

Bond pad stack on an integrated circuit under development for high temperature aerospace application. Secondary electron image taken after high temperature exposure (300 °C for 10000 hours) to investigate the mechanism of catastrophic failure.

(Acknowledgement: Dr Colin Johnston Oxford Materials Characterisation Service Department of Materials University of Oxford ([www-omcs.materials.ox.ac.uk](http://www.omcs.materials.ox.ac.uk)).

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Message from the Editor

Welcome to the 2018 Institute of Physics Materials and Characterisation Group Newsletter. It's Spring – a time for renewal and new initiatives and a good example of this is the IOP HQ move scheduled for October, see <http://kingscross.iop.org/> for updates. In this edition you'll find reports from the conferences we ran and supported in the past year, along with information about forthcoming conferences. We sponsored a large number of student travel awards and details of the students' experiences of meetings they attended are described. We also aim to keep our members updated on initiatives they may be interest in. Since we have a large and diverse membership we would like to hear from you if there are any items or information you would like to see included in the newsletter. We've canvassed some of our members and have been informed that they still value receiving the printed version of the newsletter. If you would like to get involved, or have ideas for a conference please get in touch. The contact details for the group officers can be found on the back page.

I would like to thank Paul Binks for his editorship of previous newsletters. Paul will hopefully return to this role in 2019 but in the meanwhile happy reading.

Alison Crossley, Newsletter Editor
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This newsletter is also available on the web and in large print sizes: see <http://mc.iop.org>

The contents of this newsletter do not necessarily represent the views or policies of the Institute of Physics, except where explicitly stated.

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Chair's report

Dear M&C group member,

Quite a lot has happened since our last newsletter a little over a year ago. We have organised and co-sponsored numerous events, had two new members elected to the committee, supported many of our members' applications for travel bursaries and we capped 2017 off with another excellent Christmas lecture.

In the following newsletter, you will find reports offering a summary of some of the events we ran or co-sponsored. Running and supporting relevant events, either through our own initiative or by co-sponsorship, is something we strive to excel at and would welcome ideas and calls for support from our many members. For 2018, we already have a group led event planned (Nano medicine and characterisation) and others under consideration; we are again sponsoring PVSAT through a best student prize, while preparation for selecting a topic and speaker for this year's Christmas lecture is already at an advanced stage. All the relevant information can be found on our website and calendar

(<http://www.iop.org/activity/groups/subject/mc/>). I would suggest checking this periodically because it is continually being updated.

Regarding the committee and due to vacant positions arising, we advertised for two new ordinary committee members in 2017. The call was well received and as such it went to a vote. The successful applicants were Thomas Hase (Warwick University) and Andrew Pollard (NPL), and we look forward to their valuable contributions going forward. For those who missed out, I would again like to thank you for your interest.

Our committee also supports members in applying for travel subsidies. During 2017 we actively supported 11 students and young researcher applications for IOP travel bursaries, and look forward to receiving more in 2018 where we hope to again offer valuable financial support to our group members.

Finally, I would like to conclude by mentioning the Christmas lecture which followed on from our inaugural one of 2016. This committee led initiative has proven to be well attended and received by you and the IOP, hence plans are afoot to hold this again in mid to late December 2018. We will endeavor, as was the case last year, to also hold our committee meeting earlier in the day, thereby offering an excellent opportunity for you to engage face to face with our committee members over a glass of mulled wine and a mince pie at the evening lecture. So please, take this opportunity as we are always keen for feedback and to learn more about what our members would like us to focus on.

All that is left for me to say now is that I hope that you enjoy the following newsletter.

Best regards,

Richard (Chair M&C group).

Email: Richard.Morris@imec.be

Characterisation of Materials used in Nuclear Environments IOP Portland Place, London, 4 July 2017

Report by Paul Binks (Wood)

Characterisation of Materials used in Nuclear Environments was a one-day meeting held on Monday 4th July 2017 at the IOP, Portland Place, London. This event was organised by the Materials and Characterisation Group and sponsored by the IOP Nuclear Industry Group and AWE.

The first speaker was Mrs Helen Hulme (Amec Foster Foster) who discussed the corrosion behaviour of zirconium alloys. Zirconium alloys are used as nuclear fuel cladding materials due to their favourable corrosion resistance and hydrogen pick-up properties in nuclear reactor conditions. However, the corrosion behaviour is strongly dependent on the alloying elements present within the material and corrosion environment the material is subjected to. Work conducted in the Core Materials team at Amec Foster Wheeler focuses on extensive corrosion testing over a number of years to produce test specimens which have then been characterised using a range of techniques with the aim of understanding more about the physical mechanisms of zirconium alloy corrosion in order to aid corrosion predictions required to justify the safe operation of a nuclear reactor. The presentation focused on electron microscopy techniques such as Scanning Electron Microscopy (SEM) and Scanning Transmission Electron Microscopy (STEM) equipped with Electron Energy Loss Spectroscopy (EELS) which have been used to study the oxide microstructure formed under different corrosion environments. Results from this characterisation provide information on what effect the corrosion environment has on the developing oxide and metal microstructures and subsequent changes that occur during the transitional behaviour of oxide growth.

