Research cluster potential projects: Surface Science

Supervisors

Heike Arnolds
Rasmita Raval

Projects

Project Title: Ultrafast spectroscopy in molecular electronics
Supervisor(s): Dr Heike Arnolds and Professor Richard J. Nichols (Applied Physical)
Email: Heike.Arnolds@liv.ac.uk

The ideal molecular electronic device is uniquely determined by the properties of the molecule, its interaction with charge passing through and its connection to the outside world. To date, no one has looked at the molecule-electron interaction on the timescale of molecular vibrations in molecular electronic devices. In this project we will monitor energy transfer and dissipation in these devices for the first time with femtosecond pump–probe spectroscopy. The student will work at the frontier of physical chemistry and have a rare opportunity to answer fundamental questions on molecular conductance relevant to chemists, physicists, electrical engineers, materials scientists and spectroscopists.

Project Title: Portable nonlinear optical spectroscopy
Supervisor(s): Dr Heike Arnolds
Email: Heike.Arnolds@liv.ac.uk

Nonlinear optical spectroscopy is an extremely powerful tool to investigate the properties of interfaces in the presence of bulk material and has been widely applied to problems as diverse as heterogeneous catalysis, biofouling, corrosion and lubrication. It is still a niche technique because it currently requires major investment in ultrafast laser technology and a researcher with considerable laser experience. In this project we will develop a portable device based on an Erbium fiber oscillator and apply this to monitoring adsorption at solid-liquid interfaces (biofouling), atomic layer deposition (switchable glass) and chemical vapour deposition (thin film solar cells).
Project Title: Developing a Road Map for Cell Surface Interactions

Supervisor(s): Dr Heike Arnolds and Prof Peter Myers (Applied Physical Chemistry), Prof John Hunt and Dr Jude Curran (Institute for Chronic Disease and Ageing)

Email: Heike.Arnolds@liv.ac.uk

The chemical modification of a surface can control the adhesion of cells and their ultimate phenotype. Efficient control of cell adhesive events requires controlled deposition of a group of interest at the sub-micron scale, providing a platform for the development of non-invasive, microscopy based techniques that can be used to monitor cell adhesion and ultimate cell phenotype. We will use nonlinear optical spectroscopy to selectively probe the conformation of the self-assembled monolayer in the presence of serum and attached cells. The student will gain skills in cell culture, general biochemical techniques, nonlinear optics, standard surface characterisation and surface coating techniques.

Project Title: Genesis of Complex Functional Nanostructures at Surfaces

Supervisor(s): Prof. R. Raval

Email: Raval@liv.ac.uk

A main challenge in nanoscience and nanotechnology is creating complex and functional nanostructures at surfaces. This project will address this objective by controlled linking of component molecules at a surface to generate molecular nanostructures. Sophisticated surface science methods will be used to manipulate, activate and directly link individual molecules on surfaces in ultra-high vacuum, and then probe them using vibrational and electronic spectroscopic methods and scanning tunnelling microscopy (STM). The nanostructures created will be tested for functions such as: catalysis, spintronics, sensors, energy harvesting, etc. This PhD position will suit candidates from Physics, Chemistry or Materials Science.

Project Title: Self-Assembly of Chiral Molecules at Surfaces

Supervisor(s): Prof. R. Raval

Email: Raval@liv.ac.uk

Chiral or 'handed' surfaces are implicated in major advances in nanoscience e.g. smart sensors, ultra-selective catalysts, non-linear optical materials and even as potential environments that could have initiated the evolution of life on earth! This project will investigate how to create chiral surfaces by self-assembly of molecules into patterned monolayers, which will then be evaluated for specific chiral responses. The research will use sophisticated surface science methods to assemble chiral surfaces in ultra-high vacuum and then probe them using spectroscopic methods and scanning tunnelling microscopy (STM). This PhD position will suit candidates from Physics, Chemistry or Materials Science.
Project Title: Energy Harvesting at the Single Molecule Level

Supervisor(s): Prof. R. Raval and Dr H. Arnolds

Email: Raval@liv.ac.uk and Heike.Arnolds@liv.ac.uk

Artificial harvesting of solar energy is one of Grand Challenges of 21st Century. PhD project offers a unique opportunity for a student to work within two world-leading experimental research groups at the University of Liverpool. The research will combine state-of-the-art tools at the Surface Science Research Centre to create self-assembled monolayers of light-harvesting molecules at surfaces. The nanoscale details of how such systems interact with light and what energy conversions occur at the molecular level will be probed using advanced scanning tunnelling microscopy and linear and nonlinear optical surface spectroscopies.