in press.

Surfactant-Microbe Interactions in Microbial Oil Degradation
Steve Lupton (NSW)

A cationic and an anionic surfactant inhibited the growth of two bacteria on hydrocarbon substrates. Non-ionic surfactants increase the rate of selective hydrocarbon utilization by Acinetobacter SL1 but do not affect the relative utilization of small chain aliphatic hydrocarbons compared to

the heavy aliphatic chains. It is proposed that this increase in hydro-
carbon degradation is a result of an increase in the interfacial surface
area between the hydrocarbon and aqueous phases, due to emulsification
of the oil by the surfactant.

This effect may be dependent on the surfactant HLB value. These results
were discussed in relation to the selection of suitable detergents to
increase the effective biodegradation of pollutant oil in aquatic
habitats.

The Effect of Free, Non-Interacting Polymer on Colloidal Stability
Robert Feigin (Sydney)

Sterically stabilized latices have been shown to be flocculated by the
addition of free polymer to the dispersion medium. However, at much
higher free polymer concentrations, flocculation is often no longer
observed.

Monte Carlo simulations (using RIST) of free polymers between two naked
and energetically neutral walls, separated by a distance d, show that the
polymer concentration is low near to the walls. It only reaches its
bulk solution value if d exceeds *ca* twice the width (w) of a polymer
molecule. In that case, as the walls approach, solution of bulk polymer
concentration is moved from between the walls to the bulk. No
significant change in free energy (ΔG) results. For w<d<2w, however,
closer approach reduces the polymer concentration between the walls. In
a good solvent, this raises the free energy because the polymer
concentration becomes less evenly distributed. For d<w, little polymer
remains between the plates. The excluded liquid, predominantly dispersion
medium, has a negative free energy of mixing with the bulk solution. The
potential energy diagram of naked, uncharged colloidal particles in free
polymer may thus exhibit both a maximum and a minimum: at low v_2, $|\Delta G^{min}|$
may be insufficient to cause flocculation, whereas at high v_2, $|\Delta G^{max}|$
may be sufficient to prevent flocculation. Flocculation may occur in the
intermediate domain, as observed experimentally. No electrostatic or
steric barriers are necessary for these effects.

Anomalous Forces in Colloid Science: Fact or Artifact?
Barry Hughes (ANU)

Recent experiments of Hough and Ottewill and Israelachvili and Adams show,
by a direct measurement of the distance-dependent interaction between
half spaces separated by aqueous electrolyte, that existing theories of
the electrical double layer and van der Waals forces are broadly correct.
However, Hough and Ottewill find lower values for the inverse Debye length,
κ, and surface potential than are predicted by theory, while Israelachvili
and Adams report an anomalous short-range repulsive force with concentration-
independent decay length of approximately 1 nm.

A new model of elastic contact developed with Dr L R White (ANU) removes a
fundamental paradox arising in the use by Hough and Ottewill of Hertz's
theory of contact to relate applied load to pressure at the centre of the
experimental surfaces. Using this model, it is shown that the agreement
of the results of Hough and Ottewill with theory is much better than they
initially reported. The model also shows that the anomalous force of
Israelachvili and Adams, while substantially magnified by the effect of
elastic deformation, is not an artifact of the elastic deformation of the
experimental apparatus.

General principles of experimental design are outlined; it may be
confidently established for individual experiments whether or not elastic
deformation of the apparatus may be neglected or accounted for in terms of
Hertz's theory of contact.

References
Hough, D B and Ottewill, R H, 1976. *Colloid & Interface Sci.* Vol. IV,
(ed. M Kerker), pp. 47-57. Academic Press, New York.

Israelachvili, J N and Adams, G E, 1978. *J. Chem. Soc. Faraday Trans. I*
74, 975-1001.

