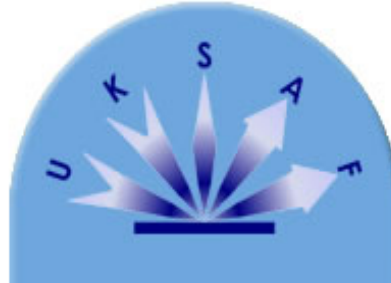
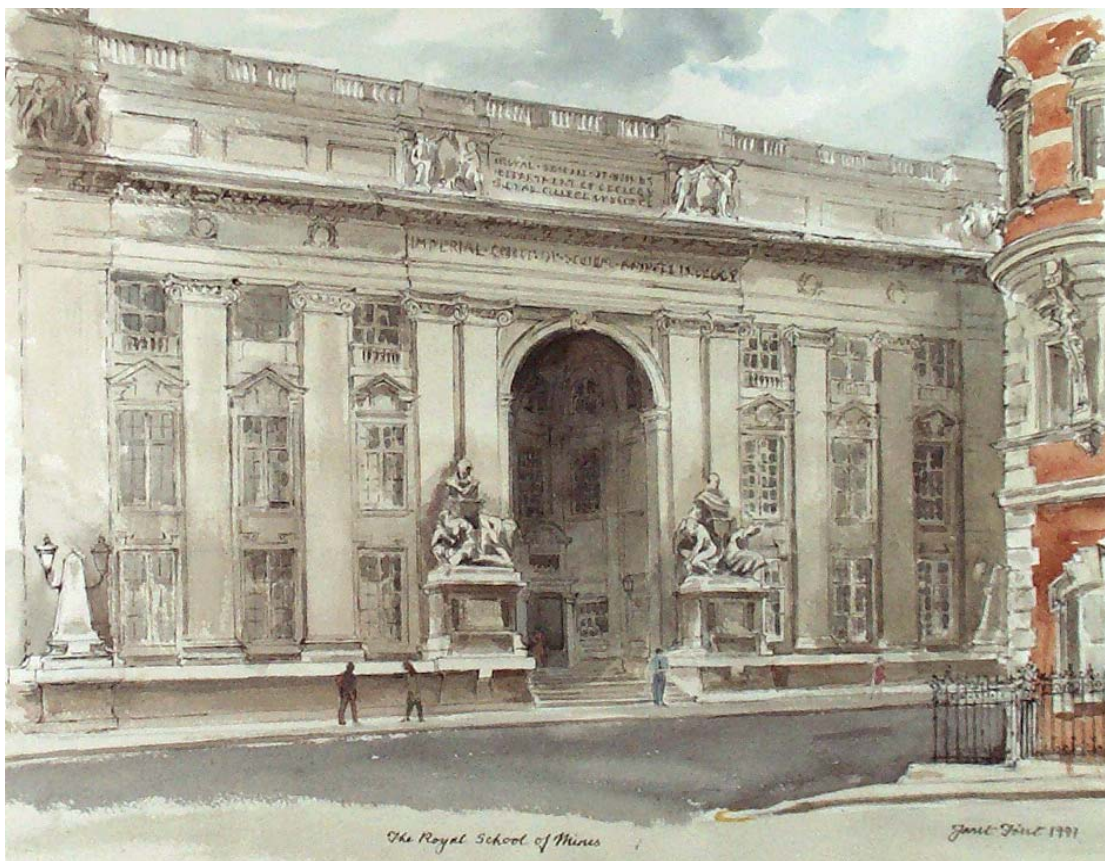


The UKSAF Winter Meeting



Materials Past, Present and Future

Wednesday 7th January 2009



What challenges will the materials scientist be setting the surface analysis community in the next decade - and can we deliver?

