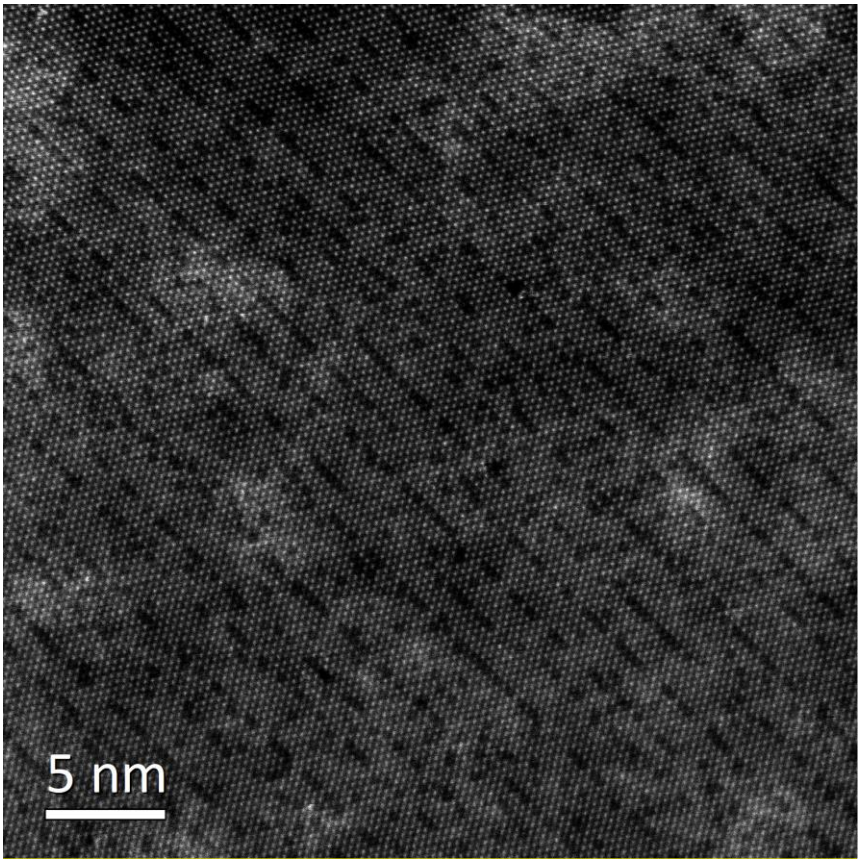
IOP | Institute of Physics
Electron Microscopy and Analysis Group

NEWSLETTER **January 2021**



ADF-STEM image recorded using a JEOL ARM200 double corrected microscope along the tip of a $Nb_{0.1}W_{0.9}S_2$ monolayer. The Nb atoms tend to form atomic lines along <100> crystallographic directions and are separated by several unit cells of WS_2. (image courtesy of Xue Xia, University of Warwick)

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LETTER FROM THE CHAIR

Dear Friends and Colleagues,

Well, what a year! It is unfortunate that most of the news was not fake however, the COVID-19 enforced move to online activity has been kind to EMAG and for that I would like to thank you our members for your engagement and positivity under the rapidly changing circumstances.

Our focussed EMAG workshop for 2020 was due to be in Glasgow, covering **Microscopy enabled by direct electron detection.** We duly moved this event online, prepared a compressed format (aimed to fit with the pressures of working from home) and held our breath! We need not have worried, come the 6th July we had ~280 delegates registered with typically more than 200 in-attendance at talks (7 invited speakers, 22 contributed scientific flash talks, 8 short trade talks and 10 online posters plus a Zoom pub quiz on the evening of the 7th July). We feel the meeting was of high scientific quality with good, lively engagement of participants and, for us, set the benchmark of what is possible with online meetings. Thanks therefore go to Donald MacLaren for all the hard work in arranging and re-arranging this meeting as conference chair and to the IoP team for all their support in the organisation. There is a full meeting report by Donald in this Newsletter (page 18).

Online meetings are clearly here to stay and bring many benefits such as reduced travel for example, see the excellent report on the Virtual Early Career European Microscopy Congress meeting by Tamsin O'Reilly (Queen's University Belfast; page 19). On this note, EMAG 2021 will be online, again as part of the RMS's MMC conference series in July 2021 (www.mmc-series.org.uk). Abstract submission is to be confirmed but we have a fantastic group of invited speakers already lined up (www.mmc-series.org.uk/conference/emag-2021). I encourage you all to submit your recent work and look forward to 'seeing' many of you there!

