

HAADF-STEM image (top left) and STEM-EDX maps of a bismuth ferrite-lead titanate thin film analysed by a non-aberration corrected, FEI Titan Themis G2 300 (sample prepared by Dr Faye Esat, images courtesy of Dr Andy Brown, University of Leeds).

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## EMAG COMMITTEE

### Chair

Dr Sarah Haigh

School of Materials, University of Manchester, Manchester, M13 9PL

Tel: 0161 306 3618 Email: [sarah.haigh@manchester.ac.uk](mailto:sarah.haigh@manchester.ac.uk)

### Secretary & Honorary Treasurer

Dr Andy Brown

School of Chemical and Process Engineering, University of Leeds, Leeds, LS2 9JT

Tel: 0113 343 2382 Email: [A.P.Brown@leeds.ac.uk](mailto:A.P.Brown@leeds.ac.uk)

### Ordinary Members

Mr David Beamer

FEI Company, [David.Beamer@fei.com](mailto:David.Beamer@fei.com)

Mr Michael Dixon

Hitachi Europe, [Michael.Dixon@hht-eu.com](mailto:Michael.Dixon@hht-eu.com)

Dr ZiYou Li

University of Birmingham, [ziyouli@nprl.ph.bham.ac.uk](mailto:ziyouli@nprl.ph.bham.ac.uk)

Dr Budhika Mendis

University of Durham, [b.g.mendis@durham.ac.uk](mailto:b.g.mendis@durham.ac.uk)

Dr Ana Sanchez

University of Warwick, [a.m.sanchez@warwick.ac.uk](mailto:a.m.sanchez@warwick.ac.uk)

Prof. Jun Yuan

University of York, [jun.yuan@york.ac.uk](mailto:jun.yuan@york.ac.uk)

### Co-opted

Dr. Caterina Ducati

University of Cambridge, [cd251@cam.ac.uk](mailto:cd251@cam.ac.uk)

**[Note: we have recently advertised for applications for new ordinary committee members \(deadline 31<sup>st</sup> January 2017\)](#)**

## LETTER FROM THE CHAIR

Dear Friends and Colleagues,

I'd like to start by thanking our out-going chair Dr Caterina Ducati (Cambridge University) for her excellent work for the last two years. As Chair I will be trying to build on her success with the support of the group's honorary secretary and treasurer, Dr Andy Brown.

I also like to thank Dr Budhika Mendis (University of Durham) for his role in leading the organisation of the highly successful focussed EMAG Workshop last April. This meeting demonstrated the key strengths of the electron microscopy and analysis group (EMAG): vibrant and exciting scientific presentations combined with friendly, relaxed opportunities for social interactions (see report on page 9).

Plans for this year are already well established for our full 3.5 day biennial EMAG conference which will again be held as part of the MMC conference in Manchester from 3<sup>rd</sup>-6<sup>th</sup> July 2017 ([www.mmc2017.org.uk](http://www.mmc2017.org.uk)). Abstract submission is open now with a deadline of 17 February 2017 – I encourage you all to submit your recent work. Participants will benefit from exciting plenary presentations, a bigger than ever exhibition and the opportunity to submit a 4 page conference paper which will be peer reviewed as part of the conference (see page 5 for more information). The 5 minute 'flash' oral slots to advertise poster presentations trialled at the Durham workshop last year was a particular highlight – this format will be applied again at EMAG 2017 and also at other MMC sessions. I look forward to seeing many of you there!

Finally I'd like to thank Andy Brown for putting together this excellent newsletter – we welcome your contributions for future issues!

Best wishes,



Sarah Haigh  
University of Manchester, EMAG Chair

## FORTHCOMING EVENTS

### ***EMAG2017 Call for Papers***

**Abstract submission deadline 17th February 2017.**

**Submit through [www.mmc2017.org.uk/](http://www.mmc2017.org.uk/)**

The EMAG conference in 2017 will again be part of The Royal Microscopical Society's Microscience Microscopy Congress (MMC2017) on 3-6 July 2017.