The Department of Materials at Imperial College

<http://www.imperial.ac.uk/materials>



Chairman

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Committee Members

Morgan Alexander, Stephen Jenkins, Simon Morton, Alex Shard, Graham Smith, John Watts, Bob Wild, John Wolstenholme

UKSAF Winter Meeting 2009

Materials Past, Present and Future

10.00 a.m. – 4.30 p.m. Wednesday 7 January 2009

Host: Imperial College London

Venue: Department of Materials, Prince Consort Road, South Kensington

9:30 -10:00

Registration – Coffee/Tea

Welcome & Introduction

Dr. Dave Sykes, UKSAF Chairman

10:00 -10:15

The Materials Vision

Professor Bill Lee, Head of Department

Conservation Science

10:15 –10.50

Professor Graham Martin

Victoria & Albert Museum, London

Conservation of Plastics & Polymers – The Contribution of Surface Analysis

10.50 -11:15

Dr Marie- Laure Abel

University of Surrey

11.15 - 11.35

Coffee/Tea

The Future of Nanoscience and Surface Science

11:35 -12:20

Professor Andrew Wee, Dean of the Faculty of Science

National University of Singapore

Biomaterials: Present and Future

12:20 -12:45

Dr Julian Jones

Imperial College London

A New Instrument for 3-D Imaging SIMS

12:45 -13:10

Mr Rowland Hill & Dr John Fletcher

Ionoptika Ltd. Southampton & University of Manchester

13:10 -13:15

UKSAF Announcements

13:15 -14:30

Lunch and Tour of the Materials Department

14:30 -15:05

Applications of SIMS to Solid Oxide Fuel Cells

Professor John Kilner, Department of Materials

Imperial College, London

15:05 -15:30

Alloys for Transport & Aerospace

Dr. Barbara Shollock, Department of Materials

Imperial College London

15:30 -16:05

MeV Ion Beams – from Bench to Bedside

Professor Karen Kirkby

University of Surrey

16:05 -16:30

UK Needs for Surface and Nanoanalysis Measurement and Characterisation

Dr Ian Gilmore

National Physical Laboratory, London

16:30

Close of Meeting

16:30 - 16:45

Coffee/Tea

Conservation Science

Graham Martin, Head of Science

The Victoria and Albert Museum, London

To some readers the term 'conservation science' is not new. However, I do anticipate that the term 'heritage science' is relatively new to all. So some term definitions; the recent 2006 House of Lords Science and Technology Committee Inquiry on Science and Heritage[1] that reviewed the state of play of science in the service of heritage in the UK certainly preferred the term heritage science. This House of Lords report goes into far more depth than I can in this abstract. For reasons of clarity I will broadly define conservation science/heritage science as the use of science in the understanding and care of heritage. To me, conservation science and heritage science are interchangeable

There is a further subdivision that we need to highlight in that heritage is split into movable and immovable heritage – the latter typically being buildings or large structures usually open to the weather. The former are those objects of heritage that are deposited in libraries, archives, museums or collections of some type and it is in the care and understanding of these 'movable heritage' items that I have spent most of my working career.

To turn my attention to surfaces – the subject of this meeting – the V&A collection can be considered a collection of which the surfaces are the most important aspect. Many of the challenges set to my team are totally concerned with surfaces – although many would wish to debate this particular issue. Therefore, we have many problem-led surface queries on a wide range of materials and substrates.

The presentation will show representative examples of the type of surface challenges that we are presented with – from chairs to books via metals.

[1] (<http://www.publications.parliament.uk/pa/ld200506/ldselect/ldsctech/256/25602.htm>)

Conservation of Plastics and Polymers: The Contribution of Surface Analysis

Marie-Laure Abel

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The production of thermoplastic polymers may date back as far as the end of the 19th century, and numerous examples may be found in museums such as The Science Museum. Until recently, it was thought that such materials were not prone to degradation. However, the work of Anita Quye has highlighted that this is far from reality and that artefacts like early cinematographic films, toys or fashion accessories, may be damaged to the point of no repair [1, 2].

Degradation factors include light, moisture, loss of components from the formulation or influence of other polymers in the vicinity. Recommendations consisted of keeping the artefacts away from light in a cool environment and on acid-free tissue; but this is unfortunately insufficient to maintain artefacts in their original condition. Consequently, it has now become obvious that more studies need to be performed on the mode of degradation of the materials. One of the main challenges that museums are facing is that although polymeric artefacts are many, they are often classified under the general heading of "plastic". Their degradation is extremely specific to their inherent chemistry and hence identification of the material as well as the presence of minor components is of utmost importance.

Several examples will illustrate how surface analysis techniques such as X-ray photoelectron spectroscopy (XPS) and time of flight secondary ion mass spectrometry (ToF-SIMS) can contribute to conservation science. Those examples will be provided by both in house studies [3] as well as taking inspiration from work performed in other institutes. The question of sample preparation will also be considered.

[1] *Plastics – Collecting and Conserving Book*, Anita Quye and Colin Williamson, NMS Publishing (1999).