Student engagement remains a real feature and goal of EMAG meetings and I would like to draw your attention to reports from our prize-winning contributors to the **EMAG 2020 workshop;** Kirsty Paton (University of Glasgow; page 14) and Thomas Danz (University of Göttingen; page 16).

I would like to welcome our new committee member for 2020, Dr Jo Sharp (University of Sheffield). Special thanks are also due to our outgoing co-opted committee member, Prof Sarah Haigh (University of Manchester). Sarah has made a fantastic contribution to EMAG over the years, finishing by taking on the role of editor for the Journal of Microscopy Special Issue covering EMAG 2019 at MMC 19. We deliberately chose to reflect recent trends and publish in a journal

rather than as a conference proceedings, and are pleased with the result of 21 published articles (https://onlinelibrary.wiley.com/toc/13652818/2020/279/3). We thank Sarah for all the hard work and hope you enjoy reading the Issue. We will be aiming for a similar approach to a Special Issue for EMAG 2021 at MMC 21.

Last but not least, I'd like to thank Ana Sanchez for putting together this excellent newsletter. We have updated the list of physical science facing Microscopy Infrastructure Access Schemes in the UK as we feel this remains a useful listing for EMAG members (page 21). As always, we welcome your contributions for future issues or please let us know if we have missed anything – you can always stay up to date with us on Twitter (@IoP_EMAG)!

Best wishes for 2021 and stay safe,

Andy Brown
University of Leeds, EMAG Chair

FORTHCOMING EMAG EVENTS

EMAG2021

Call for Papers

Abstract submission deadline TO BE CONFIRMED.

Submit through https://www.mmc-series.org.uk/conference/emag-2021.html

Organised by **the Institute of Physics's Electron Microscopy and Analysis Group (EMAG)**, the 2021 EMAG Conference will be part of mmc2021.

The EMAG2021 conference will be held online on 5-8th July 2021

Confirmed Invited Speakers

- Prof. Ido Kaminer (Technion – Israel Institute of Technology, Israel)
- Dr. Demie Kepaptsoglou (SuperSTEM laboratory, Daresbury, UK)
- Dr. Emanuela Liberti (University of Oxford, UK)
- Dr. Lorena Ruiz-Perez (Imperial College London, UK)
- Dr. Steven R. Spurgeon (Pacific Northwest National Laboratory, USA)
- Dr. Andy Stewart (Department of Physics and Bernal Institute, University of Limerick, Ireland)
- Dr. Toma Susi (University of Vienna, Faculty of Physics, Austria)

Abstract submission TO BE CONFIRMED (https://www.mmc-series.org.uk/).

Remote Hyperspy Workshop

Date TBC. ePSIC, Harwell, UK

This workshop is aimed to be an introduction to the Hyperspy python package for the analysis of multidimensional data (primarily in electron microscopy). Topics will include an introduction to Hyperspy and analysis of spectroscopic, scanning diffraction and atomic resolution data. Due to COVID-19, we are aiming to run this year's workshop fully remotely. Participants will need to have their own computer and will be assisted over Zoom. Further details will be released shortly, but please contact mohsen.danaie@diamond.ac.uk if interested in attending.

SuperSTEM Summer School

In light of the further public health and travel restrictions worldwide, it would be unreasonable to expect we would be in a position to deliver the essential hands-on training that the SuperSTEM summer school normally offers this year. The event, initially scheduled for the summer of 2020, will now be taking place in summer 2022. Please check the facility's website regularly for further updates, or sign up to receive regular updates: https://www.superstem.org/signup

EMAG Annual General Meeting 2021

No AGM of the EMAG group was held in 2020 as all our meetings were online! This may well remain the case for much of 2021 and IoP do not insist we hold an AGM however we will aim to have a short online meeting as part of EMAG 2021 at mmc21. Assuming we do indeed go ahead with this an 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.m.sanchez@warwick.ac.uk).

NEWS

In memoriam

Dr Ziyou Li (29.09.1959 – 18.12.2020)
It is with sadness to report the passing of Dr. Ziyou Li. She was a Reader in Physics at University of Birmingham. She was well-known to members of the EMAG group, serving as a committee member from 2011-2018. She and Yu-long were the local organizers for the successful EMAG2011 meeting held in Birmingham. Her research interests range from adsorption studies on surfaces to three-dimensional structure imaging of ultra-small nanoclusters and catalytic nanoparticles using techniques including quantitative scanning transmission electron microscopy. She was the first to apply quantitative atom counting techniques for nanoparticle metrology. Her research has broad impact in cluster and catalytic science.

