## Liverpool University research on nanoparticle synthesis in top ten most cited materials papers

Research from the labs of David Schiffrin and Don Bethell at the Centre for Nanoscale Science, University of Liverpool, has recently appeared in the **top ten most cited documents** in materials science on the CAS Science Spotlight list. (*J Chem Soc, Chem Commum*, 1994, 801 **Synthesis of Thiol derivatised Gold Nanoparticles in a Two-phase Liquid-Liquid System** by *Mathias Brust, Merryl Walker, Donald Bethell, David J Schiffrin and Robin Whyman*). With over 530 citations, this may be the most highly cited *Chem Commun* paper ever.

The paper, published in 1994, reports the reduction of $AuCl_4^-$ by sodium borohydride in the presence of an alkanethiol, in a two phase water-toluene system. Solutions of 1-3 nm gold particles bearing a surface coating of thiol were prepared. It appeared in the CAS top ten list of materials papers most frequently cited in patents, journal articles, conference proceedings, and web preprints published in 2000.

The new hydrophobic metal clusters formed behaved like simple chemicals in that they could be precipitated, redissolved and chromatographed without any changes in properties. It was envisaged that these types of materials would find applications in catalysis, sensors and molecular electronics.

Commenting on the significance of the paper, David Schiffrin stated 'It provided a simple starting point for the synthesis of nanostructured materials. The technique was extremely simple, requiring only readily available chemicals to prepare stable quantum dots in the gram to kilogram scale. In addition, the synthetic ideas were easy to grasp since they were a combination of what Faraday did over 150 years ago and modern self-assembly methods on electrode surfaces'.

Since 1994, David Schiffrin has continued research into thiol derivatised gold nanoparticles. Amongst other projects he has looked at further syntheses introducing chemical functionalities onto the ligand shell, self-organisation of the nanostructures, construction of nanowires and nanoscale switching units and the use of the nanoparticles as scaffolds for the creation of DNA-binding systems. Although the work gained considerable recognition, Schiffrin commented that UK industry has been very reluctant to invest in this area, with commercial application in magnetic materials, sensors and DNA diagnostics taking place elsewhere.

The paper can at present be downloaded for free at the RSC web site **(www.rsc.org/is/journals/current/chemcomm/cccpub.htm)** and a review article by David Schiffrin focusing on this area is soon to appear in Chemical Communications. More information on CAS Science Spotlight can be found at **www.cas.org/spotlight/index.html**

## International Review of Materials – UK interdisciplinary research is 'best in the world'

The International Review of Materials reported its preliminary findings to the EPSRC council in June giving some very positive feedback. Amongst other findings, the panel commented that interdisciplinary materials research within the UK was excellent and in their opinion the best in the world.

The EPSRC commissioned the Institute of Materials, in conjunction with the RSC, Institute of Physics and Royal Academy of Engineering to conduct an international review of materials science and technology including materials chemistry. The review took place during the first week of March and was chaired by Professor Anthony Evans of the University of California at Santa Barbara. The review brought together 13 leading international researchers with the objective of benchmarking the quality and impact of materials science and technology research in the UK against that conducted internationally. The panel spent a week visiting a sample of British academic institutions and examining statistical data on UK research. The review also provided comment on particular strengths and weaknesses evident in the UK portfolio.

Although the preliminary report has not been made publicly available, other feedback from the panel included the rating of UK research in organic semiconductors as outstanding and the assessment of work in polymer science as highly competitive. The full report is scheduled to be published in the Autumn.

## Materials under Extreme Conditions

In September 2002, the University of Edinburgh will open a unique, multidisciplinary Centre for Science at Extreme Conditions (CSEC), bringing together expertise and equipment to study materials – their synthesis, structures, reactions and physical properties – at extremes of pressure, temperature and in electromagnetic fields. CSEC will unite researchers across a wide range of disciplines – biology, chemistry, earth sciences, engineering, materials science and physics. £6.9m was provided by JIF (Joint Infrastructure Fund) to construct and equip a dedicated building, while a new chair in materials synthesis at extreme conditions, together with a readership, lectureships and research studentships, will shortly be created through funding from the Leverhulme Trust.

Extreme temperatures and pressure are common in geological processes, greatly expanding the available thermodynamic space and accelerating bond breaking and ion migration in the formation of new phases. While high temperatures are also common in chemical synthesis, high pressure is not, despite the opportunities it offers to tune chemical potential rapidly, continuously, strongly and cleanly. It has only recently become possible to apply very high pressures – up to 100 GPa (@ 1Mbar) - to significant quantities of material, and to study structure and physical properties *in situ*. Pressure is poised to become a routine tool for the materials chemist, and not limited to specialised applications such as the formation of diamond and other super-hard substances. This is an exciting area and an exciting time for chemists: extreme pressures can alter relative orbital energies in some elements, effectively changing their chemical character and giving parts of the periodic table an additional dimension.

Molecular systems will also come under the spotlight in CSEC, from small species, studied to test models of intermolecular bonding and reactivity and perhaps providing new routes in molecular synthesis, to more complex macromolecules of biological importance. The discovery that some organisms (known as extremophiles) thrive at extremes of pressure and temperature could be of immense practical importance in biotechnology. The study of such organisms, and the molecules from which they are made, may provide new insights into mechanisms of protein folding, and self-assembling systems in general, which in turn may be of great importance in the development of biomaterials.

*Further details of CSEC and its activities may be found through the Web (**www.csec.ed.ac.uk**), or by email through its Director, Professor Andrew Harrison (**a.harrison@ed.ac.uk**), or through the Director of the Centre for Materials Science at Edinburgh, Professor Christopher Hall (**christopher.hall@ed.ac.uk**)*