Professor Michael Preuss from the University of Manchester presented results of detailed studies using a multiscale characterisation approach by employing diffraction and novel electron microscopy techniques. In order to develop a better understanding of the evolution of damage and micro-segregation, proton as well as neutron irradiated zirconium alloys have been investigated using STEM-based ultrahigh resolution EDX spectrum imaging and synchrotron x-ray diffraction. These investigations have been carried out on two types of zirconium alloys, Zircalloys (containing no Nb) and Zr-Nb type alloys. These studies have provided a detailed picture and have enabled quantitative analysis of the evolution of $\langle a \rangle$ and $\langle c+a \rangle$ dislocation loops as a function of dpa. In addition, ultrahigh resolution EDX mapping provides new insight in the possible role of micro-segregation and the formation of nano-precipitates or nano-clusters on dislocation loop formation. These new observations are interpreted in the view of dimensional instabilities observed for zirconium alloys, particularly growth, as well as the potential impact on corrosion and hydrogen pick-up.

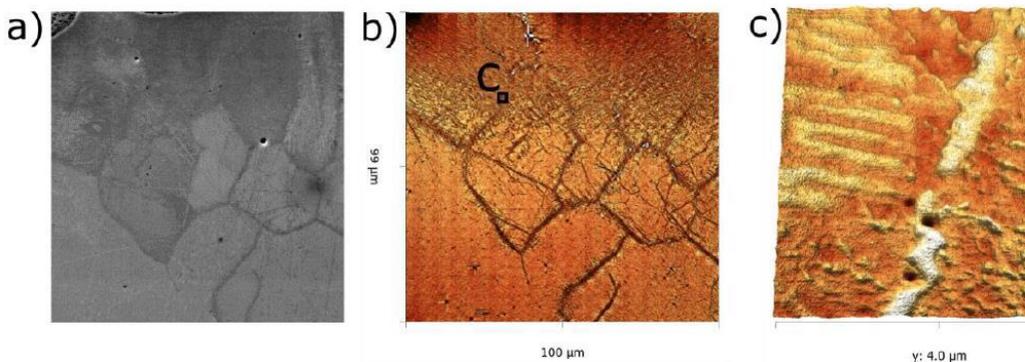
Dr Paul Styman from the National Nuclear Laboratory presented work on Support from Multiple Characterisation and Modelling Techniques in Predicting Reactor Pressure

Vessel (RPV) Embrittlement. The progressive embrittlement of the steel RPV is a life-limiting factor in the majority of Gen II and Gen III commercial nuclear power plants. It develops from the clustering of point defects into hardening centres and the segregation of solutes to grain boundaries. The hardening centres are on the nanometre scale, but no single microstructural characterisation technique is able to characterise the hardening centres and segregants completely. Paul illustrated how multiple techniques have been applied to characterise the hardening features, their development and interactions, and how understanding of microstructural development has underpinned the formulation of the embrittlement trend curves used to predict RPV structural integrity. Advances in experimental techniques and the contribution from mechanistic modelling were discussed. Examples were given on the information being acquired to support current plant lifetime extension and the 60-80 year planned operational lives of Gen III+ reactors.

The final talk of the morning was on understanding the corrosion of uranium by using Atom Probe Tomography (APT). This was given by Ms Camille Coe from AWE. Understanding the corrosion of uranium is important for its safe, long-term storage. Uranium metal corrodes rapidly in air, but the exact mechanism remains subject to debate. Camille used APT to investigate the surface microstructure of metallic depleted uranium specimens following polishing and exposure to moist air. A complex, corrugated metal-oxide interface was observed, with approximately 60 at.% oxygen content within the oxide. Interestingly, a very thin (~5 nm) interfacial layer of uranium hydride was observed at the oxide-metal interface. Exposure to deuterated water vapour produced an equivalent deuteride signal at the metal-oxide interface, confirming the hydride as originating via the water vapour oxidation mechanism. Hydroxide ions were detected uniformly throughout the oxide, yet showed reduced prominence at the metal interface. Camille's results support a proposed mechanism for the oxidation of uranium in water vapour environments where the transport of hydroxyl species and the formation of hydride are key to understanding the observed behaviour. Niobium is added to uranium to increase its corrosion resistance. The actual mechanism behind this enhanced resistance is uncertain with two proposed hypotheses: formation of a layer enriched in niobium or the formation of a mixed oxide. APT was used to investigate the surface microstructure of UNb₃ and UNb₆ specimens following polishing and exposure to moist air. Analysis of the APT data has provided fundamental information on the structure of these alloys that directly relate to their corrosion properties. Both alloys showed some phase separation, displaying niobium rich and depleted regions. This separation was most evident with the UNb₆ specimens. This phase separation is most likely due to ageing with the UNb₆ material being significantly older than the UNb₃. Any phase separation due to ageing will affect the properties of the material, such as an increase in strength but a decrease in ductility and corrosion resistance.