The Microscience Microscopy Congress is set to be as big and as bold as ever with six parallel conference sessions, an exhibition with more than 100 companies represented, and a brilliant selection of features such as pre-event workshops and turn-up-and-learn training opportunities. MMC2017 is proud to present:

- an international scientific conference of six parallel sessions, covering an enormous range of microscopy and imaging topics
- a huge free exhibition with companies both large and small showcasing their latest equipment and available to answer your questions
- a poster village featuring cutting-edge research from all over the world
- pre-congress workshops covering the latest emerging topics
- a drop-in Learning Zone filled with a range of equipment and experts on hand to offer advice and demonstrations

Abstract submission closes 17 February 2017. On acceptance, full papers will be requested before the start of the conference. For more information, including the call for papers please visit the group webpage.

**[http://www.iop.org/activity/groups/subject/emag/conference/page\\_64333.html](http://www.iop.org/activity/groups/subject/emag/conference/page_64333.html)**

## ***EMAG Annual General Meeting 2017***

The AGM of the EMAG group will be held as part of MMC2017 in Manchester, UK ([www.mmc2017.org.uk](http://www.mmc2017.org.uk)) during the conference (3-6<sup>th</sup> of July 2017). No fee is charged to attend the Annual General Meeting. Agenda and more details will be circulated nearer the time. If you cannot attend the AGM but have any issues you would like to be raised at the meeting, please contact the honorary secretary ([a.p.brown@leeds.ac.uk](mailto:a.p.brown@leeds.ac.uk)).

## ***Nanoanalysis of Steels and Structural Alloys***

Buchanan Arms Hotel, Drymen, Stirlingshire, UK

7–8<sup>th</sup> September 2017

Advances in sub-nanometre resolution chemical analysis can have huge benefits in the study and development of steels and other structural alloys. This meeting is an opportunity to learn about, present and discuss the latest advances in analytical techniques like EELS and EDX on the transmission electron microscope, and 3D atom probe tomography, and how these can be applied to understanding the nanochemistry in high performance alloys.

The location of the conference will be the Best Western Buchanan Arms Hotel in Drymen, Stirlingshire, Scotland. Drymen is located about 20 miles to the north of Glasgow, very close to the east shore of Loch Lomond and set amidst beautiful countryside on the edge of the Scottish Highlands.

Presenters are requested to submit a short 150-word abstract with a title and an author list by **1 February 2017**.