Coagulation of Concentrated Sols
Col Bensley (Sydney)

A brief summary of previous work in this field was presented. Some of this
earlier work is of dubious value, as critical variables in these experiments
were not controlled. A new experimental technique has been developed to
measure the effect, if. any, of colloidal volume fraction on the electrolyte

coagulation of sols. Basically, the method is to place dispersions of the same colloid, but at different volume fractions, in dialysis bags and equilibrate the dispersions against the same external solution. In this way, the dispersions should all attain the same surface potential. Also, electrolyte can be added to the external solution and thus diffuse into the dispersion without dangerous concentration gradients occurring. The stability of the dispersions was determined by rheological methods and by using a capillary suction timer. The results from both methods were similar, though problems arose in the rheological measurements due to shear coagulation. The greatest problem, however, is the length of time required for the diffusion of electrolyte through the bags and into the dispersions to reach completion. This time lag, which can be up to five days, smooths out any differences in the behaviour of the dispersions and so no meaningful interpretation of the results can be made. New techniques are now being attempted to eliminate this difficulty.

The Effect of Monovalent and Divalent Cations on Lipid Membrane Interactions
Michael Sculley (ANU)

A numerical technique is applied to the investigation of salt effects on the electrostatic repulsion between lipid membranes with chargeable anionic groups.

It is found that when such groups dissociate easily, the effects of mono- and divalent cations are antagonistic under low salt conditions. However, when the surface anionic groups have pK values closer to the bulk pH value, the effects are much more subtle.

The results of the analysis are applied to explain experimental observations on chloroplast grana thylakoid membranes, but they may find more general use.

Changes in the Internal Fluidity of Lipid Bilayers caused by the Introduction of Proteins as measured by Nuclear Magnetic Relaxation Times
Max Keniry (Sydney)

Biological membranes consist not only of lipids but also of proteins, which may sit on the surface (eg, cytochrome c), partially penetrate (eg, the basic protein of myelin), or span the bilayer (eg, the proteolipid protein of myelin). Nuclear magnetic relaxation times are sensitive to the mobility of nuclei along the lipid chain and such changes in these relaxation times can be used to probe the position of a protein in the bilayer. No significant change in the relaxation times of any of the groups along the

lipid chain are observed when cytochrome c binds to the bilayer in accordance with the known position of cytochrome c on the surface of the bilayer. On interaction of the basic protein of myelin with the bilayer, a decrease in the relaxation times for those nuclei near the centre of the bilayer is observed but no change in the relaxation times of those nuclei further up the chain is observed. This same effect is observed when cholesterol is intercalated into bilayers where the rigid steroid rings restrict the motion of groups near the polar head group but those groups near the centre of the bilayer are much less restricted. From these studies and the scanty theoretical work published so far, it appears that the relaxation times of those nuclei undergoing multiple restricted internal motions near the immobile end of a long chain are insensitive to small changes in the mobility of the nuclei but as one proceeds further from the immobile end, the relaxation times become sensitive enough to mobility changes for these effects to be seen when a protein penetrates the bilayer.

Transbilayer Distributions of Mixed Lipid Vesicles

Steven Carnie (ANU)

Using the theory of Israelachvili, Mitchell and Ninham[1] of self-assembly of lipid micelles and vesicles, we calculate the radii and transbilayer distributions of mixed PC[*]-cholesterol and PC-lysoPC vesicles of varying composition. The results compare well with available experimental data, except for the transbilayer distributions of cis-unsaturated PC-cholesterol vesicles of concentrations of cholesterol above 30%. It is concluded that interactions more specific than the geometric packing constraints in the theory need not be invoked for saturated and trans-unsaturated PC mixed with LPC or cholesterol.

[1] Israelachvili, J N, Mitchell, D J and Ninham, B W. *J. Chem. Soc. Faraday Trans. II*, 72, 1525-68 (1976); *Biochim. Biophys. Acta* 470, 185-201 (1977).
[*] PC - phosphatidylcholine

Osmotic Pressure in Dense Colloidal Systems

Jos Beunen (ANU)

It is well known that latices undergo an order-disorder transition as the volume fraction is varied. At high concentrations the stable phase is ordered with latex particles occupying the sites of a body-centred or face-centred cubic lattice.

The calculation of the properties of latices is complicated by the many-body interactions which occur for reasonable particle densities. Summing repulsive interactions between pairs of particles does not provide an adequate approximation to the osmotic pressure, for example. For the ordered phase, the net result of these many-body effects is to confine each latex particle to a Wigner-Seitz cell which is electrically neutral.