Dr Kenneth Smith (20.03.1928 – 15.03.2020)
We are sad to report that Ken Smith (K.C.A. Smith) passed away on 15.3.2020, a few days before his 92nd birthday - his name will be familiar to the older generation of EMAG members. As you may be aware, the SEM as we know it today was developed in Charles Oatley's lab in the Cambridge University Department of Engineering in the years after WWII. The first instrument was constructed by Dennis McMullan; it was taken over and very considerably improved by Ken Smith who was also responsible for the first British HVEM in the Cavendish Lab. Ken published an autobiographical article entitled *"Electron Microscopy at Cambridge University with Charles Oatley and Ellis Cosslett: Some Reminiscences and Recollections*" in Advances in Imaging & Electron Physics 177 (2013)189–277.

Prof. Sir John Meurig Thomas (15.12.1932-13.11.2020)
It is also a great sadness to share the news that Professor Sir John Meurig Thomas passed away on 13.11.2020. He was Director of the Royal Institution of Great Britain, a former head of the Department of Physical Chemistry and former Master of Peterhouse, University of Cambridge. Sir John was renowned for his work in the science of catalysts and solid-state chemistry and received a knighthood in 1991. Sir John was among the first to use electron microscopes to study structure/properties relationship in materials. He applied TEM imaging techniques to analyse organic crystals, nanoporous materials and improve their catalytic properties. His research also had a major impact in heterogeneous catalysis and surface science.

SuperSTEM Facility updates

New instrumentation – hybrid-pixel detectors for EELS

Covid-19 permitting, the electron energy loss spectrometers (EELS) of the SuperSTEM2 and SuperSTEM3 microscopes will be retro-fitted in Spring 2021 with new hybrid-pixel detectors optimised for EELS at low- to mid- primary beam acceleration voltage (40-100 kV). These will enable virtually noise-free low-signal detection at high data rates.

The monochromated SuperSTEM3 instrument will be equipped with a Nion/Dectris ELA camera, specifically developed in collaboration with Nion Co. to exploit the 4 meV capabilities of the IRIS spectrometer, while the specifications of the SuperSTEM2 detector are still being finalised. Check www.superstem.org for news and further updates.

New instrumentation – Triple-beam FIB and high-resolution analytical low-voltage TSEM

SuperSTEM is in the process of commissioning a new highly specified triple-beam FIB/SEM/Ar+ instrument. The bespoke Hitachi NX5000 will be dedicated to the fabrication and finishing of high-quality, uniformly thin specimens. Thanks to the third beam (Ar+/Xe+) for low-damage highly-uniform milling, a 7-axis sample stage for advanced positional control and an additional side-entry cryo-stage for direct milling at low temperatures, this new nanofabrication platform will uniquely address the very demanding requirements for samples with minimal surface damage, roughness, and amorphisation. These are particularly strict given the facility's focus on atomic-level characterisation at mid- to low-acceleration voltage, necessitating fabrication capabilities that go beyond typical FIB-SEM instrumentation.
The NX5000 will also provide the ability to observe the as-prepared sample lamellae in the advanced SEM column using analytical capabilities such as the observation of samples in transmission mode ('transmission' SEM or TSEM), along with chemical (high solid-angle EDXS) and crystallographic (EBSD) characterisation. This instrument will be available to the user community through the usual facility access procedures https://www.superstem.org/facility/access. It will be supported by a dedicated FIB scientist, Dr Aleksander Mosberg (abmosberg@superstem.org), who recently joined the team with a research focus on methodological and instrumentation developments in FIB science.

In close collaboration with Hitachi High-Tech Europe, the triple-beam FIB-SEM will be complemented by an additional *high-resolution analytical low-voltage TSEM – a Hitachi SU9000*. This instrument, also equipped with state-of-the-art analytical instrumentation (windowless, high solid angle EDXS), will expand the facility's capabilities for low-voltage TSEM down to 0.3 nm spatial resolution.

ePSIC Facility Updates

ePSIC, a national user facility for electron microscopy, has made significant upgrades to its equipment over the last 12 months. These upgrades will allow new experimentation, opening up fast TEM at high voltages and fully anaerobic studies. The specific upgrades include:

- A new Direct Electron DE-16 direct detection camera, installed on the ARM 300. This camera has a 4K x 4K field of view with a readout time of 60 s at full frame, or 4237 fps when reading out small areas (128 X 128 pixels). The performance of the DE-16 is particularly tailored for high energy electrons (200 and 300 kV) and therefore will complement our existing MerlinEM camera that has optimal performance at low energies (80 kV and below). High-kV experiments

including fast-TEM, 4D STEM and scanning electron diffraction can now be performed on this new camera.

