

Summer 2015

## Welcome from the Chair

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*“our work is more important than ever as the societal drive to make things small means that thin films, surfaces and interfaces play an increasingly dominant role”*

Dear members,

Welcome to the latest of our infrequent Thin Films and Surfaces Group (TFSG) newsletters. The world of thin films and surfaces has not stood still since our last newsletter and we have been active in supporting several of the exciting conferences and workshops in our field. Our 20th Interdisciplinary Surface Science Conference (ISSC-20) was held from 30th March – 2nd April 2015 in Birmingham, with 127 attendees from more than 60 institutions, following on from the equally successfully ISSC-19 held in Nottingham in 2009. We also co-sponsored a number of events ranging from the 19th International Vacuum Congress (with 2500+ delegates) to the one day workshop “Theory Meets Experiment: Organic Molecules on Inorganic Surfaces”, which boasted a number of highly distinguished international speakers including Nobel Prize winner John Polanyi. In addition we teamed-up with the Ion and Plasma Surface Interactions Group to co-sponsor two one-day meetings. We were also one of the most active IOP groups in the funding of student bursaries, the benefits of which are obvious from reading the reports of some of the recipients in this newsletter.

These are challenging times for the scientists and engineers working in the field of thin films and surfaces. On the one hand our work is more important than ever as the societal drive to make things small means that thin films, surfaces and inter-

faces play an increasingly dominant role in technological applications. On the other hand, the term 'surface science' seems to have gone out of fashion in some circles, with the Engineering and Physical Sciences Research Council (EPSRC) listing it as an area where they are de-prioritising funding. As active members of the thin films and surfaces field we must continuously remind the broader scientific community that the properties of thin films, surfaces and interfaces play a vital role in technologies as diverse as integrated circuits, fuel cells, catalysis, self cleaning windows, night vision glasses, and molecular self-assembly.

I would like to take this opportunity to remind you of some of the opportunities provided by the group, of which you can find more details within these pages. The annual Surface Science Lecture Series provides the possibility for you to host a funded overseas speaker to give a seminar at your institution of a topic of interest to the surface science community. The Wooduff Prize is a chance to recognise an exceptional PhD thesis in the general field of surface science and student bursaries are available for conference attendance.

Best Regards,

**Neil Curson (Chair of the TFSG)**

London Centre for Nanotechnology

UCL



(n.curson@ucl.ac.uk)

## Reports on TSFG Sponsored Meetings

### Surface Science with Synchrotron Radiation

The Solid Surfaces Group of the Royal Society of Chemistry hosted a half day symposium entitled 'Surface Science with Synchrotron Radiation' at Burlington House in London on 22 January 2014. Prof. Geoff Thornton, introduced the meeting with a tribute to his friend and colleague, Dr Paul Wincott, to whose memory the symposium was dedicated.

Dr Jorg Zegenhagen (Diamond); Prof. Georg Held (University of Reading) and Prof. Chris Lucas (University of Liverpool) presented invited talks describing the use of state-of-the-art synchrotron techniques for the characterisation of surfaces at the gas-solid and liquid-solid interfaces. In addition, six talks and nine posters were presented by PhD students and post-docs

covering a wide range of synchrotron-based research activities.

Sponsorship was gratefully received from SPECS, XMaS and the Thin Films and Surfaces Group of the Institute of Physics.

### ICSOS11: 11th International Conference on the Structure of Surfaces

The 11th International Conference on the Structure of Surfaces was held in the Arts Centre of the University of Warwick from 21-25 July 2014. The conference was the latest in a series that has been held every three years since the first meeting in Berkeley, USA, in 1984, focusing on structural studies (and particularly quantitative structure determinations) of solid surfaces and interfaces. This was the first time it has been held in the UK. The 131 delegates included 39 from the UK, 57 from Europe, 27 from the Asia-Pacific region and 6 from North America; a total of 24 countries were represented. The format was of a single oral session including 15 invited lectures and 51 contributed lectures, plus 50 posters presented in two separate evening sessions. In addition Professor Klaus Heinz (University of Erlangen), the winner of the 2014 ICSOS Prize, presented his prize lecture on *Surface crystal-*

*lography by LEED - a demonstration of present capabilities* while the meeting also provided an opportunity for the British Vacuum Council to present its annual medal and Prize to Professor Geoff Thornton (University College, London).