After lunch Dr Oliver Payton from the University of Bristol presented a talk on High-Speed Atomic Force Microscope (HS-AFM). Bristol are using this new microscope as

a predictive and diagnostic tool in the field of material science and material failure analysis. The HS-AFM is capable of mapping out nano and micro structures across millimetre sized areas in a matter of minutes, a task that would take a conventional AFM over a year to carry out. The macro sized physical properties of a material are often a product of the nano sized structures within. In order to better predict the lifespan of a piece of plant or storage apparatus it is vital to know how these nanostructures are affected by the harsh and unique environments to which they are exposed. It is also important when designing the next generation of materials for the nuclear industry to know how the nano and micro structure of these materials is affected by the upscaling in manufacturing. The nanostructures of interest may be implanted into the material deliberately, such as the use of nanoparticles in ODS steel; however, the nanostructures might also be nano-fractures, secondary inclusions or any other inhomogeneities in the components of the new materials. There is currently no tool to map and characterise the distributions of these nanostructures across macro sized areas with spatial information. Many of the existing techniques such as SEM are sensitive only to the larger structures, while characterisation tools such as transmission electron microscopes have the necessary resolution but are limited to mapping small sample areas. Oliver presented the current state of the art of HS-AFM technology and demonstrated how at the University of Bristol they have used this new tool on materials relevant to the nuclear industry, such as type 316 steel, 9-chrome steel, ODS steel, and actinide material.



This figure shows a section of type 316 steel which has been heavily carburised along its top edge. a) shows the SEM image of the 100,000 μm^2 area, b) shows the HS-AFM topography map of the same sample, and c) shows a blown up section of the highlighted region in b) indicating the high resolution achievable using HS-AFM. A grain boundary and carbides, some measuring only 10 nm in size, can clearly be seen in c).

The next talk was presented by Dr Christopher Hardie from Culham Centre for Fusion Energy on Understanding the effect of radiation damage on mechanical properties.

Due to the harsh environment within nuclear fusion and fission reactors, degradation of structural materials occurs over their lifetime. Investigating the effect irradiation has on materials is limited to a few techniques which impose different challenges. Irradiation by charged particles offers a relatively fast, cost effective and for the most part non-radioactive method of irradiating materials, however charged particles have far smaller stopping distances in materials and the volume of irradiated material is limited. Unlike many characterisation techniques which require inherently small volumes of material, the limited volume of irradiated material presents a significant challenge for the measurement of mechanical properties. Chris presented the challenges, limitations and pitfalls of using nano-indentation and micro-mechanical testing for testing ion implanted layers. Recent efforts at UKAEA was shown, which included the use of spherical indentation and high resolution strain mapping from Transmission Kikuchi Diffraction (TKD) analysis. The research capabilities within the newly established Materials Research Facility at UKAEA, funded by the National Nuclear User Facility and the Henry Royce Institute, were described.

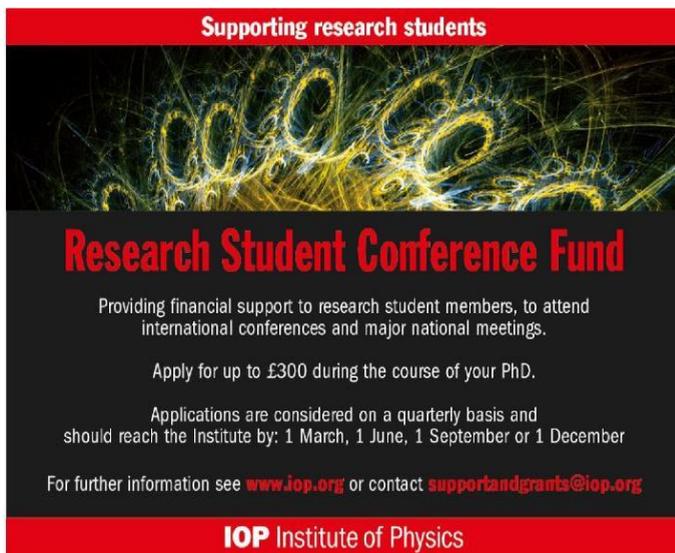
After an afternoon coffee break, Dr Christopher Mallinson (Fraser-Nash) presented his PhD work which he did at the University of Surrey on the localised corrosion of beryllium: a multi technique approach to study the role of second phase particles in pitting corrosion. Chris began by stating beryllium is a metal with a number of niche applications including: x-ray windows, space telescope mirrors and as cladding material in nuclear reactors. It is similar to aluminium as it is passivated by a thin native oxide layer which makes it susceptible to corrosion in the form of pitting. Pits are believed to be associated with sites of heterogeneity in the surface oxide such as second phase particles. Second phase particle compositions include: AlFeBe_4 , Ti_3Si , BeO , elemental silicon, Be_2C and Al_2O_3 . The particles range in size from $\sim 0.5 \mu\text{m}$ – $20 \mu\text{m}$ and so high spatial resolution techniques are required to investigate the corrosion mechanisms associated with them. A combination of techniques that have recently been utilised to provide new information about the corrosion process. These include: scanning Kelvin probe force microscopy, Auger electron spectroscopy and energy/wavelength dispersive X-ray spectroscopy.