- In conjunction with the new DE camera, a new scan generator has also been installed on the ARM 300. This scan generator allows arbitrary patterns to be input. Experiments exploring new scan geometries are now possible (including spiral and Lissajous patterns), in addition to sparse scans for compressed-sensing approaches. The scan generator can also be used to trigger the new DE-16 camera, enabling arbitrary patterned 4D STEM experiments.

Equipment has been installed to allow anaerobic transfer of specimens at ePSIC. A vacuum transfer holder for JEOL TEMs allows anaerobic transfer from a glove box to the microscope. In addition, a transfer chamber allows anaerobic transfer to and from a glovebox to the JEOL FIB. It is now possible to perform FIB sample preparation of TEM samples with no exposure to air, opening up atomic resolution studies of materials such as lithiated batteries and hydrogen embrittled grain boundaries.

Electron Microscopy - Research and Technological Platform at Warwick University

Instrumentation update: New FIBSEM for sample preparation

A new multi-source Focus Ion Beam (FIB)-Scanning machine has been recently installed at the University of Warwick, funded by the university as part of Warwick's capital plan for central research facilities. Currently, researchers are pushing the boundaries of elemental analysis and high-resolution imaging with transmission electron microscopy (TEM), and for these studies they require ultra-low damage specimen preparation. Focused ion beam (FIB) milling and argon (Ar) ion beam milling are used for preparation of electron transparent specimens for a diverse class of materials, including semiconductors, metals and ceramics. The new system acquired will provide significantly improved capabilities, specifically for low-energy operation to produce damage-free, clean specimens only a few nm in thickness for high resolution TEM studies. This is part of Warwick's central facility for electron microscopy and is available not just to researchers at Warwick, but more widely to academic and commercial users throughout the UK, e.g. with Warwick Analytical Science Centre funding (EP/V007688/1), which runs until 2024.

Our new FIB is a Tescan Amber FIBSEM that has two columns. First, a 1-30 kV electron column with a Field Emission Gun enabling the taking of high-resolution (1.5 nm) Scanning Electron Microscopy images (SEM). Second a 0.5- 30kV ion column with a Ga+ ion source to allow focused ion beam (FIB) cutting and imaging of samples with a multiple Gas Injector System (GIS) for depositing a

variety of different materials. There is also an Oxford Instruments EDS system to enable elemental analysis and element mapping of samples. The FIB allows for very precise cutting of samples, with the SEM able to image the process in real time to give good control. A micromanipulator is available to allow the user to pick up small sample objects. This opens up many possibilities, including picking up individual particles a few micrometres in size, making a TEM specimen from a specific site with nm precision and obtaining a model system through repeated cutting and imaging.

Specification

FIB

- FIB resolution of 2.5 nm at 30 keV
- Accelerating voltage 0.5 to 30 kV
- Magnification 30 to 300000x
- Probe current: < 1 pA–100 nA

SEM

- 1.5 nm at 1 keV
- 0.9 nm at 15 keV
- Accelerating voltage 50V to 30 kV
- Dual in-column SE and BSE detection

EDS

Oxford Instruments Aztec system

RESEARCH HIGHLIGHTS by young scientists

Enhancing the Performance of Hybrid Pixel Detectors for High-Energy TEM Using High-Z Sensors

By Kirsty A. Paton, University of Glasgow

Direct electron detectors (DEDs) are facilitating innovations in all branches of electron microscopy, so it was fitting that EMAG 2020, which focused on DEDs, was innovative in terms of its format, becoming a virtual conference due to the COVID-19 pandemic. While certainly a different experience, the virtual format nevertheless facilitated the same kind of discussions and socialising that one would expect of a traditional, in-person conference. I was delighted to have the opportunity to share my work investigating the advantages of novel sensor materials for hybrid pixel detectors (HPDs) and thrilled to be jointly awarded best student presentation for my talk.