[2] *Slowing down the Degradation of Cellulose Acetate*, Sue Mossman, MSc thesis, University of Surrey (2005).

[3] Marie-Laure Abel and Camille Coppitters, *Surf. Interface Anal.*, 40 (2008) 445-449.

The Future of Nanoscience and Surface Science

Andrew T S Wee

Department of Physics, National University of Singapore

2007 will be remembered as the year when Nobel Prizes were awarded to scientists in the fields of surface science (Gerhard Ertl, Chemistry) and nanoscience (Albert Fert & Peter Grünberg, Physics). Surface science had its origins in the 1960s with stated applications in corrosion, catalysis and semiconductors. Today many surface scientists have moved into the fields of nanoscience and nanotechnology. The key development that brought the fields together was the invention of the scanning tunnelling microscope (STM) in 1981 [1,2]. This invention led to the development of the atomic force microscope (AFM) and a whole range of related scanning probe microscopes (SPM), which are the instruments of choice for nanotechnology researchers today.

In this talk, I will give examples on the use of surface science techniques to investigate fundamental interface issues in the areas of graphene and molecular electronics. We used *in situ* STM, synchrotron photoemission (PES) and density functional theory (DFT) calculations to investigate the structure of the various reconstructions of 6H-SiC(0001) prior to its thermal decomposition to form epitaxial graphene (EG) [3]. Using the Co-decoration technique coupled with STM, the evolution of EG was found to preferentially begin at step edges of the silicon carbide surface and occurs with the loss of Si and breakdown of the C-rich $(\sqrt{6}\times\sqrt{6})R30^\circ$ template, which provides the C source for EG growth [4]. Raman spectroscopy was used to study the structure of EG and its interaction with SiC substrate [5]; EXAFS revealed deep defects within the SiC substrate after EG growth [6]. We also show that EG thermally grown on 6H-SiC(0001) can be p-type doped via surface transfer doping with the electron acceptor, tetrafluoro-tetracyanoquinodimethane (F4-TCNQ) [7].

The key to the development of molecular electronics is the understanding of molecule-metal and organic-organic interfaces. We used STM to study self-assembled organic donor/acceptor nanojunction arrays [8], and 2D supramolecular chiral networks on Ag(111) [9]. We assembled nanoscale molecular nanomeshes that could preferentially trap C_{60} molecules in the nanomesh voids [10]. Synchrotron techniques revealed molecular orientation dependent interfacial dipoles at the $F_{16}CuPc/CuPc$ organic heterojunction interface [11]. Configuration-dependent interface charge transfer at the molecule-metal interface was also demonstrated by resonance PES [12].

- [1] Binnig, G., Rohrer, H., Gerber, Ch. & Weibel, E. *App. Phys. Lett.* **40**, 178–180 (1982).
- [2] Binnig, G., Rohrer, H., Gerber, Ch. & Weibel, E. *Phys. Rev. Lett.* **50**, 120–123 (1983).
- [3] Chen W., Xu H., Liu L., Gao X.Y., Qi D.C., Peng G.W., Tan S.C., Feng Y.P., Loh K.P., Wee A.T.S., *Surf. Sci.* **596**, 176 (2005).
- [4] Poon S.W., Chen W., Tok E.S., Wee A.T.S., *Appl. Phys. Lett.* **92**, 104102 (2008).
- [5] Ni Z. H., Chen W., Fan X. F., Kuo J. L., Yu T., Wee A. T. S., Shen Z. X., *Phys. Rev. B* **77**, 115416 (2008).
- [6] Gao X.Y., Chen S., Liu T., Chen W., Wee A.T.S., Nomoto T., Yagi S., Soda K., Yuhara J., *Phys. Rev. B*, in press.
- [7] Chen W., Chen S., Qi D.C., Gao X.Y., Wee A.T.S., *J. Am. Chem. Soc.* **129**, 10418 (2007).
- [8] Chen W., Zhang H.L., Huang H., Chen L., Wee A.T.S., *App. Phys. Lett.* **92**, 193301(2008).
- [9] Chen W., Li H., Huang H., Fu Y.X., Zhang H.L., Ma J., Wee A.T.S., *J. Am. Chem. Soc.* **130**, 12285 (2008).
- [10] Zhang H.L., Chen W., Huang H., Chen L., Wee A.T.S., *J. Am. Chem. Soc.* **130**, 2720 (2008).
- [11] Chen W., Chen S., Huang H., Qi D.C., Gao X.Y., Wee A.T.S., *App. Phys. Lett.* **92**, 063308 (2008).
- [12] Wang L., Liu L., Chen W., Feng Y.P., Wee A.T.S., *J. Am. Chem. Soc.* **128**, 8003 (2006).

