

SIXTH

AUSTRALIAN

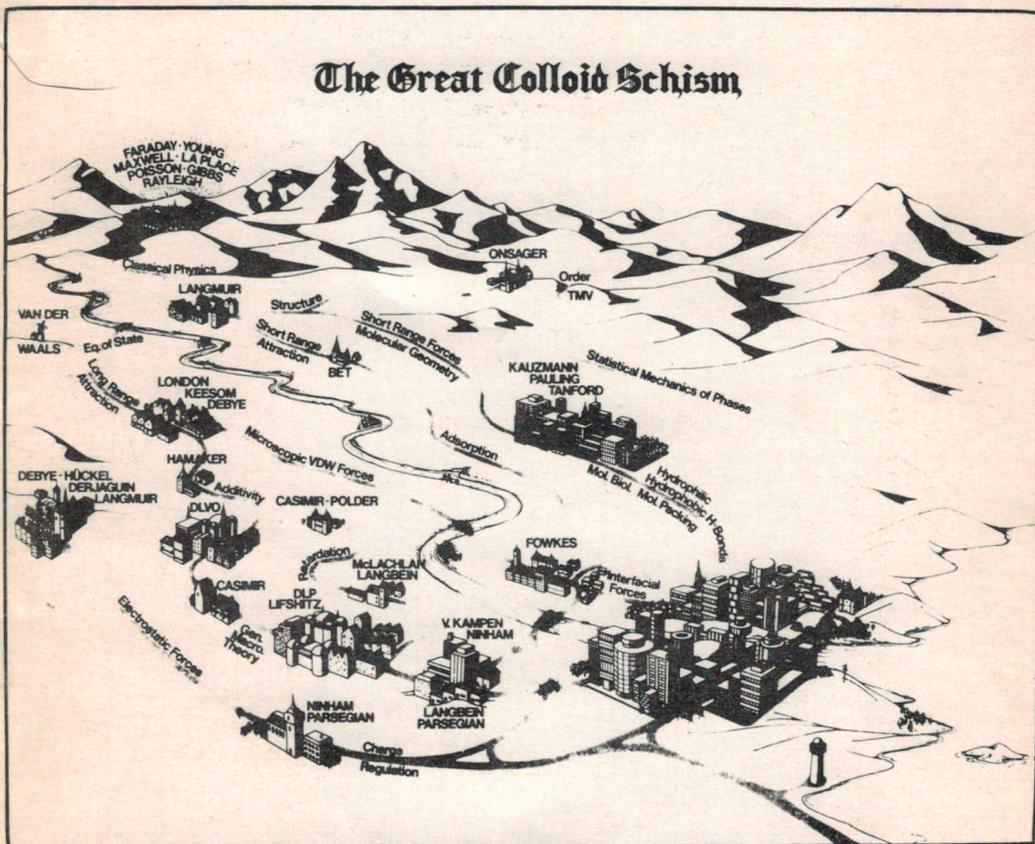
COLLOID AND SURFACE CHEMISTRY

STUDENT CONFERENCE

AUSTRALIAN NATIONAL UNIVERSITY

1976

The Great Colloid Schism



Proceedings and Abstracts

COVER PHOTO

A schematic representation of the history
of the development of theoretical colloid
science.

From: "Intermolecular Forces - the Long
and Short of It", J.N. Israelachvili
and B.W. Ninham, *J. Colloid and
Interface Science*, 58 (1) 14, 1977.

PROCEEDINGS AND ABSTRACTS

OF THE SIXTH

AUSTRALIAN COLLOID AND SURFACE CHEMISTRY

STUDENT CONFERENCE

AUSTRALIAN NATIONAL UNIVERSITY, 1976

<u>Contents</u>	<u>Page</u>
Preface and Short History of the Conference	1
Participants 1976	5
Conference Programme	7
Abstracts	11

Acknowledgements

Student and Staff participants contributed in part to the running of the Conference. However, the major financial support came from generous donations by the Universities of Sydney and Melbourne, ANU, CSIRO, Catoleum Pty Ltd, Unilever, CSR, Hardman Chemicals, Laporte Aust., Geopeko Aust., and BHP.

