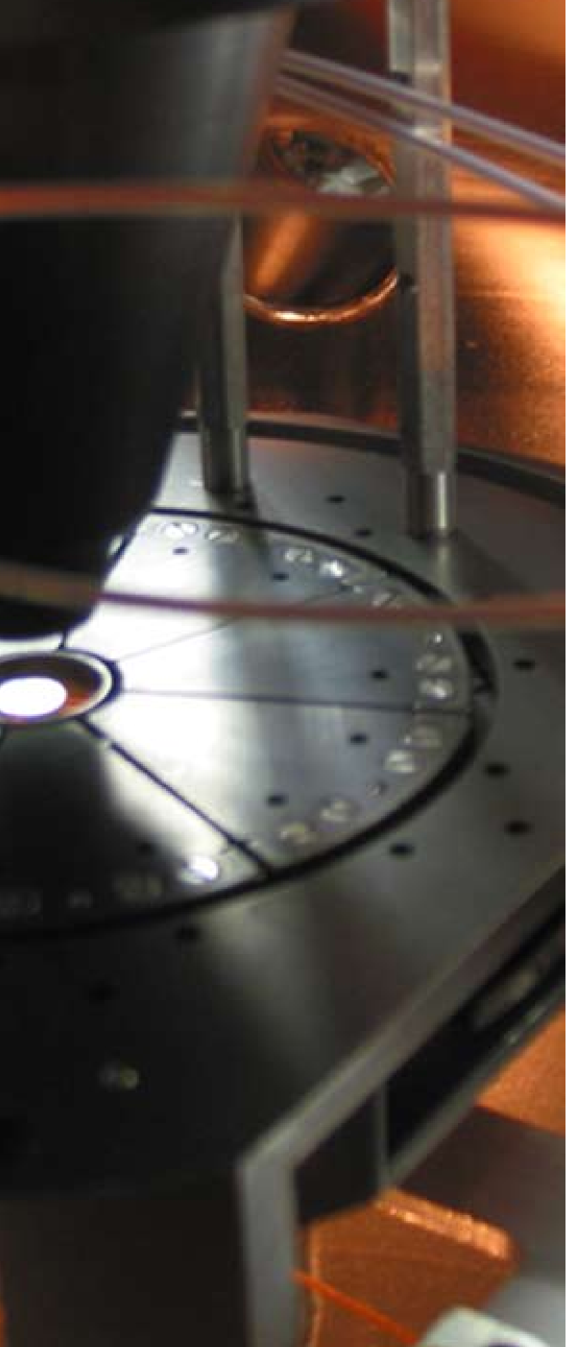
SURFACE AND NANOSCIENCE GROUP



FACULTY OF SCIENCE AND INFORMATION TECHNOLOGY

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

OVERVIEW

The surface of a solid is the link between the bulk of the material and its environment. It is the surface where chemical reactions like rust occur or where one material bonds to another. The reactivity of the surface is different to that of the bulk material so an accurate understanding of surfaces is essential for a range of modern technologies.

Our primary research focus is on the modelling and analysis of the structure of the surface of solids from the surface atomic layer through to the bulk.

The properties of materials structured on the nanometre scale are unique and fundamentally different from the bulk materials from which they are composed. As such, they have an important role to play in the design and development of new materials and devices.

The materials studied and the techniques used in our studies are at the cutting edge of modern surface and nanoscience research.

OBJECTIVES

The objective of the Surface and Nanoscience group is to be a centre of renown for the modelling and analysis of surfaces and nanometre scale materials. The group comprises a strong theoretical and experimental component whose research is aimed at Modelling, Analysing, Understanding, Modifying and Utilising materials properties at the nanometre scale

To achieve these goals, there is considerable national and international collaboration with groups from around the world who have complementary skills and equipment.