Biomaterials: Present and Future

Julian R Jones

**Department of Materials, South Kensington Campus, Imperial College London
julian.r.jones@imperial.ac.uk**

There is a large drive to move from a procedure of tissue replacement with bioinert materials to tissue regeneration with materials that can act as temporary templates (scaffolds) that can stimulate the body's natural healing mechanisms. There are many criteria for an ideal scaffold. In the case of bone, these include having a pore network large and open enough for cells to and blood vessels to penetrate and the ability to bond to bone and resorb safely at a controlled rate while maintaining mechanical strength.

Bioactive glasses are materials that have the potential to fulfil many of these criteria. Sol-gel derived bioactive glasses can be foamed to produce scaffolds that mimic cancellous bone macrostructure. They also have a nanoporosity that has a large effect on cell response and on resorption. Bioactive glass foams with optimised nanoporosity are strong in compression and may be ideal for non load bearing sites, however they have low toughness and pore strength when loaded in tension. Therefore an ideal scaffold would have all the properties of the glasses with enhanced toughness. This can only be achieved by creating nanoscale composites or inorganic/ organic hybrids. Ideally, cells will recognise the hybrid materials as one material rather than two materials combined together (as in a conventional composite). Resorbable polymers must interact with the silica based inorganic network at the nanoscale to maintain bioactivity and controlled resorption. This is a complex problem.

My research group have been developing new inorganic/ organic hybrid systems in monolith and porous scaffold form. We can quantify their macrostructure (by X-ray microtomography) and their averaged atomic structure using NMR. However we cannot investigate the role of calcium in the network and we cannot determine the distribution of the inorganic and organic regions in the material to assess whether the materials are "true hybrids" or whether further optimisation is required. Surface techniques may be able to help us achieve this.

A New Instrument for 3-Dimensional Imaging SIMS

Rowland Hill^{a*} and John Fletcher^b

^a **Ionoptika Ltd**

Unit 7 Warrior Park, Eagle Close, Chandler's Ford, Hants SO53 4NF

^b **The University of Manchester**

School of Chemical Engineering & Analytical Science, Manchester M60 1QD

Time of flight SIMS is finding increasing use in the analysis of biological materials and biochemical interfaces. The scope for using the technique to probe organic samples has vastly increased since the introduction of cluster primary ion beams. In particular, ToF-SIMS can be used to provide mass-spectral images in 2 or 3 dimensions, with spatial resolution down to the order of 100nm. In this presentation, we will describe a new instrument, recently installed in The University of Manchester, for use in analysis of bio-materials.

In conventional ToF-SIMS instruments, the need for rapid pulsing of the analysis beam results in some limitations to the performance envelope. In particular, a trade-off exists between spatial and mass resolution, especially when using large cluster beams, while the duty cycle can lead to long acquisition times or loss of information during etch cycles.

We have designed and built a mass spectrometer which utilises a new method of time-of-flight analysis to provide rapid data acquisition with simultaneous high spatial resolution and high mass resolution. In this instrument, the mass analysis is performed by sampling the secondary beam into a two-stage time-of-flight system. This removes the requirement for a pulsed primary beam as a time-of-flight reference. The two stage analyser allows analysis in normal time-of-flight mode and in ms-ms mode. The instrument is equipped with 40 kV C₆₀ and liquid metal cluster primary ion beams. These operate in d.c. mode, or, with long pulses when charge neutralisation is required. The dc beam operation removes the short duty cycle, enabling fast acquisition of images in 2D or 3D.

The instrument has an automated sample entry system with heating to 670K and cooling to 105K and includes a novel method of freeze-fracture for tissue samples or other organic samples in aqueous suspension. We will present the design features of the new instrument and illustrations of its performance in SIMS imaging of organic samples.

