



Australian Colloid and Interface Symposium

**Crowne Plaza Hotel
Coogee Beach, Sydney**

4–8 February, 2007

Program and Abstracts

Prof. Donald L. Sparks
University of Delaware, USA

Keynote Speaker in the theme Spectroscopy and Scattering in Surface and Colloid Science

Sponsored by the Australian Synchrotron.

Donald's lecture "The role of X-ray absorption spectroscopy in advancing the frontiers of environmental interfacial chemistry" is scheduled for Monday at 8:50 am, in the West ballroom. See his abstract on p.29.



Donald L. Sparks is the S. Hallock du Pont Endowed Chair at the University of Delaware. He is internationally recognized for his research in the areas of kinetics of geochemical processes and mechanisms of metal/oxyanion/nutrient reactions at biogeochemical interfaces using in-situ spectroscopic and microscopic techniques. He is the author or coauthor of 270 publications including two widely adopted textbooks, *Kinetics of Soil Chemical Processes and Environmental Soil Chemistry (two editions)*. Dr. Sparks has given plenary and keynote presentations throughout the world and he has mentored more than 70 graduate students and postdoctoral fellows.



A/Prof. Zhan Chen
University of Michigan, USA

Keynote Speaker in the theme Spectroscopy and Scattering in Surface and Colloid Science

Sponsored by Lastek.

Zhan's lecture "The role of X-ray absorption spectroscopy in advancing the frontiers of environmental interfacial chemistry" is scheduled for Monday at 1:40 pm, in the West ballroom. See his abstract on p. 38.

Zhan Chen received his PhD degree in Chemistry from the University of California at Berkeley. He did his postdoctoral research at the Lawrence Berkeley National Laboratory. Currently he is an associate professor in the Department of Chemistry at the University of Michigan. He also holds joint appointments in Department of Macromolecular Science and Engineering, Applied Physics Program, Biophysics, and Optical Physics Interdisciplinary Laboratory at the University of Michigan. His research is focused on the elucidation of molecular structures of polymers and biological molecules at interfaces using various spectroscopic techniques.

Prof. Jacob N. Israelachvili
University of California Santa Barbara, USA

Keynote Speaker in the theme Surface Forces, Nanotribology and Biological Interactions

Sponsored by the Particulate Fluids Processing Centre, University of Melbourne.

Jacob's lecture "Frictional properties of confined nanoparticles: effects of particle size and shape" is scheduled for Monday at 8:50 am, in the East ballroom. See his abstract on p. 47.



Jacob Israelachvili received his BA and MA in Physics from the University of Cambridge, England, and also carried out graduate and postgraduate research work there at the Surface Physics Department of the Cavendish Laboratory. He received his PhD in 1972. After a two-year European Molecular Biology Organization (EMBO) research fellowship at the University of Stockholm, he left for Australia where, from 1974 to 1986, he led an experimental research laboratory devoted to measuring forces between surfaces. In 1982 he was elected a member of the Australian Academy of Science. In 1986 he joined the faculty of the University of California at Santa Barbara where he holds joint appointments as Professor in the Department of Chemical Engineering, the Materials Department and the Biomolecular Science and Engineering Department. He was the Associate Director of the Materials Research Laboratory at UCSB from 1993 until 2003. In 1988 he was elected a Fellow of the Royal Society of London, and in 1991 he was awarded the Alpha Chi Sigma Award for Chemical Engineering Research by the American Institute of Chemical Engineers. In 1996 he was elected a Foreign Associate of the US National Academy of Engineering. He is the author of a textbook entitled "Intermolecular and Surface Forces" (Academic Press, 2nd Edition: 1991). He was given the 2002-03 Adhesion Society's Award for Excellence in Adhesion Science, sponsored by 3M. Most recently he was made a Fellow of the American Physical Society (2003) and was elected a member of the National Academy of Sciences in 2004.



A/Prof. Suzanne Giasson
Université de Montréal, Canada

Keynote Speaker in the theme Surface Forces, Nanotribology and Biological Interactions

Sponsored by Ian Wark Research Institute, University of South Australia.

Suzanne's lecture "Static and dynamic interactions at biomaterial surfaces" is scheduled for Tuesday at 8:00 am, in the East ballroom. See her abstract on p. 66.