The properties of the ordered phase are amenable to calculation if the particles are assumed fixed at the centres of their cells and the suspension is in chemical contact with a reservoir of fixed composition. If account is taken of charge neutrality in the reservoir and dissociation equilibrium for water, the only composition variables are pH and the concentration of inert cations. The potential in the cell can be obtained by solving the Poisson-Boltzmann equation with a Debye length characteristic of the reservoir. The normal derivative of the potential is zero at the boundary of the Wigner-Seitz cell and a condition of dissociation equilibrium is satisfied at the surface of the latex particle.

As the Wigner-Seitz cell is a polyhedron, the boundary value problem is quite complicated. It is simplified by approximating the cell by a sphere and assuming the problem is spherically symmetric. Using these approximations, the behaviour of the latex has been obtained as a function of volume fraction for a variety of reservoir compositions and latex sphere parameters.

Studies on the Surface Chemistry of Hematite
Keith Quast (SAIT)

The changes in surface characteristics of samples of ferric oxide were determined using microelectrophoresis. The samples examined were naturally occurring (massive and specular forms) and a high-purity synthetic sample. The results obtained indicated that the type, composition and source of the hematite modify the observed surface characteristics. Various physical and chemical pretreatments on a sample of natural hematite showed how the surface behaviour can be modified. The effect of small amounts of silica, inherent in the natural sample, was very pronounced and caused the samples to exhibit electrokinetic behaviour usually associated with silica. Pretreatment of the natural samples with hydrochloric acid depressed the effect of silica; however, the actual mechanism involved is still obscure.

An alternative method of determination of surface characteristics - pH drift method - was also used and showed good correlation with the electrokinetic studies. This alternative method also presented evidence to show that chloride ions may be specifically adsorbed on the hematite surface.

Evidence for Exit in the Seeded Emulsion Polymerisation of Styrene
Brian Hawkett (Sydney)

The results of an extensive experimental study into the rate of emulsion polymerisation of styrene in seeded systems are reported. Rates were determined dilatometrically, using carefully characterised seed latices and rigorous procedures to ensure reproducibility and the absence of new nucleation. The data

(i) prove the existence of steady states with the average number of free radicals per particle, $\bar{n}$, less than 0.5, and hence the existence of a first order radical loss process (ie, exit);

(ii) enable the rate of attaining of a steady state to be observed;

(iii) reveal the existence of a hitherto unsuspected thermal polymerisation process, occurring with a much greater rate than in bulk systems;

(iv) give reliable values for the rate coefficients for the appearance of radicals within particles ("entry") over a wide range of initiation concentrations and particle sizes.

The values obtained for the rate coefficients for the first order loss process are shown to be consistent with a mechanism involving transfer of radical activity from a growing polymer chain to a monomer unit followed by exit from the particle.

Rate Decay in Emulsion Polymerisation
Steve Lansdowne (Sydney)

γ-radiation is a convenient initiator of primary free radicals in emulsion polymerisation systems and has the advantage of being easily "switched off". The decay in polymerisation rate upon removal of the radiation source can then give valuable kinetic information about the loss of free radical activity from the polymerising locii.

This technique was examined both theoretically and experimentally. For styrene, the results so obtained were in good agreement with previous work using chemical initiation and with theoretical predictions based on the Smith-Ewart model.

Surface Forces in Adsorbed Multilayers of Water on Quartz
Richard Pashley (ANU)

The adsorption of water vapour on smooth crystalline quartz at pressures close to saturation was determined by ellipsometry. The results obtained showed that clear quartz is perfectly hydrophilic, ie, that at saturated vapour pressure a thick, stable water film (approximately 150 nm) is formed on an initially dry plate.

When quartz was contaminated by hydrophobic materials, only thin water films (about 5 nm) were formed at saturated vapour pressure. This latter result is in agreement with results previously reported in the literature for supposedly clean quartz.

Clean, heat-dehydroxylated quartz also formed a thin water film (about 7 nm) at saturation. The hydrophobic nature of this surface is apparently due to the loss of short-range interaction (through hydrogen bonds) with adjacent water layers.