Application of SIMS to Solid Oxide Fuel Cells (SOFC's)

John A. Kilner, BCH Steele Chair in Energy Materials

Department of Materials, Imperial College London, London, SW7 2AZ

Solid Oxide Fuel Cells (SOFC's) are one of a family of high temperature electrochemical devices that can be used for clean and efficient energy conversion, essential if we are to achieve our goal of a low carbon world. These devices have been demonstrated to work well, however there are a number of barriers to their commercialisation, including durability and cost, that require fundamental investigations into the materials science and engineering of complex oxide systems. In the main this revolves around the transport of oxygen through, along and across interfaces, and SIMS can be particularly useful in this respect through the use of the stable isotopic tracer oxygen 18.

The main part of this talk will be a description of the Isotopic Exchange Depth Profiling (IEDP) technique and the current challenges we are facing in analysing oxygen isotopic distributions in complex oxide structures. Most of the oxides are heavily substituted fluorite (e.g CeO_2) or perovskite (e.g LaMnO_3) materials and the challenges are to determine the oxygen isotopic distributions listed below;

- Isotopic distributions in the first few nanometers from the oxide surface (together with cation distributions in the same interval).
- Lateral isotopic distributions from the deep submicron to mm scale, including high resolution isotopic mapping.
- Small area depth profiling (submicron).
- Isotopic distributions in working porous electrode structures (single phase and composite), including depth profiling and imaging.

The aim of these analyses is to obtain information about the transport of oxygen across surfaces, grain boundaries, hetero-interfaces at all length scales to enable the modelling of the operation of SOFC's in practical environments.

Alloys for Transport and Aerospace

Dr Barbara Shollock

Department of Materials, Imperial College London, London, SW7 2AZ

As the pressure on non-renewable energy sources increases, efforts to improve performance of existing transport increase. Although design improvements play a key role, much of the improvements result from materials advances, as in the Boeing 787 Dreamliner. These advances include higher operating temperatures, new alloys and materials, coating systems and novel processing.

In this talk, I will give examples on the use of surface science techniques complemented by other characterisation techniques to investigate fundamental issues in understanding the performance of metallic alloys for land and air transport.

Many materials operate in hostile environments, but the demands on a high-pressure turbine (HPT) blade of a jet engine provide one of the greatest challenges. These blades rotate at speeds up to 10,000rpm, exerting considerable stress on these components. These blades also operate in the hottest part of the core of the turbine, where the entry temperatures of hot gases exceed 1600°C. These demands necessitate new materials, including coatings, and complex cooling technology. Advanced nickel alloys must withstand oxidation under these demands, and understanding the mechanisms of oxygen diffusion is vital. Initial experiments developed the use ¹⁸O isotope exchange experiments and FIB-SIMS analysis. [1, 2]. Using the approach established in the early studies, the effect of lanthanum on the oxygen diffusion mechanism was studied. Electron microscopy was used to correlate oxide microstructure with the oxygen diffusion mechanism.

Much of the challenge in the next generation of civil transport is developing and assessing aluminium alloys that operate at higher temperatures, for supersonic civil, aeroplanes, or that have greater stiffness, for applications in the automotive industry. Particulate reinforced aluminium alloys have been an attractive alternative to monolithic aluminium titanium alloys. The nature of the reinforcement can influence the final microstructure [3, 4] and the characterisation of the reinforcement in a 2000x aluminium alloys using SIMS complemented by electron microscopy will be described.

- [1] Novel strategies for evaluating the degradation of protective coatings on superalloys
D. P. Garriga-Majo, B. A. Shollock, D. S. McPhail, R. J. Chater and J. F. Walker, International Journal of Inorganic Materials, Volume 1(5-6), (1999), pp 325-336
- [2] Use of tracers and SIMS analysis for evaluating the oxidation behaviour of protective coatings on nickel base superalloys, A.A. Alibhai, R.J. Chater, D.S.McPhail and B.A. Shollock, Appl. Surf. Sci. 203 (2003) pp. 630-633
- [3]. Dyos, K. Department of Materials, Imperial College of Science, Technology and Medicine. London : s.n., 1996. p. 42, PhD Thesis.
- [4]. Kinetics of the Growth of Spinel, MgAl₂O₄, on Alumina Particulate in Aluminium Alloys Containing Magnesium. A.D. McLeod and C.M. Gabryel Metall Trans. A (1992) Vol. 23A, pp. 1279-1283.

