

Winter 2018

IOP | Institute of Physics

Thin Films and Surfaces Group

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Welcome from the Vice-Chair

Dear members,

Welcome to the Thin Films and Surfaces Group (TFSG) winter 2018 newsletter. First of all, I would like to welcome our two new ordinary members, Dr Hem Raj Sharma from the University of Liverpool and Dr Steven Stanley from ADS Group Ltd and Light Coatings Ltd, who were elected to the TFSG committee over the summer.

The big event for the committee this year was the second Summer School on nanoscience@Surfaces, held at the Cavendish Laboratory in Cambridge in August. The event, aimed at PhD students studying surfaces and interfaces, was first run in 2016 and was a big success with delegates. We anticipate this becoming a regular event held every two years. The TFSG also sponsored several other conferences and meetings throughout the year. You can

read the chair's report on the summer school and other sponsored meetings in the newsletter. Our main event next year will be the Interdisciplinary Surface Science Conference, ISSC22, which will be held at Swansea University in April 2019.

We received some excellent nominations for the 2017 Woodruff Thesis Prize. This is a prize the TFSG awards for the best PhD thesis completed by a student member of the group in the stated year. The value of the prize is £200 and was established to encourage and recognise high quality research and scientific writing in the field of thin films and surfaces. Congratulations to Dr Thomas James Whittles from the University of Liverpool who has been awarded the 2017 Woodruff Thesis Prize for his thesis titled "Electronic Characterisation of Earth-Abundant Sulphides for Solar Photovoltaics". Nominations are now open for the 2018 Woodruff Thesis Prize. The application form can be obtained from the TFSG group website and submitted to Andrew Jardine (Chair of the TFSG: apj24@cam.ac.uk) any

time before the closing date of 30th April 2019.

In other news, the new IOP headquarters at King's Cross is now complete and we held our first TFSG committee meeting there in November. The new building features state-of-the-art seminar rooms, great views over London and a massive touchscreen in reception! Definitely worth a visit.

Best wishes,



Karen Syres (Vice-Chair of the TFSG)

Jeremiah Horrocks Institute, UCLan

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TSFG Student and Early Career Bursaries

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

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 **£300** 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. All recipients are asked to produce a report on return from their conference before receiving payment. For details and application form please look at http://www.iop.org/about/grants/travel-bursaries/page_69141.html.

* Please note that bursaries are not available for meetings organised by the Institute of Physics including those organised by IOP Groups.

Reports on Meetings Organised and Sponsored by the TFSG

Plasma Surface Interactions and Applications for Coatings and Tribology (PSIACT)

John Colligon

14th June 2018; Bronte Lecture Theatres. Room BLG10, University of Huddersfield, HD1 3DH

The 2018 conference was held at Huddersfield University and organised by the IPSI group of IOP, with support from the Tribology and Thin Films and Surfaces Groups. We are very grateful to all participating groups for this support which allowed the event to be free.

The programme of this event is given below.

Invited talks by established researchers

Session chair: Prof John Colligon

10-35 Rob Harrison, University of Huddersfield
'A New in-situ Dual Ion Beam System for Investigation of Ion Implantation and Damage'

11-05 Roger Webb, University of Surrey
'The UK National Ion Beam Centre – what it is and what it can do for you'

11-35 Tomasz Liskiewicz, University of Leeds
'Functional DLC Coatings for Tribological Applications'

12-05 P. Eh. Hovsepiyan, National HIPIMS Technology Centre, Sheffield Hallam University
'Tribological Performance of Superlattice Structured Coatings Deposited by High Power Impulse Magnetron Sputtering'

12-35 AGM of the Ion and Plasma Surface Interactions Group
12-45 Buffet lunch and poster session

Researcher talks

Session chair: Samuel McMaster

14-00 'Effect of Humidity on the Lubricity and Lifetime of MoS₂ in Nitrogen Environments'
Z. Thompson, Institute of Functional Surfaces, School of Mechanical Engineering, University of Leeds, AWE Aldermaston, Reading, Berkshire, RG74PR

14-15 'Influence of Substrate Surface Roughness on The Characteristics of MW-PECVD DLC Coating on 3D Printed Polymers'

Frank Dangnan, School of Mechanical Engineering, University of Leeds, LS2 9JT, UK