All concerned with the meeting thank these sponsors for making this and other Australian Colloid and Surface Chemistry Student Conferences possible. The participants also wish to thank Joe Wolfe, the 1976 Conference secretary, and Norma Chin, Secretary, Department of Applied Mathematics, ANU for their tireless efforts to ensure a successful conference. Special thanks are due to Professor and Mrs I.G. Ross, who hosted the Conference Dinner at their home; it was a memorable occasion.

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 exposes 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 and the present volume outlines the programme and contents of the sixth 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 sixth student conference was hosted by the Department of Applied Mathematics, Research School of Physical Sciences, Australian National University from May 21-23, 1976. Students and staff participating came from the Universities of Queensland, Sydney and Melbourne, and the Australian National University. Some 17 student papers and three invited papers by research fellows were presented, as well as a lecture and demonstration by Dr Israelachvili (ANU) of the new force-distance measurement apparatus.

These conferences began in the late sixties as very informal gatherings (usually over a weekend) of the research students of Drs Healy (Melbourne) and 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 meeting 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 discussion 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 RACI, and was continued over the weekend at the University's field station at Blackwood near Ballarat, Victoria. The 5th meeting was held at 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.

These last three 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 D. 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 RMIT and Swinbourne State College in Melbourne. This year for the first time we welcome someone from Dr G. Barnes' group in the University of Queensland.

Roger Hackett, PhD Candidate

Information on the Australian and Overseas Candidates

Student Candidates may be obtained from the Australian and Overseas Candidates

Paul Neville, MSc Candidate

Associate Professor R. J. Hunter, MSc Candidate

Department of Physical Chemistry, University of Sydney

from the University of Queensland, Australia, to attend the meeting

Marylyn McGregor, PhD Candidate

N E W 2000

Australia

Margaret Quinn, MSc Candidate

10

from the University of Melbourne, Department of Physical Chemistry

Dr F. N. Hayes, Reader in Physical Chemistry, University of Melbourne

Dr A. Hockley, Research Fellow, University of Melbourne

Dr L. R. White, Research Fellow, University of Melbourne

Frank Griener, PhD Candidate

John Lyons, MSc Honours Candidate

Michael Moynard, MSc Candidate

John Reiston, PhD Candidate

Pauline Striglick, PhD Candidate

Special Note

Information on the Australian Colloid and Surface Chemistry
Student Conferences may be obtained from

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

or

Dr T.W. Healy, for small group discussion and social
intercourse.
Reader in Physical Chemistry,
University of Melbourne,
PARKVILLE,
Victoria, 3052
Australia.