The meeting provided an opportunity to gain insight into the current state of investigations and experimental determinations of surface structure and their understanding through theoretical and complementary experimental methods. While the traditional 'benchmark' method of surface structure determination using low energy electron diffraction figured in the meeting, not only through Klaus Heinz's insightful review, but also in contributed papers that indicated a resurgence of interest in this method, a range of other methods were in evidence including the use of scanning probe methods to provide not only qualitative imaging but also quantitative understanding of geometrical and electronic structure. Presentations also showed clearly the value of

complementary methods applied to single structural problems, such as in the growth of graphene films and ribbons on metal substrates for which X-ray scattering and low energy electron microscopy are providing new insights. Surface structural methods are also being applied to increasingly challenging materials, such as complex oxides and alloys, and topological insulators.

The single-session single-site format with suitably lubricated evening poster sessions ensured lively debate and a series of excellent presentations led to a highly fruitful scientific meeting. The weather was also (very) kind to us, dispelling some myths previously held by delegates regarding the English climate, while an afternoon excursion to Warwick Castle added to the general well-being of delegates.

**Prof. Phil Woodruff  
(Conference Chair)**



**Thin Film Oxide Coatings: recent developments and applications**

This meeting was organised jointly by the Vacuum, Thin Films and Surfaces and Ion and Plasma Surface Interactions Groups of the Institute of Physics and held in the Lovell Seminar Room in the Alan Turing Building at Manchester University on 16<sup>th</sup> April 2014.

The one-day programme comprised 7 Invited talks and 7 contributed papers and covered a wide range of techniques for forming oxide coatings, applications, optimisation of growth parameters and modelling of the growth process.

Interesting talks on the methods for formation of coatings were given by Gin Jose (Leeds) using pulsed laser methods, Louise Bailey (Oxford Instruments Plasma Technology) by sputtering, Kevin Cooke (Teer Coatings Ltd.) by closed-field unbalance magnetron sputter ion plating, by Nianhua Peng (Surrey Ion Beam Centre) by implantation of oxygen ions into Si to form a buried oxide layer, Victor Bellido-Gonzales who reported on new system designs to minimise use of sputter cathodes and by John Hodgkinson (Salford) who described the use of atmospheric plasma systems to form copper, copper-oxide and copper/silica nanocomposite

**Plasmas, Surfaces and Thin Films**

This one-day event has been organised in June for a number of years by the IPSI group. In the past the talks were equally split between academia and industry but this year they were

films for use as anti-microbial surfaces.

Martyn Pemble discussed the need to replace silicon-based devices by InGaAs and showed recent results where atomic layer deposition has been used to form pin-hole free high-k dielectric layers on this alternative material. Applications of oxides and oxy-nitrides for catalysis were discussed by Kevin Cooke and Louis Bailey, the former showing that higher levels of oxide in the discharge favour formation of anatase TiO<sub>2</sub>, the latter presenting data which showed that it was difficult to form silicon oxy-nitride directly and the best route was via oxidation of Si<sub>3</sub>N<sub>4</sub>. Russell Egddell described a novel solution-based dip-coating method followed by an anneal which produced (001) oriented anatase and Sn-doped anatase films on SrTiO<sub>3</sub> (001), the latter a promising photocatalytic material. Geoff Thornton reported results on the growth and characterisation of TiO<sub>2</sub> (110) and CeO<sub>2</sub> (111) ultra-thin films on crystalline metal substrates which indicated preferential nucleation on step edges associated with defects. Mark Jackman reported on work using synchrotron radiation of anatase (101) and rutile (110) TiO<sub>2</sub> to study effects of oxygen vacancies on the surface and sub-surface regions which showed the rutile to be

mostly academic talks.

