

IOP | Institute of Physics

Materials and Characterisation Group

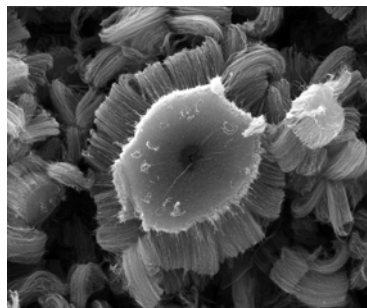
NEWSLETTER 17

May 2010

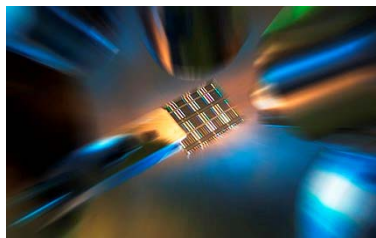
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About the Group



Carbon Nanotubes: SEM image
taken by Nicole Grobert Oxford



***Group AGM and
Photovoltaics Meeting
30 June 2010
details on page 10***

The Materials and Characterisation Group is one of 51 groups at the Institute of Physics. We are interested in the properties and application of materials, old and new, the manufacture, modification, acquisition and extraction of materials and all types of materials characterisation including physical, electrical, optical and elemental. Some materials like superconductors are so important that they have their own group also some characterisation techniques such as electron microscopy. We aim to provide coverage of the many other materials and techniques of importance to the physics community and to reflect areas of growing interest and importance. Thus our aim is "to foster activities in the fields of materials and materials characterisation within the IOP".

Message from the Editor

By Alison Crossley

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This Newsletter contains information about the IOP Materials and Characterisation Group members and their interests and activities. We are keen to encourage new group members and participation of existing ones so please let us know if you have any feedback, suggestions for events, ideas, articles or news items of interest which we can include in future annual newsletters or on the web site.



Chairman's report

By David McPhail

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The three main committee posts of chairman, secretary and treasurer changed last year. I would like to express the thanks of all the members to Dr Matthew Healy and to Dr David Keeble who have stepped down as chair and secretary. Both gave outstanding service to the group and we thank them sincerely for their efforts. Dr Jonathan Painter is our new secretary and Dr Hamid Kheyrandish our new treasurer. The committee is currently reviewing its mission and its portfolio of activities. The bottom line is that we want our activities to be relevant and useful to our members, so please provide us with feedback at any time and please respond to our surveys!

Currently we have 517 members who come from many walks of life, including industry and academia. Our members also come from many countries across the globe. To have a look at our member log-in to MYIOP <https://members.iop.org/login.asp> Our activities include: arranging conferences, seminars and workshops for our members and others; promoting interaction between physicists working in industry and research, providing opportunities for networking and a forum for meeting and discussion; producing regular newsletters to keep their members in touch with the latest developments in their field; providing information on relevant meetings organised by other bodies; awarding bursaries to help research students attend conferences via the Research Student Conference Fund; awarding prizes in our area.

We are in the process of reviewing our activities to ensure that these best meet the needs of our membership. Of course this process relies on feedback from you! Over the next twelve months we will be asking for ideas but of course you can contact us at any time with your thoughts. Our main activity remains focused on conferences and meetings, and on helping students to attend such events. We do place an increasing emphasis on short courses particularly where the emphasis is on the introduction of materials and techniques.

News in Brief



Imperial College London

The Materials department at Imperial College have just taken delivery of an EPSRC funded ToF SIMS – LEIS instrument. Built by ION TOF Germany, the instrument is the first in the UK and combines surface science and surface analysis. It will be used to study materials from a wide range of thematic areas including healthcare, energy, nanotechnology and transport. Further details can be obtained from David McPhail: d.mcphail@imperial.ac.uk

A FIRST FOR IMPERIAL: ToF SIMS – LEIS

The University of Exeter has announced an £80 million Science Strategy that prioritises investment in five interdisciplinary research themes, one of which is functional materials. "The University has brought together leading research experts from blue skies research in Physics to new manufacturing techniques being developed in Engineering to develop new materials and techniques in functional materials." Further details can be found on their web site <http://www.exeter.ac.uk/about/vision/sciencestrategy>.