PARTICIPANTS - 1976

From the University of Sydney, Department of Physical Chemistry -

Dr R. J. Hunter, Associate Professor of Physical Chemistry

Dr R.G. Gilbert, Lecturer in Theoretical Chemistry

Dr Teo G.M. van de Ven, Tutor-Research Fellow

Jean V. Leyendekkers, Research Fellow

Robert Feigen, PhD Candidate

Brian Hawkett, PhD Candidate

G. Lichti, BSc Honours Candidate

Greg March, MSc Candidate

Paul Neville, MSc Candidate

Jim Smitham, PhD Candidate

From the University of Queensland, Department of Physical Chemistry -

Marylyn McGregor, PhD Candidate

Maureen Quinn, MSc Candidate

From the University of Melbourne, Department of Physical Chemistry -

Dr T. W. Healy, Reader in Physical Chemistry

Dr A. Homola, Research Fellow

Dr L. R. White, Research Fellow

Frank Grieser, PhD Candidate

John Lyons, BSc Honours Candidate

Michael Moignard, MSc Candidate

John Ralston, PhD Candidate

Pauline Stiglich, PhD Candidate

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

Dr W. van Megan, Lecturer

Ron Hurst, BSc (Applied Science) Candidate

From the Australian National University, Research School of Physical Sciences -

Dr R. Street, Professor and Director

From the Australian National University, Research School of Physical Sciences,

Department of Applied Mathematics -

Dr B.W. Ninham, Professor and Chairman

Dr Janek Duniec, Research Fellow

Dr J. Israelachvili, Research Fellow

Dr S. Marcelja, Research Fellow

Dr J. Mitchell, Research Fellow

Peter Forsyth, MSc Candidate

Michael Sculley, MSc Candidate

Joe Wolfe, MSc Candidate

From BHP, Shortland -

Mr Col Bensley

From CSIRO Division of Mineral Chemistry -

Dr Len Warren (Melbourne)

AUSTRALIAN COLLOID AND SURFACE CHEMISTRY

STUDENT CONFERENCE 1976

PROGRAMME

Friday, May 21st - Department of Applied Mathematics, Australian National Univ.

9.00 am	Official Opening	Professor R. Street (ANU)
9.15 am	"Electro-Kinetics of Mineral Sulphides"	Michael Moignard (Melbourne)
10.00 am	"Metal-Ion Exchange at the Sulfide-Water Interface"	John Ralston (Melbourne)
	10.45 am	Morning tea/coffee
11.15 am	"Steric Stabilization in Systems involving More than One Stabilizer"	Robert Feigin (Sydney)
12.00 noon	"Steric Stabilization of Emulsions and of Non-Aqueous Systems"	Greg March (Sydney)
	12.45 pm	Lunch
2.00 pm	"Measurements of the Thickness of Adsorbed Polymer Layers"	Jim Smitham (Sydney)
2.45 pm	"Adsorption at the Drops in Mercury Electrodes"	C. Bensley (Sydney)
	3.15 pm	Afternoon tea/coffee
3.30 pm	"A Structural Model for Water"	Michael Sculley (ANU)
4.15 pm	"Photon Correlation Spectroscopy and its Application to Colloids"	Ron Hurst (RMIT)

Evening - Conference Dinner
(at Ross's Farm, Queanbeyan)

Saturday, May 22nd - Australian National University

9.00 am	"Kinetics of Emulsion Polymerization"	Brian Hawkett (Sydney)
9.45 am	"The Growth of Polymer Colloids"	G. Lichti (Sydney)

10.30 am	"The Equilibrium Penetration of Monolayers by Surfactants"	Marylyn McGregor (Queensland)
	11.15 am	Morning tea/coffee
11.30 am	"Monodisperse Chromium Hydroxide Sols"	John Lyons (Melbourne)
12.15 pm	"Cadmium Adsorption at Oxide Interfaces"	Pauline Stiglich (Melbourne)
	1.00 pm	Lunch
2.00 pm		
2.45 pm	"Rheology of Colloidal Dispersions"	Dr T.G.M. van de Ven (Sydney)
	3.15 pm	Afternoon tea/coffee
3.30 pm	"Measurement of Long-Range Forces between Two Mica Surfaces in Aqueous Electrolytes" (including a demonstration of the equipment)	Dr J. Israelachvili (ANU)
	5.30 pm	Barbecue

Sunday, May 23rd - Australian National University

9.00 am	"The Slime Coating Problem"	Paul Neville (Sydney)
9.45 am	"The Physical Properties of Lipid Bilayers"	Joe Wolfe (ANU)
10.30 am	"Phase Separation in Biological Membranes"	Peter Forsyth (ANU)
	11.15 am	Morning tea/coffee
11.30 am	"Monolayer Adsorption on Spatially Dispersive Substrates"	Dr Jacek Duniec (ANU)
12.15 pm	"Theoretical Colloid Chemistry - the Latest News"	Dr Lee White (Melbourne)

OPENING SPEECH BY PROFESSOR R. STREET

One of the most obvious characteristics of our present age is that communities and their political representatives increasingly question the values of science and of scientists. Some may say that at the present time science and scientists are under attack, at least their motives and contributions to society are being questioned closely.