HPDs are a type of DED that consist of an application-specific integrated circuit (ASIC) bump-bonded to a sensor. The on-ASIC signal-processing circuitry makes such devices capable of kHz (and above) frame-rates and MHz electron count-rates. This makes them especially suitable for techniques such as 4D scanning transmission electron microscopy, and high-speed filming of dynamical processes in transmission electron microscopy. However, high-energy (≥ 120keV electrons) scatter over multiple pixels in Si sensors that are sufficiently thick enough to absorb incident electrons and protect the ASIC. Consequently, high-energy electrons are counted by multiple pixels, blurring the images recorded.

Using sensors made of high-Z materials should enhance the spatial resolution of HPDs for high-energy electrons, as characterised by the detector modulation transfer function (MTF), due to the increased stopping power of such materials. However, there has been speculation that increased backscatter from high-Z materials may have a negative effect on detector efficiency, as quantified by the detective quantum efficiency (DQE). In my work, I have compared the performance of the Medipix3 ASIC bonded to a 500 µm Si (Z=14) sensor and a 500 µm GaAs:Cr (Z=32) sensor using electrons in the energy range of 60–300 keV. For high-energy electrons, the GaAs:Cr device surpasses the performance of the Si detector both in terms of MTF and DQE, with the enhancement in performance being greatest for 200 keV electrons.

However, high-Z sensor materials such as GaAs:Cr are compound semiconductors and feature defects that Si sensors do not have. These defects distort the electric field lines that define the detector's pixels, such that the pixels have a variety of different shapes and sizes rather than composing a regular, homogeneous array. Figure 1 shows that the variation in intensity these defects

introduce into the images recorded by the GaAs:Cr device can be corrected by applying a flat-field correction, though this does not correct geometric distortions due to the pixels having different shapes. Overall, this work confirms high-Z sensors have advantages for experiments that require high-energy electrons while motivating further research into other high-Z sensor materials such as CdTe and CZT (Z=50) and ways of correcting for the defects in high-Z sensor materials.

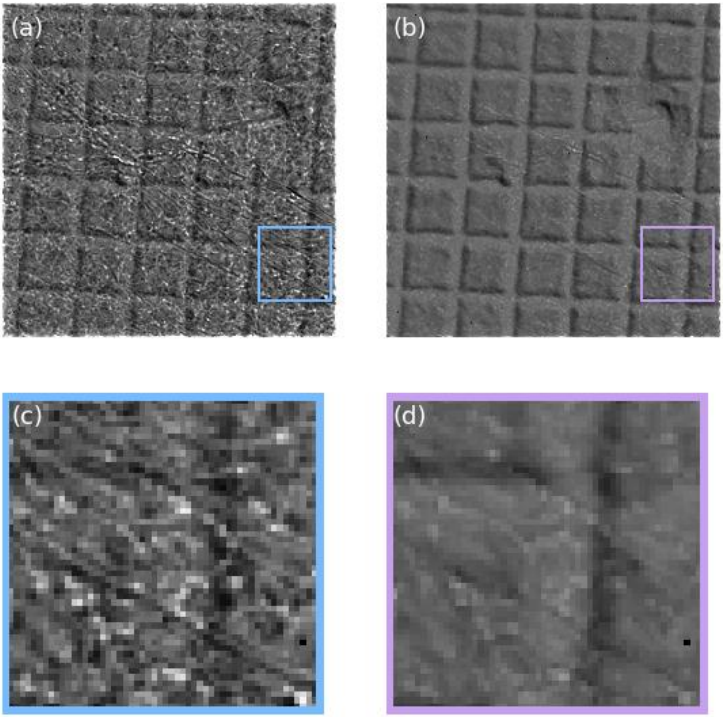


Figure 1: An image of a standard calibration sample recorded by a GaAs:Cr device using 300 keV electrons both (a) without and (b) with a flat-field correction applied. In (c) and (d), close-ups of the region highlighted in (a) and (b) are shown, demonstrating that although the flat-field correction has been effective in reducing the influence of the defects in the recorded image and much of the variation in intensity, residual artefacts remain.

Note: A preprint based on the work presented at EMAG 2020 is available at arxiv.org/abs/2009.14565.

Ultrafast nano-imaging of the order parameter in a structural phase transition

By Thomas Danz, University of Göttingen

The EMAG 2020 conference certainly is an event to remember – not only was this my first virtual conference in an exceptional year, but there were a large number of compelling contributed and invited talks as well, showcasing the new opportunities enabled by direct electron detection technology. I had the great pleasure to present my PhD work in the form of a flash talk and poster, which was awarded “Best Student Presentation”.