CUTTING EDGE: New facility at Harwell

Currently under construction on the Harwell Science and Innovation Campus is a multidisciplinary laboratory which will provide facilities for researchers to undertake cutting edge scientific research in both life and physical sciences and the interface between them. Part of the Research Complex at Harwell (RCaH) and adjacent to Diamond, the new third generation Synchrotron Radiation (SR) source the new lab is also close to other leading facilities on the campus including the ISIS neutron source and the Central Laser Facility.

www.rc-harwell.ac.uk

Focus on Historic Materials: *Bosworth Battlefield Munitions*

By Jon Painter

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Described as one of the four most important English battles of the last 1000 years, the Battle of Bosworth (1485) resulted in the death of Richard III and brought Henry VII to the throne. There is however surprisingly little known about the battle, and even its site was in dispute before this latest scientific investigation.



Battle of Bosworth Photograph Corbis

Dr Glenn Foard, a battlefield archaeologist from the Battlefields Trust & University of Leeds is leading a multi-disciplinary team which has re-evaluated the site of the 15th century Bosworth battlefield, moving it two miles from the traditional site. The investigation has included the discovery of 30 lead projectiles, most fired from artillery but several possibly from hand-cannon. This is more artillery round shot than has currently been found from all 15th and 16th century battlefields from across the whole of Europe.

Dr Foard, who originally specialised in the study of lead bullets of the 17th century is extending his analysis to these and other lead projectiles from the 15th and 16th century. The round shot is made from cast lead, in some cases with a core of an iron cube, pieces of flint or stone pebble. A trial of neutron tomography and other analytical techniques has been undertaken in collaboration with Evelyne Godfrey and Winfried Kockelmann at the Rutherford Appleton Laboratory at Harwell, Oxfordshire, which has for example revealed the detailed character of an iron cube in the centre of one of the round shot. Further neutron tomography is to be carried out at the Paul Scherrer Institute (PSI) near Zurich to image the internal structure of all the Bosworth munitions plus several others discovered in the UK from that era.

Dr Foard's current work focuses primarily on the topographic detail of the shot; including the melting and various aspects of deformation from the firing process, including the abrasion marks imparted to the projectiles travel down the barrel. It also deals with the various marks left as a result of the impact – which is in most cases was with the ground but will also include impacts with the bodies and equipment of troops and horses. This work on early projectiles over a number of years has been informed by experimental firing trials conducted in collaboration with Dr Derek Allsop of Cranfield University, a programme now being extended to the study of early artillery. Dr Foard has approached several specialists nationally including Adrian Evans from Bradford University and most recently Prof Paul Evans and Rachel Bolton-King from the Imaging Science Group, Nottingham Trent University and Dr Jon Painter, Cranfield University, for advice on high resolution scanning and related analysis of the surfaces of the projectiles. One of the many aims of this work is to establish whether it is possible to determine from the projectile the type of barrel from which it was fired, whether cast (single piece) or stave-built (metal strips held together by bands). *Continued on page 5*

Bosworth Battlefield Munitions continued from page 4

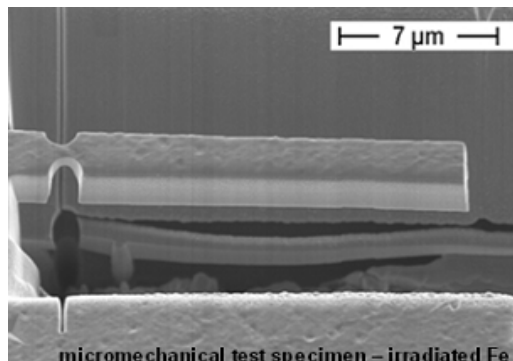
The late 15th century was a period of rapid change in the technology of gunpowder weapons and the Bosworth research has opened up the study of their use on the battlefield to archaeological investigation for the first time. This work is part of a wider programme of research being pursued in collaboration between Dr Foard, Professor Steven Walton, Penn State University, USA, Dr Allsop and others in the Origins of Firepower project being developed at the University of Leeds.