In 2014 the main invited talks were on plasma etching and deposition by magnetron sputtering and pulsed laser deposition. In addition there were a number of contributed talks and posters including a prize for the

more resilient to vacancy formation.

The status of Transparent Conducting Oxides (TCO)'s was discussed by Jake Bowers who showed that mixed In/O and Zn/O and Al-doped ZnO can be formed at relatively low temperature. Robert Treharne described a technique for assessing optimum deposition conditions for potential new TCO's from a single deposition run designed so that different regions experienced different deposition parameters. The latest drive is to improve mobility, transparency and mechanical flexibility of these layers.

Roger Smith gave a useful layman's description of a so-called "on-the-fly" Monte Carlo method for modelling TiO<sub>2</sub> film deposition. Results show that the energy of the depositing particles plays an important role in the resulting film morphology, with evaporation producing a void-filled incomplete structure whereas sputtering produces crystalline growth. Mark Lundie presented data on the oxidation of graphene which effectively opens its band gap to make it optically active for photonics applications

I take this opportunity of thanking all speakers for their very interesting presentations which provoked a lively discussion.

**Prof. John Colligon**  
(Conference Chair)

best student poster which was won by a PhD student from Manchester Metropolitan University.

**Prof. Roger Smith**  
(Conference Chair)

### 5th Vacuum Symposium UK

On 15th & 16th October 2014 at the Ricoh Arena, Coventry, the 5th Vacuum Symposium UK Conference hosted a variety of technical meetings of general and specialist interest that attracted 171 delegates. The Conference is established as an annual event alongside Vacuum Expo and provides a forum for scientists, academics, technicians and industrial users who share 'vacuum' as a common interest.

This year there were four technical meetings, three of which were free to attend made possible by the support of twenty sponsors from industry and academia.

The **Surface Modification and Analysis** meeting was jointly organised by five IOP Groups. Invited Speakers from National Research Laboratories and Universities in the UK, Germany and Austria presented latest information on many aspects of the meeting topic.

The **Functional Thin Films** meeting provided a comprehensive mix of presentations on the production, characterisation and commercial applications of functional coatings. Speakers travelled from as far as Germany and Italy, giving talks on advanced functional coatings using HIPIMS and the ionized jet deposition process as a new class of thin film deposition equipment.

The **12th UK Technological Plasma Workshop** joined Vacuum Symposium this year. The

Technological Plasma Workshop (TPW) is principally a UK-based international forum in science and technology of plasmas and gas discharges. A diverse series of presentations were given in fields ranging from impedance matching for capacitive and inductively coupled plasmas for materials processing, through the use of cold plasmas for biomedical sterilization and food treatment and environmental applications such as the use of plasmas in catalytic conversion of carbon dioxide and the removal of formaldehyde. Space applications were covered with a presentation on scaled experiments and simulations of the magnetosphere.

The **Contamination Control, Cleaning and Surface Preparation for Vacuum Applications** proved very popular with delegates, enlightening us that this topic is often more important than the selection of the vacuum equipment itself! The meeting covered the legislation related to cleaning fluids, the control of particulates during assembly, and measurement of the results using an RGA. The procedures and improvements in contamination control in the semiconductor industry, through to particle accelerators, was most informative. In addition, there was a real case study of how best practice employed by Nikon led to significant product improvement.

**Training.** Demand for basic and advanced training in vacuum science and technology within the UK continues to be high.

The small course fee did not deter attendance, in fact it encouraged people to turn-up and gain knowledge from the experienced Trainers, Austin Chambers & Ron Reid. The majority of attendees were vacuum users from UK industry where applications of vacuum continue to increase. The training course on 'Clean Vacuum & UHV' now in its second year proved very popular and has helped many to grasp a better understanding of this increasingly important area. Training was sponsored by the British Vacuum Council.