MeV Ion Beams – From Bench to Bedside

**Karen J Kirkby¹, J Charlie Jeynes¹, Miriam Barry¹,
Norman Kirkby², Boris Vojnovic³, Raj Jena⁴**

¹ Surrey Ion Beam Centre, Advanced Technology Institute

² Fluids and Systems Research Group

Faculty of Engineering and Physical Sciences, University of Surrey, Guildford, GU2 7XH

**³ Gray Institute for Radiation Oncology and Biology,
Oxford University, Oxford**

**⁴ Department of Oncology,
Addenbrooke's Hospital, Cambridge Universities NHS Trust, University of Cambridge**

MeV ion beams can be used for a wide range of applications in biology and medicine. These range from the analysis of bio-medical materials, to irradiation, with single ions of living cells in culture, to the fabrication of structures to assist cell growth, sort blood cells or large molecules or facilitate the realisation of lab on a chip.

In addition to providing fundamental information about the way in which living cell lines respond to precisely positioned and counted numbers of ions, which has applications in understanding the mechanisms responsible for cancer induction; ion beams albeit at much higher energies are increasingly being used in advanced radiotherapy strategies for the treatment of cancer. This talk will review the various applications of MeV energy ion beams, from bench to bedside, in particular their application to the study and treatment of cancer.

The talk will focus on the revolutionary new vertical nanobeam line which has been built at the University of Surrey for the irradiation of individual living cells in culture. It will show some initial results and describe how multi-scale modelling techniques are being used to translate experimental findings into the clinical environment.

UK Needs for Surface and Nanoanalysis Measurement and Characterisation

Ian Gilmore

National Physical Laboratory, Teddington, UK

The successful, modern knowledge-based economy is built on growing innovation for the development of high added-value products that have a strong competitive edge in the global market place. Central to the correct operation and novel properties of many of these products is the surface chemistry. Surface chemical analytical techniques are key to understanding and characterising these surfaces from the microscale to the nanoscale. The UK Government has a strong emphasis on science and innovation as key for UK competitiveness in the global economy [The Race to the Top, A Review of Government's Science and Innovation Policies "Sainsbury Review", 2007]. The newly formed Department of Innovation Universities and Skills (DIUS) is committed to developing the UK as the "Innovation Nation" [DIUS Innovation Nation 2008]. At the core of the Government funded infrastructure for science and technology, the National Measurement System (NMS) plays a key role in supporting high-innovation industry, providing the necessary public infrastructure backed up by a history of world-class measurement support [Sainsbury Review, 2007].

The NMS Surface and Nanoanalysis metrology programme aims to:

- develop reliable leading-edge measurements, capability and infrastructure.
- ensure that UK measurements are fit-for-purpose, support the infrastructure for accreditation and quality control and provide international comparability.
- conduct knowledge transfer activities including national and international comparisons, representation on international bodies to ensure international uniformity and traceability of UK measurements.

The new NMS Surface and Nanoanalysis research programme is currently being formulated which has involved a detailed consultation exercise across industry and academia to explore the UK measurement needs. The results of this consultation were debated and prioritised by experts at a recent workshop [Surface Analysis Measurement Steering Workshop SAMS-5 September 2008, Teddington, UK]. Here, we report on the results of this consultation and highlight the current and future UK needs for measurement and characterisation in surface and nanoanalysis to support innovation and quality of life.

Consultation has identified strong needs for metrology in the following key areas: the characterisation of nanoparticles to support measurements of engineered micro- and nano-particles and measurement of the surface chemistry for toxicology studies as well as the interaction forces between nanoparticles and cells; multivariate analysis methods to improve analytical throughput and make the most of acquired data for decision making; identification of complex molecules and orientation on surfaces especially organic substrates; metrology for cluster ion beams and organic depth profiling (both SIMS and XPS); there is a strong demand for techniques that operate in ambient conditions such as AFM especially new imaging modes for soft samples and ambient mass spectrometry methods such as desorption electrospray ionisation (DESI); plasma assisted desorption ionisation (PADI) and extractive electrospray ionisation (EESI). It has also become clear that whilst MALDI is a well-established technique with a large user base that poor repeatability is a significant barrier and that strong support has been given to develop metrology to support this technique.