14-30 'Titanium dioxide coated fly ash'
A H Gaddah, Surface Engineering group, Manchester Metropolitan University

14-45 'Characterisation of silicon-oxide coatings'
Emily McNulty, Institute of functional surfaces, school of Mechanical Engineering, University of Leeds

Session Chair: Samuel Capp

15-15 'Photocatalytic Activity of coatings prepared By Magnetron Sputtering for Future use In Non-Thermal Plasma Reactors'
Samuel C Capp Manchester Metropolitan University

15-30 'Nanomechanical and Impact-Erosion Characterisation of DLC Coating Systems'
Sam McMaster, Institute of Functional Surfaces, School of Mechanical Engineering, University of Leeds

Posters were assessed for one prize and, marks for the oral presentations, were the basis of awarding a second prize. The standard of presentation was generally high and, after much deliberation, Samuel Capp and Sam McMaster were awarded prizes for their talks. The poster winners were Emily McNulty and Frank Dangnan.

Several students expressed their appreciation for this event and we hope that more than the 25 delegates will attend the next conference in June 2019?

COMING SOON **ISSC-22 Interdisciplinary Surface Science Conference**

15-18 April 2019
Village Hotel, Swansea, UK

Registration will open soon:

<http://issc-22.iopconfs.org/>

ISSC-22 is the latest meeting in the series of interdisciplinary surface science conferences covering all experimental and theoretical aspects of surfaces, interfaces and nanoscale physics and chemistry.

If you have any ideas for future meetings or events, please contact the group chair, Dr Andrew Jardine (apj24@cam.ac.uk).

Summer School on nanoScience@Surfaces 2018

Andrew Thomas

Chair of the Summer School

The second biannual summer school on nanoScience@Surfaces, organized by members of the Thin Film and Surfaces Group Committee, was held at the Cavendish Laboratory in Cambridge from the 30 July – 2nd August 2018. Based on feedback from the previous meeting this workshop was delivered in a more pedagogical way with themed lectures/talks. Each day kicked off with an overview of a particular technique followed by some more specialized adaptations of the techniques. Prof. Rob Jones from the University of Nottingham started the meeting with the opening talk. Entitled, “Getting it off and getting it on”, the talk focused on methods for preparing clean ordered surfaces and depositing molecules or layers upon them. The rest of the first day was dedicated to theoretical methods for surface structures and electronic structure, with talks by Drs. Steve Jenkins (Cambridge), Daniele Selli (Milano Bicocca) and George Darling (Liverpool). The evening entertainment was provided by Dr Karen Syres, with her Fermi quiz, in which the teams did spectacularly well.

The second day covered spectroscopy, with Prof. Wendy Flavell (Manchester) giving the overview talk, followed by Alex Walton (Manchester) and Georg Held (Reading) who described novel ambient pressure spectroscopy techniques using photoelectrons and X-ray absorption. The late afternoon speakers, Katie Moore (Manchester) and Andy Jardine (Cambridge) gave talks on very different ways of using ions for surface spectroscopy. The topic on Wednesday was scanning probe and electron microscopy techniques. Phil Moriarty (Nottingham) gave an entertaining overview of scanning probe and also focused on the pitfalls of image interpretation. This was followed by talks from Geoff Thornton (UCL), Rachel Oliver (Cambridge) and Neil Curson (UCL) on imaging oxides, nitrides and semiconductors. Giovanni Costantini (Warwick) and Stefan Rauschenbach (Oxford) completed the imaging day theme with an overview of the deposition, assembly and imaging of large molecules on surfaces. The day was concluded with the summer school meal, hosted by Sidney Sussex College.

The subject of the final day of the summer school was surface spectroscopy and diffraction techniques. Prof. Phil Woodruff (Warwick) covered general area of surface structural determination techniques. Chris Nicklin (Diamond Light Source) and Rob Lindsay (Manchester) then discussed the use of synchrotron radiation and electron diffraction in structural determination.

Workshops also ran during the summer School. Andrew Thomas (Manchester) ran a workshop on X-ray photoelectron spectroscopy data analysis, and Joe Smerdon (UCLan) ran a

workshop on image analysis for scanning probe microscopy. On the final day Kieran Cheetham (Liverpool) and Karen Syres (UCLan) oversaw a careers speed dating event, where a number of PhD graduates in surface, nanoscience and thin film technology talked about their experiences in industry, and how their PhD studies had prepared them for this.