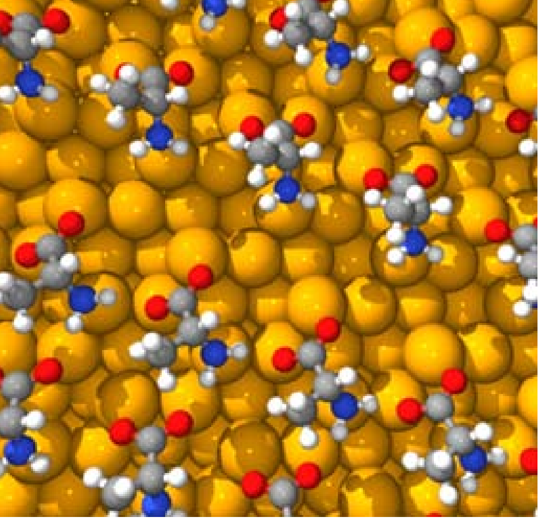
RESEARCH SUPPORT

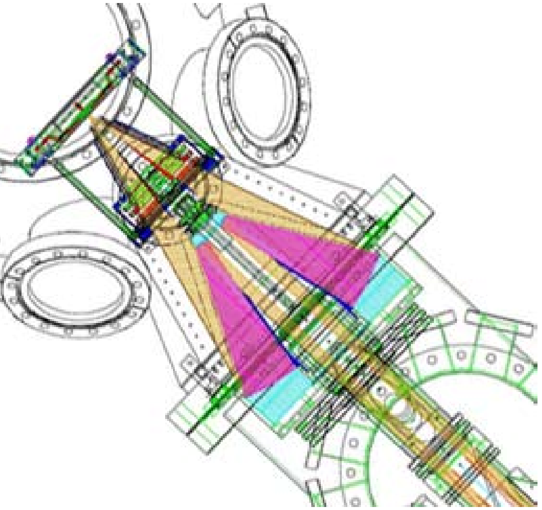
We have access to the following experimental and theoretical tools:

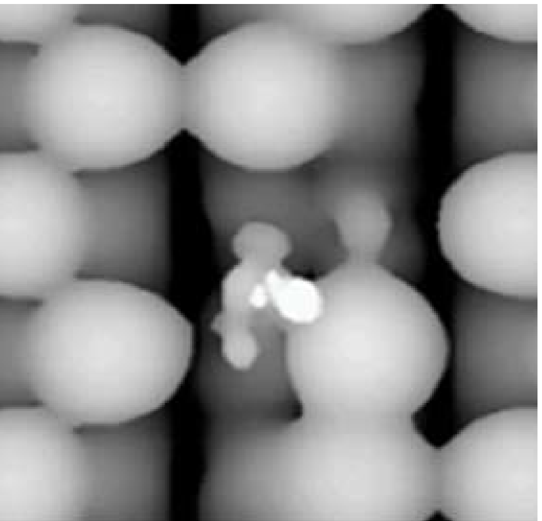
Low Energy Ion Scattering
Low Energy Electron Diffraction
Nanoprobes including STM, NSOM and AFM
Medium Energy Ion Scattering
Secondary Ion Mass Spectrometry
Electron Microscopy – SEM and TEM
Synchrotron Techniques
Gaussian, VASP, Wien2k, SIESTA, CASTEP, DMol

EXTERNAL COLLABORATORS

- Daresbury Research Facilities UK
- Australian Synchrotron
- Advanced Light Source, Berkeley
- Institute for Materials Research, Tohoku University, Japan
- Uni of Wroclaw, in Poland
- Poznan Technical University, Poland
- Dresden University, Germany
- London Centre for Nanotechnology, University College, London.
- Accelerator facilities at the Australian National University
- University of Loughborough, UK
- Manchester Metropolitan University, UK
- Glasgow University, UK
- Monash Centre for Electron Microscopy
- Institute for Nanotechnology, UTS
- University of Reading, UK
- Elettra Synchrotron, Italy
- University of Nebraska-Lincoln
- University of Sydney







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EXAMPLES OF CURRENT PROJECTS

MAX phase materials have extraordinary properties which are being investigated to determine what role they can play in high temperature aggressive environments such as high efficiency power stations, solar thermal power applications, aerospace and fusion reactors.

The next anticipated advance in miniaturising electronic components is to replace transistors by specially chosen molecules. We are contributing to the development of this new field of molecular electronics by modelling processes which will allow control of the positioning and functionality of individual atoms on silicon and germanium surfaces.

Surface plasmons produced by metallic nanoparticles have been used for centuries to modify the colours and optical properties of glasses. Recently there has been a resurgence in interest for applications such as the sub-wavelength manipulation of light and for single molecule detection. We are studying the relationship between the structure of the nanoparticles and their optical response using advanced electron microscopy techniques and a combination of classical and quantum theory.

RESEARCH OUTCOMES

Over the past five years we have received $9M worth of research funds, produced 85 referred publications and a further 50 other publications. In that time more than 20 Research Higher Degree students have participated in our research program.

RESEARCH TOPICS

- MAX phase materials
- Carbon and nitride nanotubes
- Radiation damage in fusion reactor materials
- Atomic thin films
- Ultra thin film growth on surfaces
- Ultra sensitive composition analysis
- Radiation damage in materials returned in the NASA Genesis mission
- Impurity redistribution in samples exposed to the solar wind in the NASA Genesis mission
- Inelastic phase retrieval in electron microscopy.
- Ab initio prediction of the optical properties of nanostructures
- Nanoscale mapping and prediction of surface plasmons.
- STM imaging and theoretical modelling of molecular adsorbates on silicon and germanium surfaces
- Chiral Recognition
- Nanoparticle impact on environment
- Alternative fuel cell catalysis
- Molecular Dissociation

GROUP MEMBERS

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