Find out more information and submit an abstract at

***<http://nssa2017.iopconfs.org/home>***

## RESEARCH HIGHLIGHT

### Polarization curling in a multiferroic tunnel junction

By J.J.P.Peters, PhD student, University of Warwick

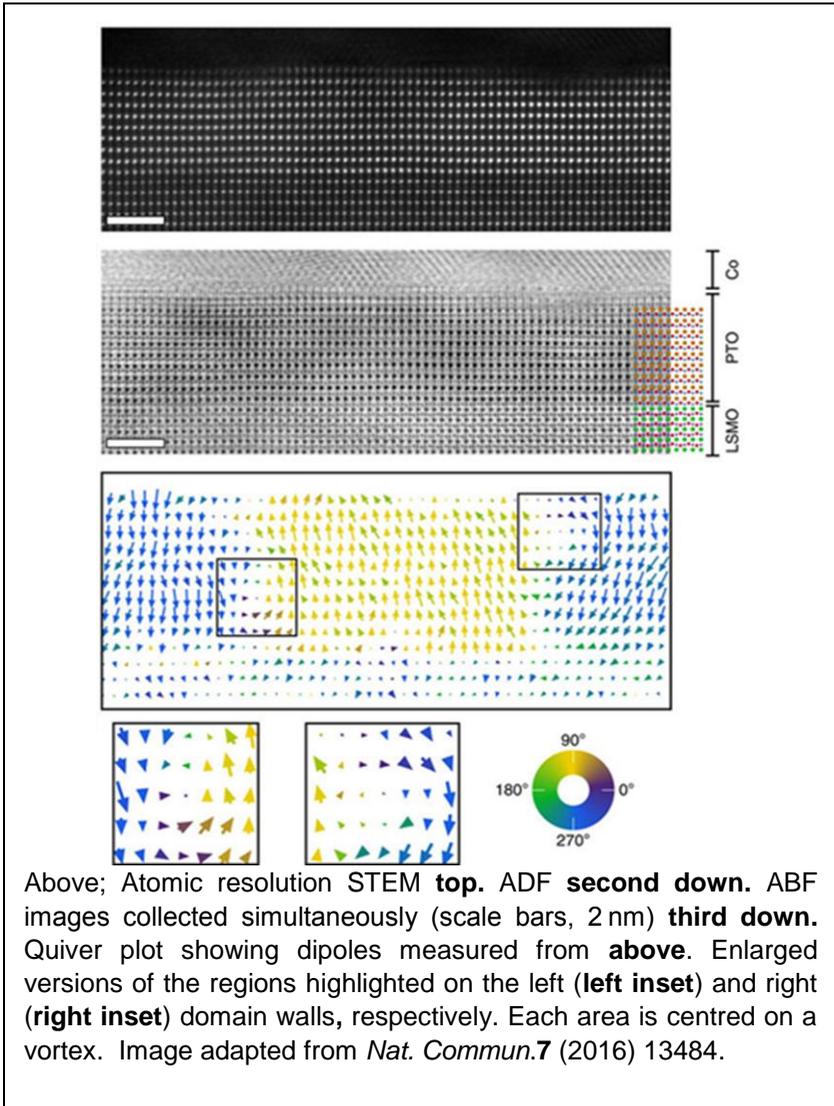
The pursuit of ever denser, smaller electronic devices has been recently fuelled by the discovery of ferroelectricity in thin films as thin as 3 unit cells (~1.2 nm). By placing such an ultrathin ferroelectric film between two asymmetric electrodes, a tunnel current is found to have an *on* and *off* state depending on the ferroelectric's polarisation direction. Such a configuration shows great promise as a non-volatile memory device. Using ferromagnetic electrodes combines a traditional, two-state magnetic tunnel junction with the two states of the ferroelectric to form a novel, 4-state memory device. However, reducing the thickness of the ferroelectric films introduces a more complex pattern in the polarisation, ranging from flux-closure domains to vortices. This is spurred by the competition between epitaxial strain and the depolarising field caused by bound charges at the ferroelectric interfaces.

Until recently, such polarisation structures were only studied in systems where the depolarising field has been maximised with insulating *electrodes* and the polarisation cannot be manipulated with electric fields. In our work, we studied polarisation in ultrathin PbTiO<sub>3</sub> (PTO) thin films between conducting electrodes. Here we might expect the free charges in the electrodes to screen the depolarising field and suppress some of the complex polarisation structures. Because the polarisation in PTO is produced by the relative shifts of the titanium and oxygen ions, transmission electron microscopy is a perfect technique for mapping the polarisation on a unit cell level. Using annular bright field imaging to accurately measure the positions of all atoms (including oxygen), we measured the polarisation for PTO films 9, 6 and 3 unit cells thick and discovered various complex arrangements of polarisation.

For PTO layers 9 unit cells thick, a relatively normal 180° domain structure is revealed, though small vortices already indicate the presence of size effects.

Reducing the thickness to 6 unit cells causes the polarisation to form complex, incommensurate flux closure domains while at 3 unit cells thick the polarisation all points in one direction but is not switchable due to the strong polarisation gradient across the film thickness.

This work was presented at EMAG 2016 and was kindly awarded best oral presentation and has recently been published in *Nat. Commun.***7** (2016) 13484.