This conference is being held at a time following statements made by Government in which many matters of concern to scientists and to technologists are being raised. For example, we hear that there is to be a stale-mate financial position in the provision of funds for CSIRO and the ARGC. Science does not occupy an important position in Government thinking at the present time. We are told of an external enquiry to look into the philosophy underlying the operation of the CSIRO, on its management and on the efficacy of its programmes and its potentialities for revenue raising. There is to be a 2% increase in funding provided for universities which by any count is very small if we bear in mind that this is a global figure for Australian universities. Much of this increase must surely be devoted to the support of commitments already entered into with the newly developing universities. The number of awards for postgraduate study will be decreased in 1977 from a total of 900 to 800. In addition to this, fees are to be charged for courses leading to second and higher degrees. All these things are of direct concern to science. It is not unreasonable for a community to ask what return it might expect on its investment in any area. In the case of science, the word relevance is consistently recurring. It is held that the cost benefit of science should be considered in any important matters of funding. All these things are entirely valid, but isolated from more fundamental considerations can lead to disaster. At the present time science seems to be living on its seed corn and a significant decrease in investment in disinterested

basic science may lead to serious future difficulties. Rather than relevance at a conference of this kind where the training of future leaders of research and industry is in our minds, I would much sooner that we should do all things to promote in our training programmes a flexibility of mind and adaptability to as yet unperceived problems. There will be challenges in the future and the community will have to rely most heavily on those who have a flexible approach to those challenges. Breadth of thinking, rather than narrow specializations will be the order of the day. As I understand, colloid science as a student training activity does satisfy this requirement of flexibility in its insistence on broad conceptual thinking. Colloid science requires a knowledge and familiarity with a multiplicity of techniques and concepts. Of this, the conceptual framework is the most important as those with this background must surely be able to move easily from one area to another as the need arises. The programme before us includes a wide ranging conceptual framework which is colloid science and in the presentation and discussion of these matters I wish you well.

ABSTRACTS

"Electro-Kinetics of Mineral Sulphides" Michael Moignard, (Melbourne)

The surface properties and reactions of the metal sulphide-aqueous interface have been examined by the use of surface chemical techniques, including adsorption and electrokinetic studies. In particular, the zinc and nickel sulphide-water interfaces have been studied as a function of conditioning pH and conditioning time. The results have been compared with other studies of these interfaces. The results are explained in terms of oxidation and hydrolysis reactions at the interface. In general, at low pH the surface properties of the sulphide are controlled by oxidation reactions of the type:



At higher pH values, hydrolysis of the aqueous ion occurs and precipitation of the metal oxide-hydroxide occurs at the sulphide surface, thereby controlling the surface properties.

Electrokinetic data used in characterizing surface phenomena have also been used in a study of metal ion adsorption at the zinc sulphide-water interface. Calcium and copper were investigated as their solution and redox properties are very different. The results have been analysed in terms of redox and hydrolysis reactions. In particular, calcium adsorption on ZnS has been analysed in terms of current double layer and chemical models of the interface.

"Metal-Ion Exchange at the Sulphide-Water Interface" John Ralston (Melbourne)

A study has been made of the leaching and ion exchange properties of a sample of amosite (an asbestos mineral of the amphibole class) as a function

of pH and temperature. Traces of elements, some derived from impurity minerals, were detected in solution, but the amphibole structure itself proved resistant to attack and there was no detectable exchange of internal cations.

Measurements of the adsorption of cetyltrimethylammonium bromide showed a well-defined plateau, followed by a sharp rise due to "hemi-micelle" formation. Correspondingly, the zeta-potential was reversed and the contact angle passed through a maximum at about 10^{-5} M CTAB (*ie*, at the start of the plateau on the isotherm). The surface chemical properties of leached amosite are, therefore, very similar to those of quartz.

"Steric Stabilization in Systems Involving More Than One Stabilizer"

Robert Feigin (Sydney)

Colloidal dispersions may be stabilized against flocculation by coating the particles with macromolecules. This phenomenon, known as steric stabilization, is important in biological systems and in the manufacture of paints, pharmaceuticals, detergents, *etc*.