My work is an example of an application where direct electron detection contributes to the emergence of new possibilities in the field of ultrafast transmission electron microscopy. In an ultrafast transmission electron microscope (UTEM), we combine a conventional TEM with a laser pump/electron probe scheme in order to obtain simultaneous nanometre spatial and femtosecond temporal resolution. One intriguing perspective of this technique is the possibility to not only investigate means of optical control over femto- to picosecond dynamics in correlated materials, but also track the spatial evolution of optical excitation in structured materials or nanoscale devices.

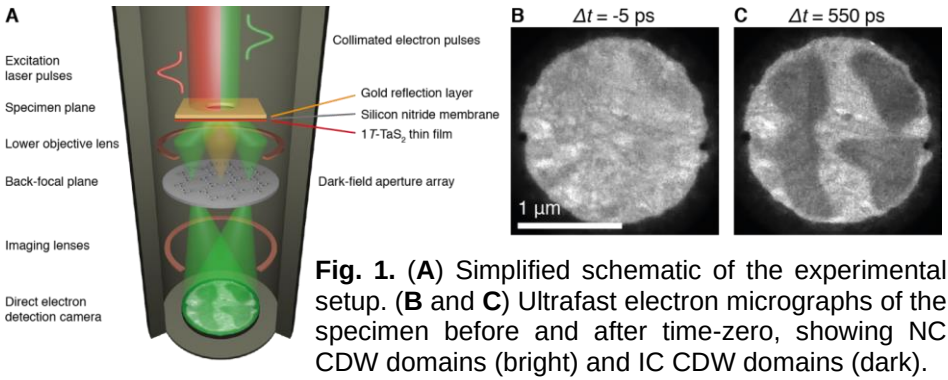


Fig. 1. (**A**) Simplified schematic of the experimental setup. (**B** and **C**) Ultrafast electron micrographs of the specimen before and after time-zero, showing NC CDW domains (bright) and IC CDW domains (dark).

Along these lines, my research presented at the EMAG 2020 conference demonstrates real-space imaging of charge-density wave (CDW) phases in the correlated material 1T-TaS2 using a tailored ultrafast dark-field electron microscopy approach (see Fig. 1A). In the experiment, a free-standing, single-crystalline 1T-TaS2 thin film is pumped out of the nearly commensurate (NC)

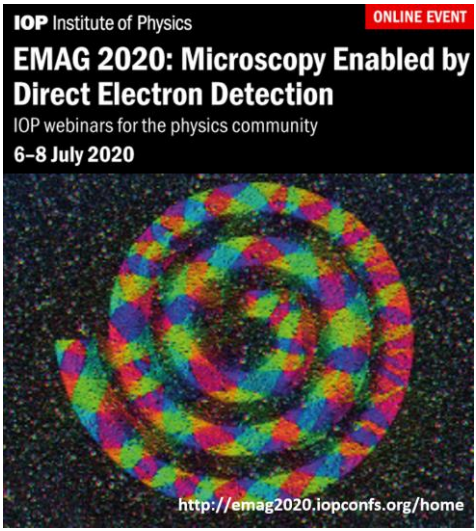
CDW phase at room temperature towards the high-temperature incommensurate (IC) CDW phase using a spatially structured laser field distribution.
Almost exclusive NC CDW contrast in the real-space images is obtained by filtering a number of 72 individual, low-intensity superstructure reflections in the back-focal plane of the microscope using a tailored aperture array. Additionally, image quality and signal-to-noise ratio is distinctly increased by the use of a direct electron detection camera instead of a conventional CCD. Specifically, this approach allows us to observe the formation, stabilization, and relaxation of CDW domains in 1T-TaS2 after optical excitation on their intrinsic femtosecond to nanosecond timescales, yielding access to the order parameter of the structural phase transition with 5 nm spatial resolution (see Figs. 1B and C).
Allowing for sensitivity to further degrees of freedom in complex materials, these results will hopefully pave the way for other types of ultrafast investigation. This work has just been published in Science:

https://dx.doi.org/10.1126/science.abd2774.

MEETING REPORTS

EMAG2020: Microscopy enabled by direct electron detection

By Dr. Donald MacLaren, University of Glasgow



With some trepidation, our annual conference, originally planned to be held in Glasgow over 6th-8th July, was moved to become the IoP's first multi-day online meeting. The meeting spread over the course of 3 afternoons, with an evening social event and hotly-contested online quiz. The conference attracted over 280 registered delegates - more than double the expected numbers - and individual sessions attracted around 200 attendees, many international.