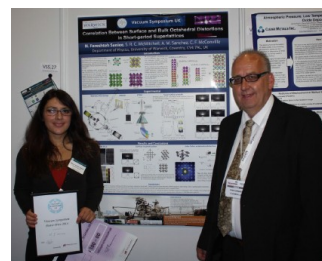
**Poster Sessions** were held in the exhibition hall (Vacuum Expo) over both days of the event and included posters covering many of the topics featured in the technical meetings.

Poster Prize winners were Dr Holly Hedgeland, London Centre for Nanotechnology, UCL and Nessa Fereshteh Saniee, Department of Physics, University of Warwick .

Plans are underway to develop an interesting programme for the **6th Vacuum Symposium UK**, 14/15 October 2015. Those wanting to participate or arrange a technical programme are invited to express their interest through the Vacuum Symposium website at [www.vacuum-uk.org](http://www.vacuum-uk.org).



Poster Prize winners Dr Holly Hedgeland, London Centre for Nanotechnology, UCL (above) and Nessa Fereshteh Saniee, Department of Physics, University of Warwick (below).



## TSG Student Bursaries

*“Research Student Conference Fund (RSCF) bursaries are available to PhD students who are a member of the Institute and of an appropriate Institute group.”*

*The Institute of Physics (IoP) provides financial support to research students to attend international meetings and major national meetings.*

The Institute of Physics handles the application process but it is the relevant IoP group that makes the decision on whether to award the bursary and its value.

Research Student Conference Fund (RSCF) bursaries are

available to PhD students who are a member of the Institute and of an appropriate Institute group.

Students may apply for up to £250 during the course of their PhD and may apply more than once, for example they may request the full amount or decide to request a smaller amount and then apply for funding again for another conference at a later stage.

Note that grants will normally cover only part of the expenses incurred in attending a conference and are intended to supplement grants from other sources.

For details and application form please look at the information for students on the iop.org website.

All recipients are asked to produce a report on return from their conference before receiving payment.

## Reports from TSG Bursary Funded Students

### Patrick Isherwood

#### **MRS Spring Conference 2013, 1st - 5th April 2013, San Francisco, USA**

The MRS Spring Conference was both fascinating and highly enjoyable. For the most part I attended the talks from my own symposium (C: Thin Film Compound Semiconductor Photovoltaics), but one of the things I enjoyed most was the opportunity to discover research into materials and technologies that I had limited knowledge of. Several talks from other symposia and various posters from the evening poster sessions provided valuable insights and potential areas for investigation that I would not otherwise have thought of. It was also a fantas-

tic opportunity to meet people from a very wide range of other universities, companies and research institutions and to discuss both my own work and that of others.

The main body of the work presented in the thin film symposium revolved around cadmium telluride, copper indium gallium diselenide and copper zinc tin sulphide. It was very interesting to see how much thin film photovoltaics research has become focussed on these three areas, and specifically on the characterisation of the materials rather than synthesis. The talks presented some fascinating results and provided a lot of interesting, informative and highly entertaining discussion, both in the sessions and in the more

informal atmosphere provided by coffee and lunch breaks.

Perhaps one of the more unusual events during the conference was a speech given by Arun Majumdar, Google's Vice President of Energy, entitled "A New Industrial Revolution for a Sustainable Energy Future". It was interesting to hear Google's take on energy security and climate change, particularly as Google is a prolific user of energy, but also an innovative company with a strong interest in new and evolving technologies.

I found this conference to be both successful and very rewarding, and I would thoroughly recommend the next MRS Spring Conference to anyone with an interest in current materials research.

### Fahima Indeir

#### **International Conference on Metallurgical Coatings and Thin Films, 29th April - 3rd May 2013, San Diego, USA**

This 2013 ICMCTF Conference was the 40th in a series dating back to 1974; it has long been held in high regard as the main annual research meeting worldwide for vacuum surface treatment techniques. The conference attracted over 700 attendees from all over the world, promoting an exchange of the latest information among scientists, technologists and manufacturers involved in metallurgical coatings and thin films.

The highlights of the conference for me were the opportunities I had to:

Attend PVD coatings and technologies sessions which gave me new ideas concerning my research.