Stability results if the polymer layers provide sufficient repulsion to outweigh attraction due to London dispersion forces. According to the theory best in agreement with experiment, this repulsion is primarily due to the free energy change when the polymer layers interpenetrate. If the interaction between polymer and solvent is strong (the solvent is "good"), the increased density of polymer in the region of interpenetration is unfavourable, because mixing of polymer with solvent is preferred to polymer-polymer interactions in a poor solvent attraction, and therefore flocculation results.

This theory has been further developed to deal with systems where particles are stabilized by different polymers. Here it is shown that the interaction of each polymer with the solvent and the interaction of one polymer with the other are important. The theory leads to some interesting predictions.

"Steric Stabilization of Emulsions and of Non-Aqueous Systems"Greg March (Sydney)

Steric stabilization is a genetic term that refers to all the mechanisms by which non-ionic macromolecules can impart stability to colloidal dispersions. Virtually all flocculation studies of sterically stabilized dispersions have utilized polymer latex systems; therefore the first section of the work dealt with the experimental problem of the preparation and flocculation behaviour of sterically stabilized emulsions.

The second section dealt with the problem of preparing latex systems in non-aqueous media and determining the critical flocculation temperature dependence, if any, on the molecular weight of the stabilizing macromolecules.

Napper and Evans have developed a theory of steric stabilization which employs Flory's theory of dilute polymer solutions. Incipient flocculation is accounted for through the correlation of the critical flocculation point of the system with the θ -temperature of the attached polymer chains in free solution.

The results have shown that the stability and flocculation behaviour of emulsions and of non-aqueous polymer latices can be described by the steric stabilization theory of Napper and Evans.

"Measurements of the Thickness of Adsorbed Polymer Layers"Jim Smitham (Sydney)

Any good theory of steric stabilization should be able to predict, among other things, the distance dependence of the repulsion between two sterically stabilized particles in a good solvent for the stabilizing chains. In order to do this, most theories require experimental values for the "thickness" of the adsorbed layer.

To date, most studies on thickness of adsorbed layers have employed unanchored homopolymer or random graft copolymers attached to a substrate.

In this study, well-anchored poly(ethylene oxide) "tails" were adsorbed onto a polystyrene latex. An effective hydrodynamic thickness of the adsorbed layer was obtained using the ultracentrifuge. This is probably the important thickness for hydrodynamic processes such as filtration. However, there is probably still a significant proportion of segments beyond this thickness which contributes to the steric repulsion.

"Adsorption at the Drops in Mercury Electrodes" Col Bensley (BHP, Shortland)

A procedure was described for independently calculating the inherent parameters of the compact or inner layer occurring at the mercury/aqueous solution interface at zero electrode charge. The relevant parameters are the dielectric constant (ϵ') and thickness (d) of this layer which can be related through the inner layer capacitance (K). The procedure involved the calculation of the electrostatic potential at the OHP due to arrays of charge situated in the inner and diffuse layers. This potential was then equated with the Gouy-Chapman potential at the OHP and the resultant expression iteratively solved for d . The expression involved only one term which required estimating, this being the distance of the centres of specifically adsorbed ion from the electrode surface.

Some discussion arose concerning the expression for the potential due to diffuse layer ions, and some future modifications may be required. Initial calculations indicate that this method shows promise, in that reasonable results are obtained for the two parameters.

"A Structural Model for Water"

Michael Sculley (ANU)

A method is given for calculating the electrochemical contribution to the interaction free energy of two charged plates at adsorption equilibrium of

all ions on the plates, from the charges and potentials on an isolated plate.

When the potential at the isolated surface can be identified with the zeta-potential, these quantities can be obtained from electrokinetic data.

The method does not require any knowledge of the Stern layer, because the surface at which measurements are made, and for which the free energy is calculated, is on the solution side of the Stern layer.