The meeting concluded with Dr Vivian Tong from Imperial College London who discussed her work on Formation of large 'blocky alpha' grains in Zircaloy-4. Zircaloy-4 is in nuclear reactors in the form of thin-walled fuel rod cladding tubes. Maintaining a fine grain size is important to withstand the large thermal, mechanical and irradiation stresses in operation. Under certain conditions, very large grains, or blocky alpha, form within the small grained matrix, which is undesirable for structural integrity of the fuel rod cladding. Understanding the mechanism by which blocky alpha nucleates and grows is essential for both optimising manufacturing processes and understanding in-service performance. In this work, a strain-anneal method for consistently producing blocky alpha grains has been developed. It was found that grain size after annealing is dependent on the applied strain, and the critical strain required for grain growth is temperature dependent. The grain growth kinetics have also been studied, and a

mechanism for blocky alpha formation was proposed based on these results. Understanding blocky alpha formation in zirconium alloys will enable manufacturers to avoid certain strain paths and temperatures in order to avoid blocky alpha e.g. during the pilgering process in tube manufacture, and also allow the long term microstructural stability of Zr in nuclear reactors to be better understood and potentially optimised.

The understanding of the performance of materials is vital for justification of next generation fission reactor plant design, plant lifetime extension of current operating reactors as well as the development of fusion reactors. High-resolution characterisation techniques have played an important role in the understanding of material degradation in nuclear environments and their vital role in providing scientists with information to aid this understanding will continue into the future. Materials in reactor plants are exposed to extreme environments such as aggressive water chemistries, high temperatures and pressures as well high radiation damage. This conference gave an insight into the study and current mechanistic understanding of various reactor components corrosion and degradation as well as the techniques that are employed to aid this understanding.

IOP Research Student Conference Fund



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IOP Institute of Physics

Student members can obtain funding from the IOP Materials and Characterisation Group to attend a meeting or conference. Each year we have several Research Student Conference Fund bursaries worth up to £300 to give away. The eligibility criteria and application form are available at

<http://www.iop.org/about/grants/>

As part of being awarded a bursary you must write a short report on your experience at the conference. Selected reports are published in this group newsletter. on the next pages.

Reports on Conferences by students supported by the Group

ECASIA 2017, Montpellier, France *Report by Simon Bacon, University of Surrey*



ECASIA 2017 was my first experience delivering an oral presentation at an international conference. I spoke to a mostly full room and was extremely pleased with how this first attempt went. Both my current EngD supervisors were in attendance and I received positive feedback from both, including on my handling of the audience questions. From the preparation stages through to the talk itself, this has provided me with a great amount of experience and confidence for presenting at future conferences, as well as further developing my ability to disseminate research.

Since my talk was on the first day of the conference I was able to relax and enjoy the rest of the week, which included a high calibre of content across a broad spectrum of surface analysis topics. When selecting which room to attend from the four simultaneous sessions I naturally opted for topics close to my own research interests. I especially looked out for anything including Auger analysis, since the technique is far less ubiquitous than, for example, XPS. The highlights, however, were from the plenary lectures, especially Guido Schmitz' talk on atom probe tomography.

It's easy to see why this particular conference has been running for so long, the production levels and organisation are at a very high level. From the exhibition stands to the conference dinner at a stunning location, it felt like a professional setup throughout. This obviously attracts the best scientists in the field and made ECASIA very worthwhile, from a social and networking perspective.

The 29th International Conference on Defects in Semiconductors

*Report by Michelle Vaqueiro Contreras
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I attended this conference the week of July 31st to present my work on carbon-oxygen-hydrogen complexes in phosphorous doped silicon crystals grown by the Czochralski technique.

It is my pleasure to inform you that the conference was very enlightening and successful to my point of view. My work had attracted a lot of attention from the audience, especially from industry members from SUMCO Corporation who were present at the conference. Also I had the delight to be part of the six nominees for the best and novel works presented at the conference for the Corbett Prize.

In terms of guest speakers I had the opportunity to listen to Hisashi Furuya and Kazunari Kurita from SUMCO Corp., Matthew McCluskey from WSU, Susumo Maeda from Global wafers Japan, Cory Cress from US Naval Research Labs, Hiudekasu Tsuchida from Central Research Institute of Electric Power Industry (CRIEPI) Japan, Tadaharu Minato from Mitsubishi Electric Corporation and Hirofumi Seki from Toray Research Centre, amongst others.

Relevant to my work it was interesting to find that there still many works related to carbon and oxygen incorporation in silicon, and more interestingly primarily focused in their positive aspects which are the opposite of what I have shown with my work results for certain materials. Several characterization techniques related to photoluminescence and infrared absorption were addressed which may be of value to my work at some point. In addition, some defect characterisations carried out by DLTS and other related techniques helped me to understand further some of my own observations. I had also the opportunity to meet other researches that are willing to collaborate with my research group in a near future which of course will enrich our current knowledge.