Hear invited talks directly related to my area of research (e.g. a review of evaluation of corrosion behaviour of PVD Al-based coatings).

At the poster session, I had the opportunity to discuss my work with eminent Academic and Industrial professionals in the field, most of who found my work to be of considerable sci-

entific interest – and relevant to current commercial issues in Surface Engineering. During the exhibition, I had discussions with manufacturers and people that can provide technical support for my current studies as well as future research ventures. Apart from the theoretical and technical knowledge gained at the conference, San Diego is a warm and beautiful city and I enjoyed every moment I stayed in it. Finally, without any doubts, I will say that the 40th International Conference on Metallurgical Coatings and Thin Films was a huge success.

**Mrs Fahima Indeir**

*“a fantastic opportunity to meet people from a very wide range of other universities, companies and research institutions”*

**Andrew Naylor**

**223rd Meeting of The Electrochemical Society, 12th - 16th May 2013, Toronto, Canada**

This major international conference, organised by The Electrochemical Society (ECS) and held in Downtown Toronto, brought together participants from all over the world to share interests in electrochemistry and solid state science. The program spanned five days and included 44 topical symposia ranging from “Nanoarchitectures for Energy Storage” and “Green Electrodeposition” through “Porphyrin and Supramolecular Assemblies” to “Advanced Semiconductor-on-Insulator Technology and Related Physics”.

Over 1500 technical presentations and more than 100 poster presentations were made, the latter spanning two evening sessions. Proceedings kicked off on Sunday with Short Courses for registered delegates. The evening offered a complimentary Student Mixer for registered students to get to know each other over some appetizers

**Fatemeh Pakpour**

**The International Symposium on Quantum Fluids and Solids (QFS2013), 1st - 6th August 2013, Matsue, Japan**

As a final year PhD student, I found the conference very informative and helpful for my progress in the subject area. Meeting famous faces in the field of quantum turbulence, which is my speciality, such as William Vinen, Ladislav Skrbek, Vladimir Eltsov, Carlo Barenghi, and many others, was a great pleasure. It was also a good chance to listen to their enlightening talks and valuable presentations in this topic.

In all other topics in the field of quantum fluids and solids there were many brilliant speakers with brand new research and interesting results. I especially enjoyed listening to a talk by

and drinks at the Real Sports Bar & Grille whilst watching the Toronto Maple Leafs beat the Boston Bruins 2-1 in the playoffs.

A huge team of ECS staff were responsible for organising the meeting and for ensuring its smooth running throughout the week: many thanks for their efforts. While the technical sessions ran from Monday until Thursday, the official opening of the meeting was made by ECS President Fernando Garzon on the Monday. “The ECS Lecture”, presented by Dr. Michael C. Mayberry of Intel Corporation, was a thoroughly interesting lecture given on the frontier of electronics research and the strategies required to deliver the next level of computing power.

The 2013 ECS Gordon E. Moore Medal for Outstanding Achievement in Solid State Science and Technology Award Lecture was presented by Prof. Fan Ren of the University of Florida on wide bandgap semiconductors for sensing applications. The opening reception took place in the evening and gave delegates the opportunity

John Beamish from University of Alberta about elasticity, plasticity and defects in helium crystals.

An interesting new technique (Magnetic Resonance Spectroscopy Imaging) to study inhomogeneous textures in superfluid <sup>3</sup>He was introduced by Yutaka Sasaki from Kyoto University. There was another interesting presentation by Victor Tseplin from Lancaster University about the turbulent drag in superfluids.

I presented a poster on experimental work undertaken in the course of my PhD project. I had very useful discussions with people about my experiment. Now I feel more confident about my research and I think our work was an achievement, which grabbed the attention of many scientists in this subject.

to discuss their thoughts on the first day of proceedings and which restaurants or bars they had found since arriving in Toronto.