"Photon Correlation Spectroscopy and its Application to Colloids"

Ron Hurst (RMIT)

Photon correlation spectroscopy may be used to determine an almost complete physical characterization of colloidal systems.

Field components of scattered laser light beat against one another to form a non-stationary interference pattern. A detector, small compared with the pattern, is used to analyse the light scattered from moving particles in liquid systems. Conventional light scattering, which is a special case of photon correlation spectroscopy, uses the intensity and angular distribution of the light to find the structure factor $S(K)$. K is the scattering vector. Fourier transformation of the structure factor $S(K)$ yields the radial distribution function $g(r)$. While the intensity of the scattered light provides information on the amplitude of the local fluctuations in thermodynamic variables, photon correlation spectroscopy studies the power spectrum of the scattered light as well. This tells us something of the time dependence of the fluctuations of thermodynamic variables. The photon correlation technique is used to measure the autocorrelation function $g^2(r)$ of the scattered laser light. The diffusion coefficient for dispersed colloidal particles can be deduced from the autocorrelation function. The size, shape and molecular weight of macromolecules may further be deduced from the diffusion coefficient. The component of particle velocity along the direction of the incident laser beam can be determined. Application of an

electric field across the scattering cell allows the electrophoretic mobility to be measured from which the zeta-potential can be calculated.

The ease with which fast, accurate measurements can be made gives photon correlation spectroscopy dramatic advantages over conventional methods for material analysis.

"Kinetics of Emulsion Polymerisation"

Brian Hawket (Sydney)

Previous attempts to solve the Smith Ewart equations for the kinetics of emulsion polymerisation, based on the Harkins theory, have involved making steady state assumptions about the average number of free radicals per particle. This treatment has the disadvantage of not telling us anything about the approach to the steady state, nor about the kinetics of a reaction which goes to completion without ever reaching a steady state. Analytical solutions obtained in the absence of a steady state assumption will be presented for Case I (bimolecular termination negligible as a consequence of rapid free radical exit from particles) and Case II (no exit of free radical activity from particles) and for the two cases combined. The Case I solution will be shown to be applicable to any system for which bimolecular termination can be neglected, not just those systems with small \bar{n} .

The solutions obtained are compared with previous steady state solutions.

Apparently anomalous experimental data obtained from the literature are qualitatively explained in terms of the combined Case I and Case II solution.

"The Growth of Polymer Colloids"

G. Lichti (Sydney)

Emulsion polymerisation experiments are at present rationalised in terms of the number of latex particles containing "i" actively polymerising radicals. This approach takes no account of the volume of the polymer colloid particles present, and so much experimentally attainable data on volume distribution cannot be interpreted.

An approach to emulsion polymerisation which includes particle volume information is developed. Coupled partial differential equations which describe the development in time of the volume distributions are derived, and solutions presented for some simple but chemically interesting systems. These solutions are relevant to the emulsion polymerisation of styrene and vinyl acetate.

"The Equilibrium Penetration of Monolayers by Surfactants"

Marylyn McGregor (Queensland)

Penetration of a soluble surfactant into an insoluble monolayer was carried out by injecting the surfactant into the aqueous substrate underneath the spread monolayer and mixing by means of an external pump.

Penetration isotherms for the octadecanol/hexadecyl-trimethyl-ammonium bromide (CTAB) system have been measured, and the corresponding adsorption of CTAB for various surface concentrations have been calculated. Plotting of these adsorptions against the inverse of the area per octadecanol molecule, as required for the accessible area theory, reveals two linear segments corresponding to penetration at high monolayer areas and low monolayer areas. At high areas, adsorption into the accessible areas of the surface is similar to adsorption at a monolayer-free surface, while at low areas adsorption is determined by the size of the surfactant ion.

"Monodisperse Chromium Hydroxide Sols"

John Lyons (Melbourne)

A general description of problems in investigating colloidal oxide systems was given. The need for monodispersed spherical oxide particles was stressed which permit reliable, precise size determinations for more convenient mathematical modelling. A summary of methods of production of

monodispersed metal hydroxides was presented. Mention was made of the techniques which will be used to investigate one such system, $\text{Cr}(\text{OH})_3$. Combined potentiometric-conductimetric titration data of an irregular oxide system (TiO_2), which was currently being investigated, was presented.