EMAG conferences alternate between the large RMS co-sponsored Microscience Microscopy Congress (mmc) events and smaller, less formal meetings that offer an opportunity to focus on a specific theme. The theme of this year's conference was 'Microscopy Enabled by Direct Electron Detection' and the ambition was to capture the tremendous science now being enabled by modern detector technologies. It was fitting that a conference focused on improved technologies and methodologies for seeing the world should be timed for the year 2020, a number that is synonymous with perfect vision.

Our IOP conference team, headed by Claire Garland and Keenda Sisouphanh were early proponents of the move to an online format and approached the organisation with remarkable competence and gusto. A compressed format was adopted to accommodate the pressures of home-working; and each session comprised an invited talk and a series of contributed 'flash' talks, sponsor presentations and virtual posters from academia and industry. We are grateful for the strong industrial support received – this has always been a staple of EMAG conferences and is an essential component of a successful event.

The conference truly show-cased the 'state of the art' in modelling, development, use and analysis of direct electron detectors within electron microscopy. Distinguished international speakers spanned the breadth of the field, including: ptychography of beam-sensitive materials (Pete Nellist, University of Oxford, UK);

4D-STEM (Colin Ophus, Lawrence Berkeley National Laboratory, USA); EELS (Mitra Taheri, Johns Hopkins University, USA); Lorentz imaging (Stephen McVitie, University of Glasgow, UK), Momentum-resolved STEM (Knut Muller Caspary, Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons, Germany) and SEM-based diffraction (Carol Trager-Cowan, University of Strathclyde, UK). Each session was lively, engaging and enthusiastically embraced by the online audience, with the online format affording greater opportunity for questions. Student contributions were particularly strong and the eventual prizes, to Thomas Danz of the University of Göttingen and Kirsty Paton of the University of Glasgow, were very well deserved.
This was the first such online event run by the IOP on this scale and judged a great success by all who attended. The initial trepidation was unwarranted! At the time, we had envisaged the online format being a one-off event; but the enthusiasm for the conference indicates that the most successful online aspects are here to stay.

Virtual Early Career European Microscopy Congress (EMC) 2020

By Tamsin O'Reilly, Queen's University Belfast.

EMC is held every four years and is one of the largest European stages for cross-disciplinary research. Many felt disappointment when the original meet in Copenhagen had to be cancelled. Fortunately, EMS and RMS organised a virtual platform for the event, giving early career researchers an opportunity to share their research with the community. The event was held from 24th-26th November and had an action-packed schedule with three full days of impressive talks and poster presentations. The event had four conference sessions, they were: Life Sciences – from molecules to complex systems, Physical Sciences Applications, Ultra structural imaging in life sciences and Physical Sciences Tools and Techniques.

Early Career EMC was a well-attended meeting, with over 150 contributions from researchers all over Europe. The congress was split across two meeting rooms, with dedicated oral presentation and poster sessions and included short talks from sponsors that showcased the newest range of products available. In the life sciences sessions, 'from molecules to complex systems' covered a range of interesting topics including high resolution imaging of sub-cellular events and

dynamic interactions in organisms. ‘Ultrastructural imaging’ brought us great talks on cryo-electron and correlative microscopy techniques, whilst also delving into the world of Artificial Intelligence. In physical sciences, ‘tools and techniques’ covered exciting techniques such as in-situ and in-operando environmental microscopy as well as ultrafast microscopy and spectroscopy. Not to be outdone, the ‘applications’ symposium highlighted new exciting developments of microscopy techniques and methodologies in materials science, including my own contribution to one of the poster sessions! Although the event was virtual, there was an active participation from the audience after talks and posters, which was helped by the excellent organisation and running of the programme. Many thanks to the organisers and sponsors of this great event. The next EMC will be held in Copenhagen Aug 2024. See you all there!