This was the first time that I have attended this conference, however I am looking forward attending the following one if possible for me to be able to learn more advances in the field of defect characterisation and get to know the very experts in the field who make this conference as rich as it is

The Materials Research Society (MRS) fall 2017

Report by Eisner

This meeting was a great experience, with many fantastic talks from a huge variety of different fields. The symposium most relevant to me was Organic Semiconductors - Surface, interface, bulk doping and charge transport, in which many experts from the field were invited to give talks. One of the highlights of this symposium was the talk given by Henning Sirringhaus, in which he talked about the transport Physics of new high mobility polymers and the relationship between the charge transport and luminescence properties of such materials. Another great talk was given by Nicola Gasparini on controlling recombination in ternary polymer blends. Directly applicable to my own project, this talk gave me some great ideas about things to try out in my own lab and was incredibly useful.

In addition to the many fantastic talks, I also had a chance to meet many other scientists from across the world, and have some very interesting and useful talks with them, and set up some collaborations with groups around the world. One of the great things about this conference is the wide array of different fields present, and I learned a huge amount about many different things from chatting to people from different fields. It is really useful to go beyond the narrow field of work that you work in during your PhD and chat to people from other fields - not only is it very interesting but also gives you ideas you would otherwise never have considered.

Overall, I think the conference was a great success and I would definitely attend again. In such a large conference I gained both the opportunity to attend talks by leading scientists in my field and learn from peers around the world by talking and listening to them. I would encourage anyone from the material science world to go.

BioEI 2017

Report by Dr Stuart Higgins

*Research Associate, Department of Materials and Department of
Bioengineering*

Imperial College London, UK

<http://www.imperial.ac.uk/people/stuart.higgins>

The wonder of shape-shifting squid and the new field of organic bioelectronics.

Colour-changing squid were among some of the material platforms on display at BioEI 2017 – the annual winterschool on bioelectronics. Each year, a diverse group of material scientists, chemists, biologist, physicists, bio- and electrical engineers descend upon the picturesque town of Kirchberg in

Austria, to discuss topics as varied as the electrical stimulation of neurons to soft robotics.

The conference began with a spectacular talk on the use of photovoltaics to help partially restore sight in visually impaired patients. Daniel Palanker, Professor at Stanford University reported on their approach to restoring visual acuity, which involves implanting small inorganic photovoltaics below the retina at the back of the eye. A camera fitted to a pair of spectacles records the surrounding environment, projecting the image to the back of the eye using near-infrared light. The implants convert this light into electrical charge, triggering underlying cells and bypassing the damaged layer within eye, paving the way for partial sight restoration (DOI: 10.1038/nm.3851).

Alon Gorodetsky, Assistant Professor at the University of California, Irvine, also caused a stir with his talk on the colour-changing and shape-shifting behaviour of cephalopods, the class of creatures that includes octopuses, squid and cuttlefish. Alon told us how he changed his research focus after being inspired by a video showing cephalopods incredibly ability to camouflage themselves (<https://www.youtube.com/watch?v=1VjxvrXGEHk>). He told us how squid skin can be comprised of multiple coloured components that expand and contract, changing the reflected colour. Squids can also take advantage of structural colour thanks to built-in Bragg reflectors. In his work Alon emulates squid skin in the lab with the aim of understanding this behaviour.

As a researcher with a background in organic electronics, but not biology, the conference provided an amazing chance to meet some of the pioneers of the new field of organic bioelectronics – the use of conjugate semiconducting polymers for bioelectronic applications. This includes organic-electrochemical transistors, electrical switches which are ion-sensitive. This new class of devices can potentially provide the bridge between the electron-based signals of the inorganic world, and the ion-based conduction of the natural world (DOI: 10.1021/cm4022003).

The small size, and well-balanced conference programme, gives attendees ample opportunity to meet and discuss research. A particularly useful trick of the conference organisers was to balance longer tutorial sessions against shorter contributed talks with lots of coffee breaks, which helped avoid the dreaded 'sea-of-laptops' familiar to most conferences.

**12th International Conference on Advances in Experimental
Mechanics
University of Sheffield, Sheffield, UK, 29-31 August 2017.**

Report by Waris Ali, QMUL

BSSM 12th International Conference, I attended, covers vast aspects of materials advances in research and industry. Topic of my PhD research is about the mechanical properties of the deformed materials under stress at small size. This conference was perfect platform for an early result of my work because it is an international forum, consists of well-known researchers, academics, scientists, and industry representatives who are experts in the strain measurements and the study of the mechanical properties of novel materials. Also, this forum acts as a strategic think tank to enhance a constructive dialogue and collaboration on themes relevant to Material science and to present the latest research results in all areas of mechanical properties of the materials. My submitted paper in the conference was placed in Strain Measurement at the Microscale session. The paper is: W. Ali, D.J. Dunstan and Andy Bushby: Very high resolution micromechanical measurements on thin wires in torsion and published in the conference proceedings and can be accessed online. I presented an oral presentation in the conference for twenty minutes on Wednesday, 30th August and I was attending the other conference events from 29th and 31st August. The participants and invited speakers of conference came from all around the globe and they shared their ideas in the same field as of mine and in allied research under one roof. It provided me with a valuable learning experience. For instance, it was an excellent opportunity to meet, interact and exchange their findings and views during conference sessions, coffee breaks and conference dinner. Consequently, I have known many academics and professionals from different countries who have common research interest. I would like to thank my supervisor, Professor D J Dunstan for his generous support and guidance