Dr. Suzanne Giasson, is currently Associate Professor in the Department of Chemistry and Faculty of Pharmacy, University of Montreal, since 2002, prior to which she held a faculty

THE ROLE OF X-RAY ABSORPTION SPECTROSCOPY (XAS) IN ADVANCING THE FRONTIERS OF ENVIRONMENTAL INTERFACIAL CHEMISTRY

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There have been major advances in the development and use of state-of-the-art in-situ synchrotron-based techniques that enable one to study an array of important interfacial reactions and processes at the molecular scale. One of the most widely used techniques is x-ray absorption spectroscopy (XAS). XAS can be used to study most elements in crystalline or non-crystalline solid, liquid, or gaseous states over a concentration range of a few mg/L to the pure element. XAS can be used to probe structural sites ranging from those in crystals and glasses to those at interfaces such as mineral/water and mineral/microbe. With advanced generation synchrotron light sources that provide x-ray energies ranging from the infrared to the hard x-ray region, higher flux and more intense brightness, beamline optics that produce microfocussed beams for spectromicroscopy and imaging studies, and state-of-the-art detectors, important advances in many scientific areas, including surface and colloid science, will occur over the next decade.

One of the major advantages of XAS, particularly if one wants to simulate natural conditions in natural systems, is that one can study reactions in the presence of water (*in situ*). This is a major advantage over many other molecular scale techniques, which are *ex-situ*, often requiring drying of the sample material, placing it in an ultra-high vacuum (UHV), heating the sample or employing particle bombardment. Such conditions can alter the sample, creating artefacts, and do not simulate most natural environmental conditions. It is especially important to study environmental reactions and processes in water as it is the principal medium of transport of inorganic and organic species, and biochemical reactions take place in aqueous media and across biological membranes that are water based. XAS is an element specific, bulk method that yields information about the local structural and compositional environment of an absorbing atom. It “sees” only the 2 or 3 closest shells of neighbors around an absorbing atom due to the short electron mean free path in most substances. Using XAS, one can ascertain important chemical information such as the oxidation state, information about next nearest neighbors, bond distances and coordination numbers.

The use of XAS and other synchrotron-based techniques (x-ray fluorescence spectroscopy, microtomography, and spectromicroscopy) to study reactions and processes in terrestrial and aquatic environments will be highlighted in this presentation. These include: reaction mechanisms of ions at mineral/humic substance/water and mineral/microbe interfaces, functional group distribution and structure of humic substances, and speciation of contaminants in heterogeneous systems such as soils, sediments, and plants.

SRXPS EVIDENCE FOR SURFACE STABILIZATION OF TRANSITION METAL CHALCOGENIDE FRACTURE SURFACES

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Sulphide ores include some of our most exploited sources of metals such as Cu, Fe, Zn and Ni, consequently, they are of great interest to the mining community. Metal sulphides are commonly extracted from their ores by flotation and the efficiency of their recovery is dominated by their surface properties. The preparation of ores for industrial beneficiation and extraction processes such as flotation and leaching often involves grinding them to specific size fractions. The result is the production of fractured and cleaved surfaces that often have dissimilar properties than the bulk of the material. These surfaces are then commonly exposed to air, water, collectors and frothing agents during flotation procedures. Understanding the surface chemistry of these minerals provides insight into their reactivity and reaction mechanisms, and ultimately opens a route to controlled manipulation of the surface properties of these materials for custom applications in metal extraction.

Metal chalcogenides may fracture by cleavage along crystal directions or, more commonly, conchoidally (poor cleavage). The fracture of the material involves breaking of bonds between surface atoms, resulting in the formation of high energy dangling bonds and reduced co-ordination (and altered symmetry) at the fracture surface. The response (relaxation) of a surface to fracture is dependant on: crystal orientation; electronegativities of the atoms involved; defects; and impurities. The formation of new bonding configurations (reconstruction), in particular, will be constrained by the possible bond geometries at the surface, orbital direction limitations and potentially significant electron density changes (changes in effective oxidation state).

Synchrotron radiation excited X-ray photoelectron spectroscopy (SR-XPS) and conventional XPS have been used to study the in-situ fracture surfaces of a series of industrially important transition metal chalcogenides. These studies were complemented by parallel, *ab initio*, quantum mechanical simulations of bulk and fracture-surface electronic DOS and electron population. The outcomes of these studies provide links between crystal structure, electronic structure and surface speciation resulting from stabilization of fracture surfaces. Predictable and systematic changes in the surface stabilization of chalcogenides have been observed. Electronic structure measurements of the surface and bulk of in-situ fractured minerals has provided information on metal chalcogenide bonding, surface states and offers information on potential surface sites for adsorption. Changes in surface speciation as a function of crystal structure, has provided a route for prediction of mineral surface properties and reactivities.