Two poster prizes were awarded for research poster presentations by the students. First prize went to Henry Chandler for his presentation “Molecular Maracas: Investigating the potential of Li@C60 as a multi-state molecular switch.” The runner up prize was awarded to Alexander Allen for his presentation “STM and AFM investigation of bi-isonicotinic acid assemblies on Au(111)”.

The organizing committee is hoping that the summer school will run again in two years’ time. I would like to thank my fellow organisers, Joe Smerdon, Holly Hedgeland, Kieran Cheetham, and Karen Syres. A special thanks goes to Andy Jardine for all the local organization and handling the registration process. I’d also like to thank the following IOP Groups: Ion and Plasma Surface Interactions, Nanoscale Physics and Technology, Vacuum Group and Thin Films and Surfaces as well as the Royal Society of Chemistry Solid Surfaces Group and the Centre for Doctoral Training for Advanced Characterisation of Materials at UCL for their generous financial support.



Dr Andy Jardine (left) presents Henry Chandler (centre) with his First Prize Poster Certificate.

Thin Film and Coating Technologies for Science & Industry

Hayley Brown et al.

Dr Tomasz Liskiewicz from the University of Leeds opened the day's session by presenting several interesting case studies on the application of diamond-like carbon (DLC) coatings in internal combustion engine, oil and gas flow control devices, and surface sensors. This was followed by Prof Tomas Polar from the University of Southampton who explained that friction of solids in extreme applications is a complex and multiscale problem. With fascinating simulations Polar demonstrated that by using solid lubricant coatings (such as graphene or transition metal dichalcogenides) with self-adaptive nanostructure, it is possible to produce an ultra-low friction interface based on optimised low-dimensional structures in situ, i.e. during sliding. Prof Papken Hovsepian (Sheffield Hallam University) began his talk by explaining that main challenges faced by different steel components of the power plant consist of material failure due to high temperature oxidation, and phenomenon such as creep, erosion and descaling after a stipulated period of time. Hovsepian explained that their HIPIMS process does not have an adverse effect on the mechanical properties of the substrate material (P92 steel) and has been used to deposit excellent CrN/NbN coatings for environmental protection of steam turbine components due to its very dense microstructure. The morning session concluded with a keynote speaker, Dr Alex Ribeaud from Buhler Alzenau GmbH, Germany. Although Ion Beam Sputtering (IBS) is not a novel coating technique, Alex presented impressive results from the new IBS system. Their High Throughput version (HT) version enables the coating of 4 planets of up to 350 mm diameter substrates and their High Precision version (HP) allows coating of substrates up to 600 mm diameter in a single planet configuration, without the use of a mask.

The afternoon session commenced with a presentation from Professor Richard Fu from Northumbria University focussed on acoustic wave devices fabricated using piezoelectric thin films (mainly ZnO and AlN) for acoustic wave sensing and microfluidic applications. With some impressive videos, Professor Fu showed how thin film acoustic techniques have been used to fabricate surface acoustic wave (SAW) and film bulk acoustic wave (FBAR) devices, which allow sorting, mixing, pumping, nebulization and dispensing of fluids as well as gas sensing and bio-sensing. The thin film based flexible SAW devices have the potential to be integrated with other microfluidic and sensing technology on a variety of substrates including CMOS integrated circuits to make novel lab-on-chip for bio-detection for wearable and flexible applications. Dr Peiman Hosseini from Bodle Technologies Ltd (a start-up from Oxford University), then presented the highly innovative solid state display technology being developed by

the company. The technology is based on ultrathin layers of a phase change material which simply reflect light pixels. Colour in the image comes from a structural interference effect. The reflective nature of the display drastically reduces the power required to project an image and eliminates power requirements for a static image altogether. The materials are capable of a high enough refresh rate to deliver video and capable of use in both flexible and on-glass displays. Compared to traditional displays, the main advantage is power usage: if no backlight for the screen is required, the battery lasts longer or mains supply is minimal. Clearly, a technology with a great deal of promise!