## MEETING REPORTS

### EMAG 2016, Durham

By Dr Budhika Mendes, University of Durham

The EMAG 2016 workshop on 'Quantitative Electron Microscopy: Imaging, Diffraction and Spectroscopy' was held in Durham on 6-8<sup>th</sup> April 2016. This was the first of a shorter EMAG workshop format focussing on a specialised topic, in this case Quantitate Electron Microscopy. The 100+ delegates attended sessions on Imaging and Diffraction, Spectroscopy and Applications as well as a poster session and exhibition. The conference opened with a plenary talk by Prof Ferdinand Hofer (STEM applications), followed by two other plenary talks by Prof Paul Midgley (Tomography) and Prof Alan Craven (EELS). Invited and contributed talks covered the latest advances in STEM strain measurement through to atomic resolution chemical mapping (to name a few).

A very pleasing aspect of EMAG conferences are the student awards. For EMAG 2016 Jonathan Peters from Warwick University won the best oral presentation (**see Research Highlights**), while there were three poster prizes awarded to Shanshan Wang (Oxford), Thomas Furnival (Cambridge) and Sam Marks (Warwick).



**Above:** EMAG 2016 winners (left to right): Thomas Furnival (Cambridge), Sam Marks (Warwick), Shanshan Wang (Oxford) and Jonathan Peters (Warwick).

**EMC2016, Lyon** [28<sup>th</sup> August-3<sup>rd</sup> September 2016]

By Mark S'ari, PhD student, University of Leeds

The 2016 European Microscopy conference was held in the French city of Lyon, and offered a busy and exciting presentation schedule, with talks from a co-recipient of a Nobel Prize (Eric Betzig) and numerous other high profile speakers.

The conference covered 27 symposia split into three main sessions which included life sciences, material science plus instrumentations and methods. During the week there were over 400 different talks and 900 posters as well as multiple plenary talks, numerous scientific workshops and a large exhibition, showcasing state-of-the-art equipment and technology.

The plenary talk on the Monday given by Eric Betzig, one of the 2014 Nobel Prize awardees in Chemistry, on the technique he and a few other people developed (super-resolution PALM microscopy) was very fascinating and gave some truly amazing images of cells.



Lyon in early September

Invited speaker Paul Midgely gave an interesting talk on scanning precession electron diffraction and the uses it has for obtaining a wealth of information, even on samples that are extremely beam-sensitive. This is of particular interest to me

since my area of work lies in low-dose analysis of pharmaceutical materials and it was great to see the importance of low-dose recognised outside of cell biology and being applied to different kinds of materials. Some of the talks that I found particular interesting were by Dorothea Muecke-Herzberg and Arnabd Béch  on the possible use of compressive sensing that could allow for lower-electron dosages to be used in STEM and still extract the same amount of information as if a higher dose was being used.

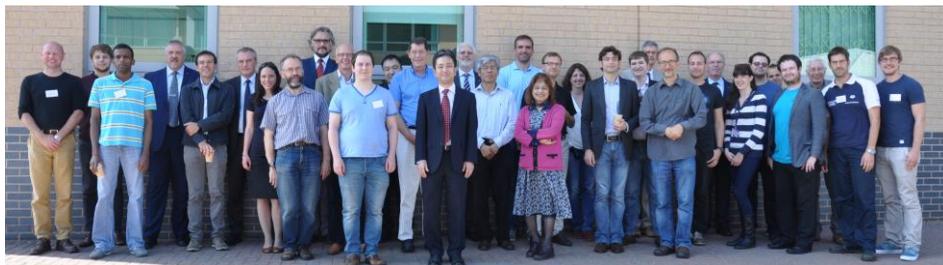
This was my first international conference and it was exciting to be involved in a much larger event than I have previously attended. Overall it was a great experience from hearing all the interesting goings on in the field of microscopy, the entertaining social events, stunning location and delicious food. I eagerly look forward to the next one.