Annual World Conference on Carbon - CARBON 2017

*Report by Maria Rybarczyk
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The CARBON Conference, organized this year by the Australian Carbon Society and the Royal Australian Chemical Institute (RACI), was held at the Melbourne Convention and Exhibition Centre in Australia (Victoria), from 23-28 July 2017. The Centenary Congress was an amazing opportunity to

celebrate the contributions that chemistry has made to Australia's (and the world's) society. The Centenary Congress brought together several thousand delegates from across the chemical sciences and technologies. Carbon 2017 with their motto: "Carbon for Grand Challenges" gathered around 800 scientists, engineers and technologists from across academia and industry. The Congress encompassed the RACI celebrating 100 years! Conference started on Monday with Carbon Plenary by Prof. Rodney Ruoff who gave an overview on recent developments and new routes to carbon materials (including 1 and 2D).

As a PhD Candidate, I was given the chance to have an oral presentation entitled: "Curved and n-doped carbon nanostructures obtained by salt melt synthesis" in the panel of T3: N-doped Carbons. We (me and my Supervisor, Prof. Marek Lieder) presented work on the carbon structure origination received from sustainable and renewable carbon precursors. In the above mentioned study, we have shown efficient synthetic procedure for the curved N-doped carbon nanostructures production and their complex characterization. Among different carbon precursors, biomass can serve as a renewable source for their production. In my recent research, I am focusing on the nanostructures with both homogeneous (nanorings, nanoribbons) and variable radii of curvature. However, I am aware that further studies need to be done.

The organizational issues were done in a proper way, the staff always helpful. However, the Conference Dinner (a platform for Carbon networking) was limited only to participants who registered with additional fee for that. For young scientists without grants, it can be a limitation (especially when the registration fee is very high). From my personal point of view, it will be nice to open it for all Carbon participants and thus increasing the networking opportunities. Carbon Conferences provide a platform for the discussion in carbon related research area. I met so many inspiring scientists, who gave me advice and guidance to my research. It is always important to me to receive feedback as I am pretty sure that people with different background can provide new insights and thus improve my experimental setup.

Summarizing, a participation in a world-known conference is a credible opportunity for scientific development. For early-stage researchers the network's training is always valuable in their further career. Therefore, I greatly appreciate financial support from the IOP.

I am looking forward for the next conference which will take place in Madrid

13th Photovoltaics Science, Applications & Technology Conference (PVSAT-13)

University of Bangor, 5-7 April 2017

Report by Nigel B Mason, Conference Chair

Bangor was a delight. Once again PVSAT justified its claim to be the UK's premier annual scientific conference on solar PV on the occasion of PVSAT-13 at the University of Bangor. For the third year running, we again held a Postdoctoral Training Workshop on the day preceding the conference so that student delegates could attend both events and keep costs down. This year PVSAT hosted a symposium on Printed Photovoltaics that was sponsored by Sêr Solar. The conference was opened by the vice chancellor of the university, Professor John G Hughes.

First the stats. This year 95 delegates listened to presentations by invited international guest speakers, 33 contributory speakers and 29 poster presentations. Perovskite PV technologies were clear winners in this year's category for most papers (17), beating CdTe with just 7 papers. Presentations on other PV semiconductor materials included CZTS (4 papers), CIGS (2), SbSe/SnSe (2), OPV (3), Q-dots (3), dye-sensitised (1), III/V materials (2) and other technologies (8). In other categories, 7 papers were presented on system monitoring and performance and some 6 papers on aspects of module design or characterisation.

Our principal guest speaker was Professor Christophe Ballif, Director of the PV laboratory at Ecole Polytechnique Fédérale de Lausanne (EPFL) and Director of PV Development at Centre Suisse d'Electronique et de Microtechnique (CSEM) in Neuchâtel. Prof Ballif won the Becquerel Prize in 2016 for scientific, technical or managerial accomplishments in the development of solar energy. He gave an amusing and poignant lecture entitled "*On sea, in the air and on land: when will everything become solar?*" This took the audience from current global energy challenges to the latest developments in the solar PV field that offer some realistic solutions.

Our other guest speakers were: Prof Hongwei Han, Huazhong University of Science & Technology, China, who spoke on stable fully printable mesoscopic perovskite solar cells, Dr Karsten Walzer, Heliatek GmbH, who spoke on the commercial production of organic solar films and Prof Paul Meredith, Sêr Cymru Chair in Sustainable Advanced Materials at Swansea University and until very recently a Professor at the University of Queensland in Australia, who spoke on Scaling Physics of Thin Film Solar Cells. Dr Marco Raugei, Oxford Brookes University, gave a talk on Net Energy Analysis of Photovoltaics and Dr Ian Forbes, Northumbria University, presented the latest developments in the field of kesterite thin film PV cells. The host lecture was given by Dr Jeff Kettle, Bangor University, on the stability of organic solar cells (OPVs).

