

Science Community Focus

The Royal Society of Chemistry Presents Blue Plaque to Southampton University on 40th Anniversary of Ground Breaking SERS Discovery

The University of Southampton's Chemistry department was awarded a National Chemical Landmark blue plaque on 24th July by the Royal Society of Chemistry, to celebrate the 40th anniversary of the discovery of a technique that has revolutionised science. Surface Enhanced Raman Spectroscopy, or SERS, is now used for detecting tiny quantities of molecules, in situations from crime scene forensic analysis, to drug detection, to establishing the origins of works of art.

The first SERS experiments were carried out in the Chemistry Department of Southampton University in August of 1973, following the discovery of the technique by electrochemist Professor Martin Fleischmann, vibrational spectroscopist Professor Pat Hendra and Professor Jim McQuillan. The team found that by roughening the metal surface upon which the molecules they were examining had been placed, they could increase the signal by which they could detect these molecules.

"SERS is an offshoot of Raman spectroscopy," Professor Jim McQuillan explained to Labmate UK & Ireland. "In conventional Raman spectroscopy the sample is illuminated with monochromatic laser light. The scattered light from the sample is separated to remove the laser frequency leaving a very weak Raman signal at a shifted frequency. The shift in frequency is identical to that measured in the familiar IR spectrum. Conventional Raman scattering has poor sensitivity and improvements of sensitivity have been found, one of which is through SERS."

"We discovered that a silver electrode electrochemically roughened in salt solution gave an extraordinarily strong Raman spectra of pyridine adsorbed at the silver surface. This has made SERS an extremely sensitive analytical tool. The intensity of the Raman signal was about a million times enhanced compared with the signal without the roughened silver surface. It is now understood that collective electron oscillations (plasmons) in small silver particles create the enhanced Raman signal," Professor McQuillan added.

Since this discovery, there have been thousands of papers published which have applied the technique of SERS, as well as countless uses of it across industries and around the world. For example, it is used in forensic analysis, to pick up the tiniest traces of molecules at crime scenes.

Professor Patrick Hendra said: "SERS is arguably the most sensitive method of analysis on surfaces that anyone has ever come up with. However, at the time we had no idea how important it would become beyond the academic world, or the vast range of applications that would be developed."

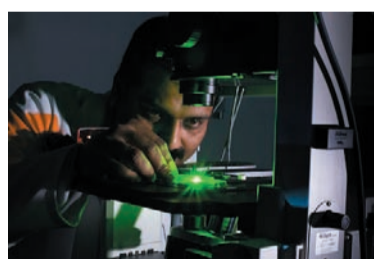
SERS Applications in 2013

Today Dr Sumeet Mahajan, Senior Lecturer in Life Science Interface at the University of Southampton is taking SERS to the next level, using the technique to advance stem cell



Patrick Hendra (left) and Jim McQuillan at the unveiling of the National Chemical Landmark blue plaque at Southampton University

therapy. Dr Mahajan said: "Stem cells could hold the key to tackling many diseases. They develop into all the various kinds of cells needed in the body - blood, nerves and organs - but it is almost impossible to tell them apart during initial development, without complex techniques, even with the most advanced microscopes.



Dr Sumeet Mahajan in the lab

"Up to now, scientists have used intrusive fluorescent 'markers' to track each cell, but this can alter or damage the cells and render them useless for therapeutic use. By using SERS, we can use very tiny particles of gold, less than 1000th of the width of a human hair, as 'nanoprobes' to enter cells. Through this, we can enhance the observation of the natural vibrations of molecules within the cell and make this otherwise almost invisible motion, easily detectable. This makes us able to detect if drugs are reaching cells correctly, and to detect abnormalities within cells on a molecular level."

The results of Dr Mahajan's work, funded by the Engineering and Physical Sciences Research Council (EPSRC), have been published in the journal *Nano Letters*. He is collaborating with major pharmaceutical companies to further develop the work for better drugs.

Prior to the unveiling of the National Chemical Landmark blue plaque, Professor David Phillips, Royal Society of Chemistry Past President said: "I am immensely proud that my former departmental colleagues at the University of Southampton were responsible for discovering SERS, particularly since I was a member of staff in the Department when the discovery was made. The practical application of SERS in chemistry, genetics and healthcare is of vital scientific importance, from the detection of cancer genes to DNA fingerprinting."



Jim McQuillan with the diary he, Patrick and Martin Fleischmann wrote in at the time of the discovery.

Professor Zhong-Qun Tian, a former PhD student of Professors' Patrick Hendra and Jim McQuillan also received an honorary degree during a graduation ceremony at Southampton on Wednesday 24 July. Professor Tian received his BSc in chemistry from Xiamen University, China in 1982, and his PhD in electrochemistry from the University of Southampton in 1987. He then returned to Xiamen University and has worked there ever since.

He was appointed as full professor in 1992. He has made several original contributions to his fields of research including surface-enhanced Raman spectroscopy (SERS), spectro-electrochemistry and nano-chemistry, especially the development of electrochemical Raman spectroscopic methods in conducting fundamental molecular-level studies of metal-solution interfaces. He is the author or co-author of more than 340 papers in peer-reviewed journals. He has served as a Member of the Chinese Academy of Sciences (2005-), a Fellow of the Royal Society of Chemistry (2005-) and International Society of Electrochemistry (2010-), and a Member of Standing Committee of the Chinese Chemical Society (2008-). He is associate editor of Chemistry Society Reviews and Journal of Raman Spectroscopy, and a member of the advisory board for 10 international journals.