"Cadmium Adsorption at Oxide Interfaces" Pauline Stiglich (Melbourne)

The adsorption behaviour of cadmium(II) at the oxide-water interface has been studied using standard analytical techniques. The model oxides chosen for this study were rutile (TiO_2) and goethite ($\alpha\text{-FeOOH}$). The results have been discussed in terms of the currently available adsorption models. The introduction of complexing ligands, such as amine and 1,10-orthophenanthroline, modifies this adsorption-pH behaviour.

It is qualitatively concluded from these results that the hydroxo ligands are important species for Cd(II) adsorption, although the exact reason for this is still undefined.

"Tritium Exchange at Oxide Colloid Surfaces" Frank Grieser (Melbourne)

The tritium exchange technique is a direct measure of the total number of surface sites (N_s) if it can be established that the surface protons *only* are exchanged and that the exchangeable protons are not present in depth.

We report in the present paper the N_s values obtained from tritium exchange for crystalline silicas, TiO_2 (rutile), $\alpha\text{-FeOOH}$ (goethite), $\alpha\text{-Fe}_2\text{O}_3$ (hematite) and amorphous iron oxide ($\text{Fe}(\text{OH})_3$).

"Rheology of Colloidal Dispersions" Dr T.G.M. van de Ven (Sydney)

The behaviour of two equal-sized spheres in shear flow will be described, taking interaction forces between them into account. Two kinds of doublet can be formed, whose existence was confirmed experimentally in monodisperse dispersions of polystyrene latex spheres in simple aqueous electrolytes:

primary, in which the spheres touch and secondary, in which they orbit around each other at a mean distance which can be calculated from their period of rotation if the electrical surface charge distribution is uniform.

Proof will be given that two kinds of linear aggregate of more than two spheres exist: rigid and flexible, depending on whether or not the spheres touch. Observed differences in behaviour of doublets and triplets indicate that caution must be exercised in describing coagulation with a two-sphere model.

Calculations have been made of the doublet formation frequency in sheared dispersions in which the effects of Brownian motion are absent and in those in which they dominate the effects of shear, proving that the usual assumption of additivity of ortho- and perikinetic coagulation rates is incorrect.

These findings have a number of important implications in theories of the stability, flocculation and coagulation of colloidal sols.

"Measurement of Long-Range Forces between Two Mica Spheres"

Dr Jacob Israelachvili (ANU)

An experiment is described in which the long-range forces between two mica surfaces, immersed in KNO_3 solutions, are directly measured in the range 10 - 1000 Å. The forces are exponentially repulsive, with a decay length equal to the Debye length to within 10%. In 0.1 M and 1 M KNO_3 solutions, the onset of repulsion is preceded by an attractive region, thereby indicating the existence of a secondary minimum at these concentrations. It is difficult to say whether at very small separations, below about 10 Å, there is also a primary minimum, since at these separations the surfaces have appreciably deformed under the influence of strong forces, and a more detailed analysis is needed here. The results exhibit all the essential features characteristic of a DLVO-type interaction involving repulsive double layer forces and

attractive van der Waals forces. In particular, we may note that even at 0.1 M KNO_3 the decay length of the exponential repulsive region was equal to the Debye length, showing that the Poisson-Boltzmann equation appears to remain valid even at this high concentration (at least for KNO_3). The magnitude of the attractive forces in the region of the secondary minimum are of the order to be expected from the general theory of van der Waals forces.