<http://www.bosworthbattlefield.com>



15TH C LEAD SHOT: examined by neutron tomography and other materials characterisation methods

More News Stories



OXFORD ODS ALLOY STUDY: *Micromechanical testing, atom probe tomography, and TEM techniques will be used.*

A team from the department of Materials in Oxford with collaborators in Liverpool and Salford Universities, CCFE Culham and the CEA, has been awarded a 5½ year programme grant by the EPSRC worth more than £5M. The focus of the project will be on alloys for high temperature applications in future fusion and advanced fission reactors. The development and evaluation of reduced-activation oxide-dispersion-strengthened (ODS) steels is widely regarded as key to the future feasibility of these power sources, and tungsten alloys are proposed for the most severe environments present within fusion reactors.

Antimatter studies missing matter: *positrons identify vacancy defects in materials*

By David Keeble

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FRMII REACTOR IN MUNICH: *used to identify vacancy defects in perovskite oxide thin films*

The research reactor FRMII is well known within the materials characterisation community, its iconic 1957 'Atomic egg' reactor dome is a Technical University of Munich landmark. As a member of the network of European neutron facilities it is funded by the European Commission and can support beamtime requests from UK scientists.

*What is possibly less well known is that it is one of only two facilities that also provide a **positron** beam line (the other is the Delft Reactor Institute). The neutron induced positron source (NEPOMUC) at FRMII provides the world's most intense 'slow' antimatter beam for materials characterisation. Thanks to the work of Christoph Hugenschmidt and his team 5×10^8 slow positrons per second are routinely produced.*

Laboratory positrons are normally obtained from radioactive table salt ($^{22}\text{NaCl}$). The β -energy spectrum implants positrons down tens of microns (energies up to 0.54 MeV), making it ideal for studying bulk materials. *Continued on page 7*

Antimatter studies: *continued from page 6*

Thin films present a tougher challenge; positrons must be moderated to thermal energies so they can then be accelerated and implanted to appropriate depths through thin films or near-surface regions.

Variable energy positron beams using 'hot' ^{22}Na sources are widespread on the international scene, with several new facilities emerging in China. Professor Paul Coleman, University of Bath, a pioneer in this field, runs several positron beams for materials characterisation. These typically have intensities in the range 10^5 - 10^6 $\text{e}^+ \text{s}^{-1}$, and so availability of greater than 10^8 $\text{e}^+ \text{s}^{-1}$ at FRMII opens new doors; experiments that would take days can now be performed in minutes.

So why use antimatter for materials characterisation? When a positron annihilates with an electron in the material two annihilation gamma-ray photons carry away information on the momentum of the electron. This is encoded in two ways; the photons are Doppler shifted, and the angle between the two is very slightly altered. These angles can be measured using two-dimensional angular correlation of annihilation radiation (2D-ACAR) this allows Fermi surfaces to be mapped. Stephen Dugdale, University of Bristol, is an expert in this area and a collaboration between the Bristol team and the FRMII positron group has been recently funded that will allow a 2D-ACAR experiment to be set up in a new experiment hall to be built at FRMII.

The other major area uniquely suited to study by antimatter, is missing matter, by which I mean open volume in materials. Positrons trap, localise, in regions with missing atomic cores. In crystalline materials this means vacancy point defects, vacancy clusters, or nanovoids. In soft matter it can be open volume resulting from molecular packing, Professor Ashraf Alam, University of Bristol, in collaboration with Nestlé, is pioneering the application of positrons in this area. It is the lifetime of the positron that provides the most insight on open volume defects. This depends on the electron density, positrons that localise at open volume sample areas with lower electron density, and hence live longer. The lifetime experiment can differentiate between several different positron states in a material, obtaining lifetime values and intensities for each component. The Dundee and Bristol groups routinely perform these experiments on bulk materials. However, the lifetime experiment is extremely challenging to perform on a positron beam. Only two beam lifetime experiments exist, one at AIST Tsukuba the other at FRMII. The FRMII positron lifetime instrument allows a 5×10^6 count spectrum, obtained a specific mean implantation depth, to be accumulated in less than a few minutes, and detailed depth profiles in a few hours. The Dundee group have been using the instrument identify vacancy defects in perovskite oxide thin films.

Comment: *So how much good does your work do?*

By Matthew Healy

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Personally most of the time I do what I do because that's what I can do and that's what pays the bills. Sometimes I look up, and do something because I really want to, and sometimes I do something because I feel I ought to make a difference.