L-R: Professor Phil Gale (Head of Chemistry at the University of Southampton,) Professor Tian (Xiamen University who received an honorary degree, Patrick Hendra, Jim McQuillan, Claire Viney (RSC representative) and Professor Phil Nelson (University of Southampton Pro Vice-Chancellor.)



RSC Attends Buckingham Palace Celebration of Queen's Awards

Senior representatives from the Royal Society of Chemistry attended celebrations at Buckingham Palace and the Department of Business, Innovation and Skills to mark the award of the society's 2013 Queen's Award for Enterprise.

The society won the UK's highest accolade for business success in the International Trade category, for its sustained and impressive international growth in scientific publishing.

Chief Executive Dr Robert Parker was presented with a crystal glass commemorative chalice and a ceremonial Grant of Appointment at a celebration at the society's headquarters at Thomas Graham House in Cambridge last week. The presentation was made on behalf of Her Majesty the Queen by the Lord Lieutenant of Cambridgeshire, Hugh Duberly CBE. The award ceremony was also attended by local dignitaries, including the Mayor of Cambridge, Cllr Paul Sanders, and Master of Trinity College Cambridge, Sir Greg Winter.

The Royal Society of Chemistry's success will be recognisable by the Queen's Award emblem, which flies on flags at the society's UK offices at Thomas Graham House and Burlington House in London, and can be used on its products and materials for five years.

Dr Parker said: "We're honoured to have the hard work of our employees and members recognised with The Queen's Award.

"The award recognises our growth strategies - which have led to an increase in overseas earnings of 45% over the last six years - our successful products, and our incredible customer relationships that we have built up as the world's leading chemistry community."

"For the next five years, we can display with pride yet more evidence of our international success."



Professor Lesley Yellowlees, President of the Royal Society of Chemistry Dr Robert Parker, Chief Executive of the Royal Society of Chemistry Hugh Duberly CBE, Lord Lieutenant of Cambridgeshire Professor Graham Richards, Oxford University and former Chair of the Royal Society of Chemistry's Publishing Board

Next RSC President Predicts Impact of Informatics on Bench Experiments

Newly-appointed President-Elect of the Royal Society of Chemistry Professor Dominic Tildesley has forecast fundamental changes in laboratory practice which will eventually be brought about by advances in modelling and computational informatics on chemistry research.

"The speed and development of computers is now so rapid, and the advances in modelling and informatics are so dramatic that in 15 years' time, no chemist will be doing any experiments at the bench without trying to model them first."

Professor Tildesley, is a world-leading expert in large-scale computational modelling and simulation, with a wealth of experience across both academia and industry. He is currently Director of the European Center for Atomic and Molecular Computation (CECAM) at the École Polytechnique Fédérale de Lausanne in Switzerland. He is also co-chair with Science Minister David Willetts on the Minister's UK e-Infrastructure Leadership Group.

Professor Tildesley said: "The field of computational modelling has been revolutionised in the past 50 years by enormous software and hardware advances that now enable us to compute material properties - for example, the optical properties of quantum dots, or the behaviour of membrane-bound proteins. It is now even possible to model what happens down to the level of making and breaking chemical bonds in an enzymatic reaction, or dislocations on a metal surface."

During his time in office, Professor Tildesley hopes to apply his academic and industrial experiences to promote the importance of the chemical sciences in global industry and to work with the RSC to forge stronger collaborations between industry and academia.

Professor Tildesley was announced as the RSC's newly appointed President-Elect at its annual general meeting on 10 July. At the same meeting, the RSC also announced the appointment of Professor David Grayson, former Head of the School of Chemistry at Trinity College Dublin, as Honorary Treasurer.



Professor Dominic Tildesley, President-Elect of the Royal Society of Chemistry

Former RSC President appointed Chair of UK Chemicals Stakeholder Forum



Professor David Phillips, Chairman of the UK Chemicals Stakeholder Forum.

Former RSC President, Professor David Phillips, has taken up his position as Chair of the UK Chemicals Stakeholder Forum (UKCSF).

The UKCSF is a Department for Environment, Food and Rural Affairs (Defra) forum that advises government on how the industry should reduce the risks from hazardous chemicals to the environment, and to human health through the environment.

Professor Phillips said: "I am delighted to have been appointed as Chair of the UKCSF. The forum has an important role to play in advising the government, based on sound science and in the public interest, on how best to manage risk to the environment and human health from the production and use of chemicals.

"I'm particularly looking forward to working with forum members on how we can improve sustainability in the chemicals industry, both to reduce the impact of industry on the environment and to boost business through lower costs."

CSI Course Plunges the Depths

Staffordshire University is embarking on an exciting and unique Underwater Crime Scene Investigation course with the help of BSAC's Newcastle (Staffordshire) Sub-Aqua Club this summer (20th-23th August, 2013). It is understood to be the first time that underwater CSI procedures are being offered as a study-course outside of the US.

Through a combination of practical open water sessions, guided laboratory practicals, lectures, guest speakers and case studies, students will look at the considerations, methods and options available to investigators of underwater crime scenes. The course includes scene documentation, evidence recovery and analysis as well as the pathology of water related deaths.

No previous forensic knowledge is needed and limited spaces are still available for interested parties. For more details please contact Yolanda.granja-rubio@staffs.ac.uk