The Student Poster Session took place on the Tuesday evening alongside the Technical Exhibit. Over 80 students took part in the session and it was pleasing to see such strong interest from the more experienced conference participants, only partly due to the selection of complimentary beers and snacks available. The Student Poster Award Presentation took place on Wednesday evening with 1st Place for Electrochemistry being awarded to Michal Osiak (University College Cork) and 1st Place for Solid State Chemistry being awarded to me.

Congratulations to all of the presenters for their hard work – it really made the conference a huge success. I look forward to many more ECS meetings in the future and to keeping in touch with newly formed contacts. I would like to acknowledge the IOP Thin Films and Surfaces Group for making my attendance at this conference a reality.

One of the most important aspects of the conference for me was the opportunity to talk to several professors in my field of research about my career. Some of them had excellent advice for me on how to find a job, and I hope at least one of them will offer me a job in the near future. The conference was an excellent medium for networking to me.

Along with the wonderful scientific aspects of the conference, everybody enjoyed the fantastic Japanese food. I personally enjoyed visiting the beautiful landscape around Matsue and on the shore of the Sea of Japan on the excursion day. The banquet in a garden of flowers was really memorable. Finally, I deeply appreciate kind hospitality of the organizers of the conference, for their hard work which made the conference unforgettable for all the participants.



*Andrew Naylor being presented with the Student Poster Award by ECS President Fernando Garzon.*

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*“One of the most important aspects of the conference for me was the opportunity to talk to several professors in my field of research about my career”*

## Woodruff Thesis Prize 2013: Winner

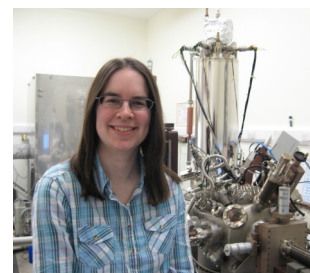
The 2013 Woodruff thesis prize (awarded for a thesis submitted in the 2013 calendar year) has been awarded to Dr. Catherine Doyle, Trinity College Dublin, Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN), for her thesis “*An Investigation of the Structural and Electronic Properties of Covalently Bonded Molecular Networks on Metal Surfaces Formed Through Debromination Reactions*”.

The thesis focused on covalently bonded nano-networks formed

via the addition of thermally debrominated molecular radicals. The deposition, self-assembly, network formation and molecule-substrate interaction of brominated molecules with four-, three- and two-fold symmetry on the Au(111), Au(110), Ag(111) and Cu(111) metal surfaces was studied.

The multi-technique nature of surface science was highlighted by the use of scanning tunneling microscopy (STM), x-ray photoelectron spectroscopy (XPS), low energy electron

diffraction (LEED), and synchrotron radiation based photoelectron spectroscopy (PES) and near-edge x-ray absorption fine structure (NEXAFS). Experimental work was performed in Dublin City University, Ireland and synchrotron radiation facilities in MAX-lab, Lund University, Sweden and ISA, University of Aarhus, Denmark.



*Dr. Catherine Doyle, Winner of the 2013 Woodruff thesis prize.*

## Woodruff Thesis Prize 2014: Call for nominations

The Woodruff thesis prize is awarded annually by the Thin Films and Surfaces Group (TFSG) of the Institute of Physics (IOP) for the best PhD thesis completed by a student member of the TFSG in the stated year. The prize is £200 and an associated certificate. Nominations must be made using an application form that can be obtained from the TFSG

group website ([http://www.iop.org/activity/groups/subject/tfsg/prize/page\\_50366.html](http://www.iop.org/activity/groups/subject/tfsg/prize/page_50366.html)) and submitted to the Chair of the TFSG (Neil Curson, email: [n.curson@ucl.ac.uk](mailto:n.curson@ucl.ac.uk)) at any time before the closing date of 31st October 2015. In addition to the application form, an electronic copy of the thesis should be submitted, with a small section iden-

tified that represents the highlight of the thesis. The qualifying period is the calendar year 2014 during which time the thesis must have been successfully examined for a PhD and the final version submitted (theses originally submitted in 2013 are therefore eligible if they were examined in 2014).