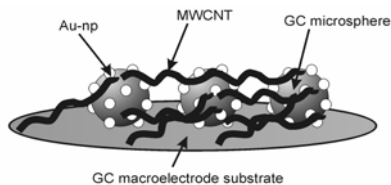
Now, this is a general newsletter to one of the very few subject matter groups that is truly cross disciplinary and whose group aim within this charitable organisation includes fostering interdisciplinary research. So for this newsletter I thought I'd introduce some challenges that allegedly might do some real good, or at least fire up a few passionate responses!

So, I entered the phrase "top 5 world problems" into Google and looked (in my biased opinion) for a web page that would be least biased. So... in the web page www.copenhagenconsensus.com/Home.aspx you will find a ranking (produced by 55 experts) of the 30 challenges that if addressed with \$75 billion dollars could bring greatest benefit to the world. And if you think that having 'Copenhagen' in the web address means there is a leaning towards climate change you may be right and I cannot prove otherwise but you will see climate doesn't appear until number 14.

Am I being moralistic? Not my intent, and those who know me will agree I have a rather flimsy ecological, social and career platform from which I could do so, but why not check out the challenges and / or submit your own top five arenas in which the skills of members of the Materials and Characterisation group could / should make a difference and perhaps we can do something with these in a future issue.



Effects of Arsenic Poisoning



A method of constructing electrodes for detection of heavy metal ion pollutants in drinking water

Professor R Compton Department of Chemistry
International Patent Application
PCT/GB2006/001643

About the Committee

By David McPhail

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We are always keen to hear from members who feel they would like to contribute to the Materials and Characterisation Group and have an interest in joining the Group committee. We would like to increase the representation of younger members on the group and of female members, both of whom are under-represented. If you are interested in becoming a committee member then please contact me or go to.

<http://www.iop.org>

Chair: Dr David McPhail *Department of Materials Imperial College London* studies interactions between the environment and materials, primarily using secondary ion mass spectroscopy (SIMS). David's interests are in surface phenomenon such as corrosion, oxidation, diffusion and segregation, with applications ranging from aerospace materials to museum conservation.

Hon. Secretary: Dr Jonathan Painter *Centre for Materials Science and Engineering Cranfield University Shrivvenham* has a background in the deposition and characterisation of thin film materials, and the surfaces of bulk materials with a recent emphasis on the use of microscopy, both optical and electron, for materials analysis.

Hon. Treasurer: Dr Hamid Kheyrandish *Aystorm Scientific Ltd.* Expertise in materials characterisation methods, especially in ion beam analysis methods including secondary ion mass spectrometry (SIMS) and Rutherford backscattering (RBS), with interests in semiconductors, photovoltaics, optical coatings and related technologies.

Members:

Professor Darryl Almond *Materials Research Centre Department of Mechanical Engineering University of Bath* has a wide experience of thermographic and acoustic methods for non-destructive evaluation and expertise in aerospace composites, superconducting ceramics and electrical characterisation of ionic conductors.

Dr Richard Day *School of Science & Technology Glyndŵr University Wrexham* is an expert in processing, mechanical and physical properties, of composites and polymers.

Professor Richard Dewhurst *School of Chemical Engineering & Analytical Science, University of Manchester* has a wide experience of optical methods for materials characterisation and non-destructive testing, and special expertise in remote optical detection of ultrasound.

Dr Matthew Healy *Department of Applied Science Security and Resilience Cranfield University* has expertise in ion beam analysis, and radiological and nuclear materials in security and defence.

Dr David Keeble *Division of Electronic Engineering and Physics University of Dundee* has expertise in local probe methods for materials characterisation; specifically electron magnetic resonance spectroscopy, and positron annihilation techniques. Main area of application is point defect identification in materials, with a current focus on ferroelastic oxides. *Continued on page 8*

Continued from page 9

Professor Haricharan Reehal London South Bank University has extensive experience in silicon based materials for photovoltaics covering thin film growth, solar cell fabrication and materials and device characterisation using a wide range of structural, chemical, optical and electrical techniques.

Professor Kenneth Thomas Institute of Mathematics and Physics Aberystwyth University has had a broad interest in the structure and properties of metals and plastics, with specific expertise in the rheology of polymeric fluids.

Co-opted Member:

Dr Alison Crossley Department of Materials University of Oxford is a Fellow of the Royal Microscopical Society and member of the Royal Society for Chemistry, and is the manager Oxford Materials Characterisation Services with wide expertise in the application of surface science to a variety of materials.