Dr Marina Ratova from Manchester Metropolitan University presented advances in current work on magnetron-sputtered photocatalytic coatings for water treatment applications. Much research in this area has been focussed on TiO₂ based materials. However, a relatively new group of photocatalytic materials, bismuth oxide and complex oxides with low band gap values and high photocatalytic efficiency under sunlight, are also attractive materials for water treatment. The photocatalytic properties of such bismuth based coatings showed a clear ability to photodegrade various pollutants and water-borne microorganisms, both in laboratory conditions and under natural sunlight. The coatings also showed considerable antifouling effects, preventing the adhesion of microorganisms to the surface and therefore, providing a longer life cycle. The final presentation was given by Steve Spencer from NPL on organic PVD thin films as reference materials for many surface analytical techniques. These multilayer coatings are the best standard materials for accurate determination of depth resolution, constancy of sputtering yield and damage in the depth profiling of organic materials. The presentation highlighted the difficulties in depositing such organic compounds and the understanding developed at NPL to improve the deposition process and the quality of the multilayer coatings such that they exhibit a known, uniform layer composition and thickness.

A MEETING CONTRIBUTING TO



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Symposium on “Charge Transfer in Metal-Organic Systems at Surfaces”

Giovanni Costantini

The symposium took place on Wednesday, November 14th, 2018 in the Scarman Conference Centre on the University of Warwick campus in Coventry. The symposium was a success in bringing together researchers from across the UK to interact with experts from around the world. There were six talks that truly covered a wide variety of experimental and theoretical approaches to the topic of charge transfer in metal-organic systems at surfaces, and this was reflected in the presentations and discussion that were quite varied.

Prof. Hans-Peter Steinrück, from the Friedrich-Alexander-Universität, Erlangen-Nürnberg, Germany, presented the talk “In Situ Metalation of Porphyrins on Metal and Oxide Surfaces” where he discussed ‘intrinsic’ metal-organic complexes/molecules on surfaces. **Prof. José Ignacio Pascual**, from the CIC nanoGUNE, Donostia San Sebastián, Spain, spoke about “Charge Redistribution & Spin Localization in Molecular Systems on Surfaces”, dealing with inter- and intramolecular charge transfer processes (potentially mediated by surfaces) and their effects on the appearance of interesting electronic and magnetic properties. **Prof. Steven Tait**, from Indiana University, USA, debated about the potential of these type of systems for catalysis in his presentation on “Metal-ligand Redox Assembly at Surfaces for Single-site Catalysts”. **Dr. Reinhard Maurer**, from the University of Warwick, presented a theoretical point of view on the topic, discussing “A First-Principles Perspective on the Electronic and Spectroscopic Signatures of Charge Transfer at Metal-Organic Interfaces”. **Dr. James O’Shea**, from the University of Nottingham investigated the dynamics of charge transfer at metal- and semiconductor-organic interfaces in his talk on “Resonant Core-Level Spectroscopies for Probing the Electronic Structure and Charge Transfer Dynamics of Molecules at Surfaces”. Finally, **Prof. Nian Lin**, from the Hong Kong University of Science and Technology, analysed charge transfer and delocalisation phenomena within extended metal-organic networks that could be promising for exotic electronic properties, presenting his paper on “Charge Transfer in Metal-Organic Systems: from Local Contacts to Delocalized Bands”.

The program was constructed to allow a 35 minute presentation from each speaker, which was followed by 10 minutes for questions and discussion. After each pair of speakers, there were additional 20 minutes for general discussion. This discussion was robust and the time was well-spent as it allowed an in-depth exploration of the topics and a debate on some of the nomenclature and concepts that need revision in this field.

As it is usually the case, most of the formal discussion was between senior researchers at the symposium. As a consequence, in the last of the discussion sessions, it was decided to shift the emphasis and to actively move the focus on hearing from the students, postdocs, and early career researchers who made up the majority of the audience. This was extremely successful, resulting in excellent ideas and questions from several of the students.

There were around 40 attendees from the Universities of Warwick, Nottingham, Leeds, and Birmingham, plus a few from the continent, including the University of Groningen and the Forschungszentrum Juelich. In addition to the six invited speakers, there were several poster presentations during the breaks and a lively discussion during lunch also. The speakers kindly agreed to act as a jury for the poster presentation and they decided for an ex-quo poster prize to be awarded to Mr Yitao Wang from the University of Birmingham, and Dr Luis Perdigo, from the University of Warwick.