## TFSG Lecture Series for the 2016 calendar year

The IOP Thin Films and Surfaces Group (TFSG) Lecture Series enables universities in the UK to bring a European or International inspirational surface scientist to give a lecture at their institution, open to all the surface science community to attend free of charge. We are looking to entice the ‘big names’ in our field who will attract a UK wide audience to the seminar. The lectures will be publicised to all members of the Thin Films and Surfaces Group of the IOP and must be open to attendees outside of the host institution

(subject to the capacity of the available venue).

To facilitate this series, funds can be requested from the Thin Films & Surfaces Group to contribute towards the travel costs of the invited speaker. Up to three separate lectures will be funded each calendar year. The call for funding for 2016 opens on 1st January 2016 and funds will be allocated on a first-come first-served basis, provided they meet the rigorous standards of the call. For this round, funds of up to £300 for a speaker from Europe, or £500 for an Interna-

tional speaker may be applied for. Application forms can be requested from the Chair of the TFSG (Neil Curson – [n.curson@ucl.ac.uk](mailto:n.curson@ucl.ac.uk)).

One applicant was awarded the a Lecture Series award this year. He is Professor John O’Connor from University of Newcastle in Australia and he will give his seminar at Imperial College London. Details of the forthcoming talk will be sent to the TFSG membership by email and a report on the seminar will be provided in the next Newsletter.

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*“The IOP Thin Films and Surfaces Group (TFSG) Lecture Series enables universities in the UK to bring a European or International inspirational surface scientist to give a lecture at their institution”*

## Research Profile: *Physics of surface analysis meets biological interfaces*

### Santanu Ray, National Physical Laboratory

The fundamentals of physics at biologically relevant surfaces are important to healthcare industry, medical technology and smart materials. At the Surface and Nanoanalysis group, National Physical Laboratory, we are focused on the measurement of physics and chemistry at surfaces and interfaces from the macroscale to the nanoscale. Our group, Surface and Nanoanalysis (under Analytical Science Division) is involved in many aspects of surface characterisations and applications. There are three strategic areas in Surface and Nanoanalysis group, namely, *Mass spectrometry imaging* – led by Dr. Ian Gilmore, *Quantitative surface chemical analysis* – led by Dr. Alex Shard and *Optical spectroscopic imaging* – led by Dr. Debdulal Roy. Currently, I am in the area of *Quantitative surface chemical analysis*. At NPL, my present interest is on quantitative measurements of biomolecules at flat and curved surfaces for Diagnostic Devices. In this short article, I would like to highlight some fundamental issues regarding characterisation of biological interfaces and some aspects of our work in this amazing field.

Biomolecular adsorption is critical and indispensable to applications in solid phase immunoassays for medical diagnostic tests, biosensors, biomaterials, and immobilized enzymes in bioreactors. Quantification of the adsorbed biomolecules/proteins is critical and could vary up to 600% depending upon techniques that are used to

analyse them. In one of our recent work (Anal. Chem. 2011), we have quantified the surface adsorbed protein using XPS and have shown the requirement of surface high resolution imaging while analysing these biologically relevant systems (see right panel, Figure 1).

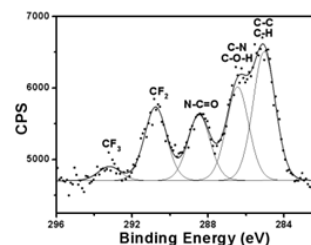
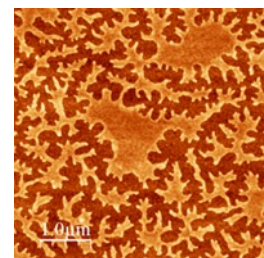
On the other hand, in the field of regenerative medicine, biomimetic extracellular matrices are prerequisite for a variety of applications for modern molecular medicine. Atomic force microscopy provides a detailed insight into its structure and can help providing fundamental details on the branching and formation of fibres. In collaboration with Dr. Maxim Ryadnov of the Biotechnology Group, NPL, we have successfully synthesized and characterised biomimetic extracellular matrices and shown the application in relevant fields (Angew. Chem 2011 and JACS 2014) - Figure 2. High resolution imaging also helped in finding a new state in pore formation mechanism by antimicrobial peptides (PNAS 2013).