Of the many excellent contributory papers presented there is space to mention just a few; Dan Lamb (Swansea) reported the first ever results of a project to evaluate CdTe thin film cells for deep-space satellite missions. Today's space cells are typically multi-junction devices based on III/V semiconductors but CdTe thin film PV offers exceptional high performance-to-weight ratio demanded for space applications. The first flight test of these "made in Wales" cells was launched on a UK-built satellite last year and the initial results are both encouraging and challenging in that the cell's space performance at 4°C is better than predicted by terrestrial behaviour. An excellent group of presentations under the Sêr Solar Symposium on Printed PV covered competing methods of fabricating perovskite cells and sparked a lively debate on whether spray coating, adopted by many institutes, was the best solution for large scale fabrication. Cell efficiencies continue to increase; small additions of cobalt to metal halide perovskite cells was reported to produce 17.2% efficient devices (Matt Klug, Oxford), 44% efficient 3-Junction III/V concentrator cells at 1000-sun concentration were reported (Andy Johnson, IQE), and a 32.8% efficient GaAs/Si-HIT tandem cell at standard 1-sun illumination shows great potential for extending the performance range of industry-leading silicon-based devices.

The conference dinner was held at Chateau Rhianfa on the isle of Anglesey. Here we were entertained by live music performed by *Trio Canig*, three tenors from Anglesey. The dinner is also where we traditionally present prizes for the best papers and posters. This year the Best Poster prize was awarded for the paper "Process Development of Sublimated Cu-free CdTe Solar Cells" by C. Potamialis, F. Lisco, B. Maniscalco, M. Togay, J. W. Bowers and J. M. Walls, Loughborough University; the Institute of Physics Best Student Poster was awarded for the paper "Dye sensitized Schottky barrier devices on steel" by Niamh Ryall, R. Crook, J. Weinstein, University of Leeds and the Best Paper prize was awarded for the paper "Novel deposition method to print binder-free inks on large scale perovskite solar cell modules" by Simone Meroni, Youmna Mouhamad, Francesca De Rossi, Ren'an Escalante, Jenny Baker, Gerko Oskam and Trystan Watson, Swansea University.

Conference exhibitors included IET Journals, Newport, IQE/CSC and Bentham Instruments.

Another first for PVSAT-13 was the coverage of some aspects of our conference by BBC Radio Wales' Science Café programme that was aired on 16th April. The programme was available on the BBC i-player until 22nd May 2017 <http://www.bbc.co.uk/programmes/b08mp2kc>.

PVSAT is, as always, very grateful to our sponsors for supporting the event and helping to keep the student fee for conference attendance to a minimum. This year's sponsors were: IET Journals, IQE & Compound Semiconductor Centre, Royal Society of Chemistry: Energy Sector Group, Supergen SuperSolar, Sêr

Solar, M.SPARC, ERN Wales, EPSRC Centre for Doctoral Training and The Institute of Physics: Materials & Characterisation Group.

PVSAT-14 will be held at Imperial College London, in April 2017 on dates to be confirmed. Further information will be available at www.pvsat.org.uk



Christos Potamialis, Loughborough University accepting the Best Poster prize at the PVSAT-13 Awards Dinner, Chateau Rhianfa, Anglesey.



PVSAT-13 delegates enjoying the after-dinner entertainment at Chateau Rhianfa, Anglesey.



PVSAT-13 delegates at lunch on the last day.

Christmas Evening Networking and Outreach Event IOP Portland Place, London, 19th December 2016

Report by Alison Crossley

It's about time: A brief history of the calendar and time keeping



The 2017 IOP Materials and Characterisation Group Annual Christmas Lecture "**It's about time: A brief history of the calendar and time keeping**" was delivered on the 19th December 2017 by Dr Donna Carroll, Lecturer of Physics, Maastricht University, The Netherlands to an enthralled audience. The event was free to those registered and almost fifty attendees were entertained by Donna

and treated to mulled wine and mince pies at the IOP HQ in Portland Place. Donna reminded us how we take time, and the measurement of time, for granted in this modern age when our lives are driven by deadlines, schedules and timetables. Time and its many divisions (hours, days, weeks, months and years) completely shape our lives and yet, it's rare that we take the time to think about where these concepts arise from. Thanks to Donna's informative lecture, we lucky attendees left with much more knowledge on this topic. Donna is clearly not just an expert in the history of time measurement, she has also demonstrated her interest practically by developing skills in watch making. Donna showed us how the calendar as we know it is inextricably linked to the mechanics of our solar system, and the way in which we describe our periods of time have arisen from ancient speculation in astronomy, mathematics and religion. Donna provided us with a history of how our calendar developed, with an introduction to time measurement from ancient sundials to modern atomic clocks. What we have today is a fascinating combination of the coming together of astronomy, astrology, mathematics, politics, agriculture, superstition, religion, and even the egos of Roman Emperors. We were reminded of the more obvious influences on time keeping, like how it was shaped by day and night and the changing of seasons, as well as more esoteric yet logical inventions like the "Nileometer" where Ancient Egyptians monitored the periodicity of the height of the River Nile floods. This proved an accurate and reliable way of measuring time.