Forthcoming Events

Perspectives on Materials and Technologies for Photovoltaics

30 June 2010

Institute of Physics, London

This one day workshop organised by the IOP Materials and Characterization Group will be a forum to discuss major issues relevant to current and emerging photovoltaic materials and technologies. A combination of oral presentations by invited speakers from Europe and the UK, and poster sessions, will review recent advances in new materials, new processes, technologies and process characterisation techniques. Review presentations by invited speakers will outline the current state of knowledge on topics including crystalline silicon and thin film silicon solar cells, advanced modelling, high efficiency III/V (concentrator) solar devices ,CdTe , CIGS technologies , organic and dye synthesized thin film solar cells and other advanced materials including transparent conducting oxides (TCOs) , photon trapping structures and plasmonics .

The workshop will offer an excellent opportunity for researchers in private industry and universities to exchange information and prioritise mutual needs for future collaborations. There is also an opportunity for table top exhibition by equipment manufacturers.

Abstract Submission is also now open for this event via the web address.

<http://www.iop.org/Conferences/y/10/pmpt/>

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***IOP Materials and Characterization Group AGM will be held after this meeting. All members are encouraged to attend.
IOP London 5 pm 30th June 2010***

Calendar 2010

More details: http://www.iop.org/activity/groups/qd_calendar/index.html

- 28 June - 1 July** **MICROSCIENCE 2010** ExCeL Centre in London
www.microscopy-analysis.com/events/microscience-2010
- 30 June** **Perspectives on Materials and Technologies for Photovoltaics**
IOP London www.iop.org/Conferences/y/10/pmpt/
- 30 June** **The Materials and Characterisation Group Annual General Meeting**
IOP London *contact: d.mcphail@imperial.ac.uk*
- 5 - 9 July** **Oxford Nanotechnology 2010 Summer School** Oxford University
Begbroke Science Park, UK <http://www.conted.ox.ac.uk>
- 7 July** **UKSAF 2010 Summer Meeting: Applications of Surface Analysis in Space Sciences** Heriot-Watt University, Edinburgh www.uksaf.org
- 9 - 12 August** **19th International Symposium on the Applications of Ferroelectrics (ISAF and the 10th European Conference on the Applications of Polar Dielectrics (ECAPD)** Edinburgh <http://isaf-ecapd-2010.com>
- 1 - 3 September** **Recent Appointees in Polymer Science incorporating Recent Appointees in Materials Science Conference** Leeds University
www.rams-materials.org.uk/conference
- 10 - 11 November** **Innovation Towards Sustainable Materials**, Royal Society, London
www.iom3.org/events/sustainability
- 24 November** **Workshop on TOFSIMS/LEIS** at Imperial College London
contact: d.mcphail@imperial.ac.uk
- 14 -16 December** **Condensed Matter and Materials Physics Conference (CMMP10)**
including symposium on Local Probe Spectroscopy Methods
Warwick University. www.cmmp.org.uk

Joining the Group

Joining a group is the means for you as a member to be part of the physics community and to take part in activities in your particular areas of interest.

To join the group please log onto MyIOP (<http://my.iop.org>), navigating to the relevant Network for the Group and selecting "Sign up for this network". Alternatively please contact the membership department. All groups are free to join, however to join a group you must first be a member of the Institute. Details of how to join the Institute can be found at www.iop.org <<file://www.iop.org>>

Why this group?

Possibly you have interests in materials characterisation that span beyond diffraction or electron beam methods, both of which are supported by specific subject groups. You may already be a member of a group, but may also consider Materials and Characterisation, possibly attracted by the breadth of coverage. You may have interests in materials that are not catered for by the more specific groups. Possibly materials for energy, photovoltaics, materials for radioactive waste storage, etc, or thermoelectric materials, ferroelectrics, rheology, aerospace materials, materials for high temperature electronics, etc. Your interest may lie in specific characterisation methods, for example ion beam characterisation, scanning probe methods, optical characterisation of materials, impedance spectroscopy, etc. If this is the case, join the group and help to strengthen and broaden its activities.

Past meeting reports

Please note that meeting reports for the following Group events are now mounted on the Group MyIOP pages (<http://my.iop.org>).

This newsletter is also available on the web and in larger print sizes

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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