## **York-JEOL Workshop on Future Technologies in Electron Microscopy, University of York**

By Prof. Jun Yuan, University of York

A workshop was held on 12<sup>th</sup> and 13<sup>th</sup> of September at the York-JEOL Nanocentre, celebrating the development of electron microscopy research in York and the UK in general and also the long-term collaboration between the University of York, a centre for advanced electron microscopy technical development and applications in physics, chemistry, materials science and biomaterials and JEOL, one of the leading international electron microscopy suppliers. A number of experts from UK and Europe gave a fascinating survey of the emerging technologies being developed. They include Dr Sawada, manager of European EM product support in JEOL UK Ltd., Professor Rik Drummond-Brydson from the University of Leeds, Dr Sarah Haigh from the University of Manchester, Professor Quentin Ramasse from SuperSTEM and Dr Giuseppe Nicotra from CNR-IMM, Italy, as well as the local contributions from Dr Vlado Lazarov, Professor Atsufumi Hirohata, Professor Pratibha Gai, Professor Ed Boyes, Dr Roland Kr ger and Professor Jun Yuan. The topics covered ranged from imaging of buried defects in junctions to TEM challenges beyond the nanoscale and in-situ scanning transmission electron microscopy of catalysts to electronic structure of dichalcogenides. The meeting was chaired by Dr Steve Tear, the new director of the York-JEOL nanocentre and attended by the CEO of JEOL(UK), Mr. Shaun Quill and five other senior staff from JEOL(UK). The

workshop ended with a dinner at a local pub where Yorkshire delicacies and scientific discussions were consumed with equal vigour.



Participants of the York-JEOL Future EM Workshop

## **International Workshop on “Nanoalloys on Atomic Scale: Theoretical and Experimental Studies of Structures and Reactions”**

By Ziyou Li, Christian Ricolleau, Roy Johnston and Jun Yuan, The organisers of the workshop at University of Birmingham, Dec 2016.

This one-day international workshop on “Nanoalloys on Atomic Scale” was held on 5<sup>th</sup> December 2016 in the University of Birmingham. It was part of the funded Royal Society International Exchanges Scheme between University of Birmingham, U.K. and University Paris Diderot, France. The workshop took place in the Nicolson Building, on the grounds of the Grade II listed building of Winterbourne House and Garden.

The aim of the workshop was to address some critical issues in bimetallic nanoalloys through direct imaging and modeling at the atomic scale, which was successfully achieved. 12 invited talks, from experts in the field focused on both theoretical and experimental studies on structures and reactions, were well received by participants of the workshop and they prompted many lively scientific discussions both during and after the talks. A poster session was held over the lunch break, which allowed the discussion to continue. Overall, one-third of the attendees were from overseas ranging from France, Italy and as far as Canada, one third from Birmingham and the rest from elsewhere in the UK such as Manchester, York, London, Southampton and Cardiff. We also had attendees from companies and organisations. As the number of attendees at the workshop was intentionally capped at 50 to allow discussions and interactions, people who requested later had to be turned away unfortunately.

The workshop has provided a unique forum to bring together distinct communities

under one roof to discuss the challenges and the advantages of various experimental and theoretical methods. The outputs of the workshop were continued in the following day, during the brainstorming discussion on the status and future opportunities of the nanoalloys field.

The organisers of the workshop are grateful for the sponsorships by the British Vacuum Council (BVC) and Institute of Physics Electron Microscopy and Analysis Group (EMAG), which allowed the workshop to be open to PhD students and post-doctoral research fellows who are interested in the field yet outside of this particular exchange scheme.



Participants of the Nanoalloys Workshop

## APPLY FOR IOP RESEARCH STUDENTS CONFERENCE FUND

If you are a student member and are looking for funding to attend a meeting or conference, please apply for an RSCF bursary, which may give you up to £300 towards your costs. We have several of these bursaries to give away each year. Check eligibility criteria and download the form at

[http://www.iop.org/about/grants/research\\_student/page\\_38808.html](http://www.iop.org/about/grants/research_student/page_38808.html)

## EMS MEMBERSHIP

EMAG members are reminded that they are all automatically members of the European Microscopy Society, at no cost to themselves. However, in order to receive information from the EMS, it is essential to send your e-mail address to the EMS secretary - this cannot be sent by the IOP due to the Data Protection Act. This is important, since almost all communications from the EMS are sent by e-mail, including information for voting for the next Executive Board.