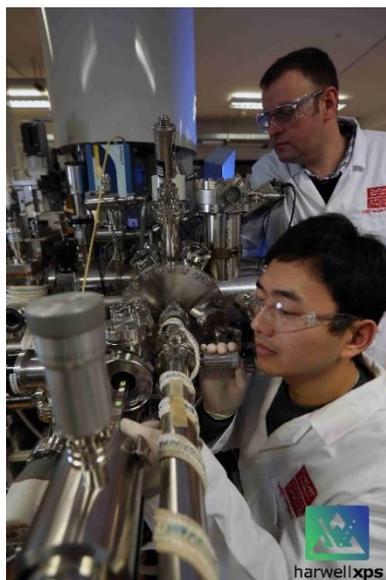
The lecture closed with an enthralled audience engaging in a lively question and answer session.

The Materials and Characterisation have set themselves a high bar with the first two events in this series but will pull out all the stops to make sure the Christmas Lecture 2018 is equally enjoyable. This is scheduled for Tuesday 18th December.

News in Brief

New EPSRC National Facility for XPS

The new EPSRC national facility for X-ray photoelectron spectroscopy opened for applications in August 2017. The “HarwellXPS” service is a collaboration between Cardiff University, University College London and the University of Manchester. Based at the Research Complex at Harwell (RCAH) with the partner hubs offering specialist analysis, the HarwellXPS



service provides XPS, UPS, XPS imaging, Low Energy Ion Scattering Spectroscopy (LEIS), cluster and monoatomic ion depth profiling, High Energy XPS (HAXPS) and Near Ambient Pressure (NAP-XPS) as well as high temperature and pressure treatments. Full details are available at the website: www.harwellxps.uk

As well as delivering rapid and economical surface analysis from experts in the field to UK academics and industry, a key goal of the facility is to act as a training centre for the UK XPS community. We invite users to attend their instrument time and work with our expert XPS practitioners to develop a deeper understanding of the experiment. We also run regular training courses on the theory and practice of XPS and on data analysis. Our

courses take place every 3 to 4 months and are advertised in advance on the web site, our mailing list and through twitter @harwellxps. Our first annual conference will take place at Harwell on July 4th and is a joint event with the UK Surface Analysis Forum (www.UKSAF.net). There will be an associated data processing workshop on the 3rd July focusing on software from the instrument manufacturers which will be free to attend for those people attending the main meeting.

News in Brief

Materials Research Exchange MRE 2018



The Materials Research Exchange event held 12-13 March 2018 at the Business Design Centre, Islington, London provided a platform for 70 exhibitors to showcase the richness of UK materials research and innovation. Together with a rich programme of speakers MRE2018 provided, over 1300 delegates an ideal opportunity to absorb current trends and future innovations in materials.

The Henry Royce Institute

The Henry Royce Institute is the UK national centre for research and innovation of advanced materials, representing a £235m investment from UK Government. It operates as a hub and spoke model, with the hub at The University of Manchester, and spokes at the founding partners, initially comprising the universities of Sheffield, Leeds, Liverpool, Cambridge, Oxford and Imperial College London, as well as UKAEA and NNL.

There are currently nine strategic themes: 2D materials; Advanced metals processing; Atoms to devices; Biomedical materials; Chemical materials design; Energy storage; Material systems for demanding environments; Materials for energy efficient ICT and Nuclear materials.

HENRY ····
ROYCE ····
INSTITUTE

Forthcoming Conferences supported by the IOP Materials and Characterisation Group

14th Photovoltaic Science, Application and Technology Conference (PVSAT) 2018

Imperial College London

18th-19th April 2017

<http://www.pvsat.org.uk>

RSC-NPL Symposium: Nanoparticle concentration – critical needs and state-of-the-art measurement.

Library, The Royal Society of Chemistry, Burlington House, Piccadilly, London, W1J 0BA

24th April 2018 09:30-17:30 <http://www.rsc.org/events/detail/28683/rsc-npl-symposium-nanoparticle-concentration-critical-needs-and-state-of-the-art-measurement>

UKSAF Summer Meeting

Hosted by HarwellXPS The EPSRC National Facility for XPS

Research Complex at Harwell (RCaH), Didcot, Oxfordshire

4th July 2018

The general theme of this meeting is complementary surface analysis techniques. The meeting will be preceded on the 3rd of July, with a data processing workshop focusing on software from XPS instrument manufactures and CasaXPS.

<https://www.uksaf.net/>

Nanomedicine and Characterisation

Organised by the IOP Materials and Characterisation Group

Institute of Physics, 80Portland Place, London W1B 1NT

10th July 2018

<https://www.iopconferences.org/iop/frontend/reg/thome.csp?pageID=737559&eventID=1216>

Reports on these meetings will be published in the next edition of the newsletter.

Updated information about conferences will be added to the group website <http://mc.iop.org> when available.

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Group Web Links

IOP Website

Our Group website address <http://mc.iop.org> is where you will find up to date information on the activities of the group including registration details for the conferences we sponsor and organise.