"The Slime Coating Problem"

Paul Neville (Sydney)

Two slime coating systems have been examined in detail - fine goethite (FeOOH) on coarse galena (PbS), and small cationic resin beads on larger anionic resin beads. Detailed characterization of the PbS and FeOOH colloids by zeta-potential techniques revealed that the PbS surface could be prepared in a reproducible manner with a low isoelectric point *circa* pH 3-4, while the FeOOH colloid yielded the usual isoelectric point of pH 8.5. Thus rheological studies could be conducted using ion exchange resins, as a realistic model of the PbS - FeOOH system. It was found that maximum hetero-coagulation (slime coating) occurred when the surfaces had opposite signs of surface charge. Under such conditions the maximum shear rate imposed could not remove the last "monolayer" of slime coating. To remove it, adjustment of pH to equal sign of the surface charge was necessary.

"The Physical Properties of Lipid Bilayers"

Joe Wolfe (ANU)

A fundamental understanding of the physical properties of bilayer lipid membranes (BLM's) is essential for a deeper understanding of, for example, biological membranes.

The apparent simplicity of the structure of BLM has encouraged discussion of their "surface tension" as though they were liquid, or "elasticity" as though they were solid. An understanding of their pressure-area relation and their intricate self-assembly mechanism involves the attractive and

repulsive forces, molecular geometry and statistical mechanics.

An experiment is described for measuring the stabilising forces of BLM's by applying minute pressures to a BLM supported across a septum in solution. Further experiments to investigate interactions and fusions of two BLM's are also planned.

"Phase Transitions in Clay Dispersions"

Peter Forsyth (ANU)

Langmuir observed that dilute clay dispersions separate into two phases - one of which is isotropic while the other is an ordered liquid crystalline phase. If the clay particles are considered as "hard" plates, then the theory of Onsager may be applied to the clay-water system. This theory predicts the concentrations of the two phases and the pressure in the coexistence region. The calculated values of the concentrations are in good agreement with those observed by Langmuir. The salt dependence of these parameters is also predicted by this theory; however, the experimental data required to verify this are unavailable at present.

"Monolayer Adsorption on Spatially Dispersive Substrates"

Dr Jacek Duniec (ANU)

Both the dispersion and chemical interactions between adsorbed molecules are affected by the presence of the substrate. The mechanism of this effect has been shown in the case of dispersion forces. The possible theoretical model for calculating the similar effect on chemical bonds has been suggested.

The interaction between adsorbed molecules is affected by the adsorbent. A theory is presented which enables one to calculate this effect in a general case of adsorption on spatially dispersive substrates (*eg*, metals).

"Ordering in Latex Dispersions"

Dr Lee White (Melbourne)

Latex dispersions are observed to order when the volume fraction is increased. The critical volume fraction increases with concentration and experimentally a broad coexistence region of ordered (irridiscent) and

disordered phases is observed. The DLVO theory, based on coagulation into secondary minima, can be shown to be inadequate to explain the phenomenon. Modern theories of entropically driven phase separations in dense liquids, as first observed by Kirkwood and Alder in machine calculations on hard-sphere systems, can be invoked to provide a satisfactory qualitative explanation of the known results.

"Phase Transitions in Clay Dispersions"
 Peter Forcay (AMU)

Landau observed that dilute clay dispersions separate into two phases - one of which is isotropic while the other is an ordered liquid crystalline phase. If the clay particles are considered as "hard" spheres, then the theory of Onsager can be applied to the dispersed phase, and the phase diagram predicted for the coexistence of the two phases and the presence of first order coexistence regions. The calculated values of the transition temperatures in various experiments are compared with the theoretical values. The agreement is in general quite good. However, the theory also predicts a second order transition which is not observed in the experiments.

"Adsorption of Organic Molecules on Spatially Dispersive Substrates"
 Dr. Jacob Dujic (AMU)

It is shown that the adsorption of organic molecules on spatially dispersive substrates is affected by the presence of the substrate. The adsorption isotherms are shown to deviate from the Langmuir isotherm in the case of dispersive substrates. The possible theoretical models for predicting the adsorption isotherms are compared with the experimental data.

"Ordering in Latex Dispersions"
 Dr. Joe White (Washington State University)

Latex dispersions are observed to order when the volume fraction is increased. The critical volume fraction increases with concentration and experimentally a broad coexistence region of ordered (iridescent) and