Send your e-mail address (and preferably your other details, postal address, phone & fax numbers) to: [secr@eurmicsoc.org](mailto:secr@eurmicsoc.org) and indicate whether you agree to include this information in the EMS Yearbook. If you do NOT wish to appear in the Yearbook, your e-mail address will be used solely for the dispatch of information by the EMS secretary ([virginie.serin@cemes.fr](mailto:virginie.serin@cemes.fr)).

The EMS web page can be viewed at: <http://www.eurmicsoc.org/>

EMAG members are also reminded of the availability of EMS Bursaries. For more details, see <http://www.eurmicsoc.org/scholarships.htm>

## ADDITIONAL FUTURE MEETINGS OF INTEREST

### **Microscopy Characterisation of organic-inorganic Interfaces**

23-24th February 2017, London

[www.rms.org.uk/discover-engage/event-calendar/microscopy-characterization-2017](http://www.rms.org.uk/discover-engage/event-calendar/microscopy-characterization-2017)

### **Cryogenic Preparation and Imaging Strategies for Soft Matter in Materials Science**

24<sup>th</sup> February 2017, London

[www.rms.org.uk/discover-engage/event-calendar/cryogenic-preparation-imaging](http://www.rms.org.uk/discover-engage/event-calendar/cryogenic-preparation-imaging)

### **Electron Back Scatter Diffraction Meeting 2017**

4-5<sup>th</sup> April 2017, Oxford

[www.rms.org.uk/discover-engage/event-calendar/ebsd-2017](http://www.rms.org.uk/discover-engage/event-calendar/ebsd-2017)

### **Microscopy of Semiconducting Materials, MSM XX**

9-13<sup>th</sup> April 2017, Oxford

[www.rms.org.uk/discover-engage/event-calendar/msm-xx](http://www.rms.org.uk/discover-engage/event-calendar/msm-xx).

### **Enhanced Data Generated by Electrons, EDGE2017**

"8th International Workshop on Electron Energy-Loss Spectroscopy (EELS) and Related Techniques

14-19<sup>th</sup> May 2017, Okinawa, Japan

[www.nims.go.jp/EDGE2017/](http://www.nims.go.jp/EDGE2017/)

### **For more microscopy events see:**

<http://www.eurmicsoc.org/en/meeting-calendar/calendar/>

**EMAG contact points**

IOP: Institute of Physics, 76 Portland Place, London, W1B 1NT, UK  
Tel: +44 (0)20 7470 4800, Fax: +44 (0) 20 7470 4900

For conferences:

Email: [conferences@iop.org](mailto:conferences@iop.org)

<http://www.iop.org/events/scientific/conferences/index.html>

Group matters: Science Support Officer

Email: [groups@iop.org](mailto:groups@iop.org)

EMS: European Microscopy Society

Email: [secr@eurmicsoc.org](mailto:secr@eurmicsoc.org)

<http://www.eurmicsoc.org/index.html>

MRS: Materials Research Society, 9800 McKnight Road, Pittsburgh,  
PA 15237, USA.

Tel: +1 412 779 3003, Fax: +1 412 779 8313

<http://www.mrs.org/meetings/>

MSA: Microscopy Society of America, 12100 Sunset Hills Rd., Suite 130,  
Reston, VA 20190, USA.

Tel: +1 703 234 4115, Fax: +1 703 435 4390

<http://www.microscopy.org/>

RMS: Royal Microscopical Society, 37/38 St. Clements, Oxford, OX4 1AJ.

Tel: +44 1865 248 768, Fax: +44 1865 791 237

Email: [meetings@rms.org.uk](mailto:meetings@rms.org.uk) <http://www.rms.org.uk/events/>

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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.

The Institute of Physics, 76 Portland Place, W1B 1NT, UK.

Tel: 020 7470 4800

Fax: 020 7470 4848