This was an outstanding event under every aspect, as demonstrated by the exclusively positive feedback that was received from the participants. There was a particularly high level of intellectual engagement and discussion compared to other meetings or workshops of this type and that was highly valued by the participants. The symposium was only possible thanks to the generous support of a number of sponsors that were acknowledged throughout the meeting: the Institute of Advanced Studies (IAS) of the University of Warwick, Warwick’s Global Research Priority (GRP) on Materials (also sponsoring poster prizes), the Thin Films and Surfaces Group (TFSG) of the Institute of Physics (IOP), the Solid Surfaces Group (SSG) of the Royal Society of Chemistry (RSC), and the Department of Chemistry of the University of Warwick.



https://warwick.ac.uk/fac/cross_fac/ias/news/events/ct_surf_symposium

In-situ Characterisation of Electrochemical Interfaces

Phil Woodruff

This one-day meeting was held on 26th September 2018 at the Photon Science Institute, Alan Turing Building, University of Manchester

The meeting comprised 5 invited papers aimed at showcasing the state-of-the-art in developing in-situ characterisation of electrochemical interfaces using microscopy, spectroscopy, and diffraction, methods that can provide comparable information on the electrochemical interface to that obtained at solid/vacuum interfaces in conventional UHV surface science.

The programme comprised:

Prof Chris Lucas, University of Liverpool

Probing the atomic and electronic structure at the electrochemical interface using surface x-ray scattering

Dr. Andy Wain, NPL

Imaging Nanostructured Solid-Liquid Interfaces using Electrochemical Scanning Probe Microscopy

Prof. Wolfgang Schmickler, Ulm University

Electron transfer at electrochemical interfaces - from outer sphere mechanism to electrocatalysis

Dr. Robert Weatherup, University of Manchester

Operando soft x-ray spectroscopy of reactions at electrode-electrolyte interfaces.

Dr Veronica Celorrio, UK Catalysis Hub

In-situ techniques for probing electrocatalytic reactions at metal and metal oxide nanostructures

55 delegates attended, including the invited speakers. A buffet lunch was provided and there was no registration fee. This was achieved with the benefit of sponsorship from the TFSG (£375), SPECS/Scanwel (£300), University of Manchester@Harwell (£200), The Sir Henry Royce Institute (£1000). This last item covered the cost of refreshments while the remainder of the sponsorship funds covered the travel and subsistence of the invited speakers.

Organisers: Phil Woodruff and Alex Walton (with Alex doing the lion's share of the work!)

Woodruff Thesis Prize 2017: Winner

The 2017 Woodruff thesis prize (awarded for a thesis submitted in the 2017 calendar year) has been awarded to Dr Thomas James Whittles from University of Liverpool for their thesis titled "Electronic Characterisation of Earth-Abundant Sulphides for Solar Photovoltaics".

Dr Whittles' thesis formed a very comprehensive study of certain materials in respect of their use as absorber layers within photovoltaic solar cells. The materials are both readily available and environmentally friendly – both important in light of the energy crisis. They were characterised using numerous surface techniques, but primarily XPS in conjunction with density functional theory, to give insight into their electronic structure. The result was a substantial increase in understanding of their performance, and the fundamental origin of that behaviour.



Dr Thomas Whittles - Winner of the 2017 Woodruff Thesis Prize

The committee was particularly impressed by the volume of Dr Whittles' published work, including 6 publications and 5 presentations that were directly related to the thesis, as well as contributions to a further 8 publications. We would like to congratulate him on winning the Woodruff thesis prize and wish him well in his future scientific career.

Woodruff Thesis Prize 2018: 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 **£250** 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) and submitted to the Chair of the TFSG (Andrew Jardine, email apj24@cam.ac.uk) at any time before the closing date of 30th April 2019. In addition to the application form, an electronic copy of the thesis should be submitted, with a small section identified that represents the highlight of the thesis.

The qualifying period is the calendar year 2018 during which time the thesis must have been successfully examined for a PhD (theses originally submitted in 2017 are therefore eligible if the viva date was during 2018). The final version, including any minor corrections, must have been submitted before the competition closing date. Please note non-TFSG/non-IOP members can be nominated for the prize provided they are nominated by an IOP member.

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