	Attendee	Organisation
1	Abel, Marie-Laure	University of Surrey
2	Alexander, Morgan R	University of Nottingham
3	Aguilar Virgen, Julio	Imperial College
4	Baker, Mark	University of Surrey
5	Bernard, Brian	Thermo Fisher Scientific
6	Betz, Wolfgang	Phi
7	Bishop, Hugh	Oxford University
8	Bulpett, Robert	Brunel University
9	Bushnell-Wye, Graham	STFC Daresbury Laboratory
10	Chater, Richard	Imperial College
11	Church, Simon	BAE Systems
12	Cooke, Graham	Hidden Analytical
13	Crossley, Alison	Oxford University
14	Cubric, Dane	Shimadzu Research Laboratory (Europe)
15	Day, John	University of Bristol
16	Deslandes, Louis-Martin	Pilkington Group
17	Dickinson, Calum	University of Limerick
18	Downing, Clive	Oxford University
19	Eccles, John	Millbrook Instruments
20	Edwards, Dean	Carl Zeiss SMT
21	El-Gomati, Mohamed	University of York
22	Farnworth, Mark A	Pilkington Group
23	Figgures, Chris	BAE Systems
24	Fletcher, John	University of Manchester
25	Geeson, David	AWE
26	Gilmore, Ian	National Physical Laboratory
27	Green, Martyn	Omicron NanoTechnology
28	Greenwood, Oliver	Thermo Fisher Scientific
29	Grilli, Rossana	University of Surrey
30	Harris, Steve	BAE Systems
31	Hazell, Len	CSMA
32	Helliwell, Colin	Ion-ToF
33	Henderson, Alex	SurfaceSpectra
34	Hill, Rowland	Ionoptika
35	Hughes, Greg	Dublin City University
36	Jackson, Ben	Imperial College
37	Jones, Julian	Imperial College
38	Kheyrandish, Hamid	CSMA
39	Kilner, John	Imperial College
40	Kirkby, Karen	University of Surrey
41	Krizek, George	Vacuum Systems - Microanalysis
42	Lee, Bill	Imperial College
43	Lok, Jimmy	University of Nottingham
44	Long, Nick	Millbrook Instruments
45	Longworth, Sarennah JP	Johnson Matthey
46	Marino, Paolo	University of Surrey
47	Martin, Graham	Victoria and Albert Museum
48	Mason, Philip	Imperial College

	Attendee	Organisation
49	McPhail, David	Imperial College
50	Morton, Simon	Lawrence Berkeley National Laboratory
51	Mullock, SJ	Kore Technology
52	Murray, Stephen	
53	Newby, Phillipa	Imperial College
54	Owen, Ian	Scanwell
55	Pang, Bo	Imperial College
56	Patankar, Sameer	University of Nottingham
57	Pishbin, Fatemehsadat	Imperial College
58	Price, Robert	PerkinElmer Life and Analytical Sciences
59	Rafati, Ali	University of Nottingham
60	Ray, Santanu	National Physical Laboratory
61	Richardson, Carl	RTA Instruments
62	Riviere, John	Consultant
63	Roberts, Adam	Kratos Analytical
64	Sano, Naoko	University of Surrey
65	Scurr, David	University of Nottingham
66	Seah, Martin	National Physical Laboratory
67	Shapcott, Steve	BAE Systems
68	Shard, Alex	National Physical Laboratory
69	Shimizu, Kyoko	University of Surrey
70	Shollock, Barbara	Imperial College
71	Smith, Graham C	Shell Global Solutions UK
72	Smith, Richard	Johnson Matthey
73	Spencer, Steve	National Physical Laboratory
74	Subhani, Tayyab	Imperial College
75	Sykes, David	Loughborough Surface Analysis
76	Télez, Helena	Universidad de Málaga
77	Thompson, Charlotte E	Millbrook Instruments
78	Thomson, Richard	RTA Instruments
79	Turner, Andrew	Leica Microsystems (UK)
80	Vadillo, Jose	Universidad de Málaga
81	Valliant, Esther	Imperial College
82	Vohralik, Peter	Millbrook Instruments
83	Walker, Christopher	University of York
84	Walton, John	University of Manchester
85	Watts, John	University of Surrey
86	Wee, Andrew	National University of Singapore
87	Wells, Luke	Hidden Analytical
88	West, Robin H	Winnats Scientific Services
89	White, Richard	Thermo Fisher Scientific
90	Wincott, Paul	University of Manchester
91	Wolstenholme, John	Thermo Fisher Scientific
92	Wu, Zoe Yunxie	Imperial College
93	Yang, Li	National Physical Laboratory