In our strategic research area, we are also involved in characterisation on nanoparticles and studying their interaction with biomolecules, which is led by Dr. Caterina Minelli. The intentional and unintentional attachment of molecules, e.g. proteins, to nanoparticles' surface is of increasing interest in applications such as drug delivery, diagnostics and catalysis. Understanding and refinement of the performance of nanoparticle

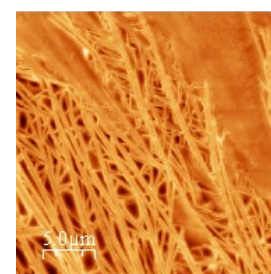
products require accurate and quantitative characterisation of their interface. The interests of our group focus on developing measurement methods to enable useful characterisation of nanoparticles' molecular interfaces. We adopt an original approach where characterisation of nanoparticles in their colloidal form and in vacuum are performed in parallel. The complementarity of the approaches reveals further insight into nanoparticles' molecular interfaces, e.g. molecular conformation and quantitation of bond water. It also allows for validation of the methods, which is important for their application to a wide range of nanoparticle types. For example, dynamic light scattering and localised surface plasmon resonance analysis are not suitable for dealing with aggregated samples, but X-ray photoelectron spectroscopy (XPS) is, while XPS measurements of organic nanoparticles are challenging and liquid based techniques may be preferred.

Dr. Santanu Ray,  
Surface and Nano-Analysis  
National Physical Laboratory  
Teddington, Middlesex,  
TW11 0LW  
United Kingdom.  
Email: santanu.ray@npl.co.uk

[www.npl.co.uk/nanoanalysis](http://www.npl.co.uk/nanoanalysis)



**Figure 1.**  
Top: AFM image of dewetted immunoglobulin-g protein after being exposed to UHV conditions following adsorption on a flat surface;  
Bottom: XPS narrow scan C1s spectra of fibrinogen adsorbed on fluorinated hydrophobic surface. *Analytical Chemistry*, **2011**, 83,8659–8666.  
© Crown Copyright



**Figure 2.**  
AFM image of peptide fibres forming extracellular matrices *Angew. Chem. Int. Ed.* **2011**, 50, 1 – 5.  
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**TFSG Committee**

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Institute of Physics  
Thin Films and Surfaces Group  
76 Portland Place  
London  
W1B 1NT

**Editors**

Dr Michael Hunt  
Centre for Materials Physics  
Durham University  
E-mail: [m.r.c.hunt@durham.ac.uk](mailto:m.r.c.hunt@durham.ac.uk)

Dr Karen Syres  
School of Physical Sciences and Computing  
University of Central Lancashire  
E-mail: [ksyres@uclan.ac.uk](mailto:ksyres@uclan.ac.uk)

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<http://tsfg.iop.org>

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**Chair**

Dr Neil Curson UCL  
[n.curson@ucl.ac.uk](mailto:n.curson@ucl.ac.uk)

**Vice-Chair**

Prof. Andrew Evans Aberystwyth University  
[a.evans@aber.ac.uk](mailto:a.evans@aber.ac.uk)

**Secretary**

Dr Andrew Thomas University of Manchester  
[a.g.thomas@manchester.ac.uk](mailto:a.g.thomas@manchester.ac.uk)

**Treasurer**

Dr Holly Hedgeland UCL  
[h.hedgeland@ucl.ac.uk](mailto:h.hedgeland@ucl.ac.uk)

**Ordinary Members**

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**Call for highlights**

We are keen to highlight significant achievements and profile research in Surface Science within the UK in order to demonstrate the vibrancy of our field. If you have a story or would like your research group profiled in the news letter, please contact Michael Hunt at: [m.r.c.hunt@durham.ac.uk](mailto:m.r.c.hunt@durham.ac.uk)