Microscopy Infrastructures Access Scheme

SuperSTEM

Covid19 update
SuperSTEM remains open and operational through lockdown, albeit at slightly reduced capacity due to Covid-19 safety procedures. The facility welcomes the submission of new proposals and collaborations through the usual access schemes. Unfortunately, current travel and social distancing restrictions mean that it is not generally possible to host external collaborators on-site in Daresbury for experimental work. However, protocols are in place for web-based streaming of the live microscopy sessions, with samples mailed in advance.
Beamtime requests are considered on a rolling basis with no specific call, but it is highly recommended to first get in touch with facility staff (enquiries@superstem.org) to discuss your project and the instruments' capabilities in detail before submitting a proposal. This is so your proposed experiments can be tailored to optimise the use of the facility, and ensure you get the most from your visit. More details are available on our website: https://www.superstem.org/facility/access

ePSIC

ePSIC, a national user facility for electron microscopy, is part of Diamond Light source and is located at the Harwell Science and Innovation Campus in Oxfordshire. The facility offers "free at the point of access" use of two aberration corrected electron microscopes. The centre is a collaboration between Diamond Light Source, Oxford University and Johnson Matthey and comprises two aberration-corrected transmission electron microscopes.

Capabilities at ePSIC include aberration corrected imaging in both TEM and STEM, high solid-angle EDX spectroscopy and imaging at both cryogenic and elevated temperatures. One of the key capabilities of ePSIC is 4D STEM diffraction imaging, enabled by the use of a direct electron detector with a frame rate above 1 kHz (Quantum Detector's MerlinEM). Experiments are supported by a team of staff scientists and instrument time is free at the point of access for academic use.

The main access route for ePSIC is through a "Standard Access" application. Scientists can apply through this route whenever calls for proposals are issued; this takes place twice a year with deadlines usually at the start of April and October. Calls are normally opened six weeks prior to the deadline. Applications are made for the allocation period in 6 months' time, e.g. proposals submitted for the April deadline will be scheduled October-March. However, due to COVID-

related interruptions, a new call will go out in January for experiments April-September. Applications for Standard Access are made online via the User Administration System (UAS). Once submitted proposals are reviewed initially by the facility staff for technical feasibility. An independent Peer Review Panel then make recommendations on microscope time allocation based on the scientific merit of the applications.

ePSIC also has a “Rapid Access” route for proposals, which may be submitted at any time. These proposals must meet one of the following criteria:
· The proposal is a short feasibility study, the results of which will inform whether an application is submitted via the standard route for the next allocation period.
· The proposed experiment is necessary to complete a paper that would be ready for submission upon successful completion of the experiment.
· The proposed experiment will contribute towards a PhD thesis that will be completed before the end of the next allocation period and therefore could not wait for the standard access route.

For more information visit https://www.diamond.ac.uk/Instruments/Imaging-andMicroscopy/ePSIC/ or email christopher.allen@diamond.ac.uk

ESTEEM 3

ESTEEM3 is a network of laboratories and SMEs across Europe, which exists to enable access to electron microscopy facilities to academics in both EU and non-EU countries. ESTEEM3 is funded until the end of December 2022. Small amounts of funding for travel and subsistence may be available from some of the participating facilities. There are 15 facilities to which you can apply to use – with a broad range of specialities across sample prep, (S)TEM techniques and data analysis. Details of the available facilities and the application form are available at www.esteem3.eu. Access to UK facilities by UK users can be possible under certain circumstances, for more information on this, contact Angus Kirkland (Oxford).

Leeds EPSRC Nanoscience and Nanotechnology Facility (LENNF)

Leeds EPSRC Nanoscience and Nanotechnology Facility (LENNF) is a research facility with access funded by the EPSRC for characterization analysis of soft matter systems such as hybrid organic/inorganic systems. Access has been extended until at least July 2021 and we welcome applications (even though current travel and social distancing restrictions mean that it is not generally possible to host external collaborators on-site). The facility offers access to a unique suite of instrumentation including analytical TEM with cryogenic capability, cryo-FIB, low kV FEG-SEM, and near ambient pressure (NAP)-XPS, together

with EBL and cleanroom capabilities. For more information please contact Dr Mark S'Ari (m.s.s'ari@leeds.ac.uk).

Accessible facilities include a synergistic combination of inter-related techniques for both nano-characterisation and nano-fabrication including:

- **Analytical TEM**
  - FEI Titan3 Themis 300: X-FEG 300 kV S/TEM with S-TWIN objective lens, monochromator (energy spread approx. 0.25 eV), multiple HAADF/ADF/BF STEM detectors, FEI Super-X 4-detector high solid angle EDX system and Gatan OneView 4K CMOS digital camera.

- **Low kV FEG-SEM**
  - Hitachi SU8230: high performance cold field emission (CFE) SEM with 80mm2 Oxford Instruments X-Max SDD detector – Ultra high resolution, low kV, Simultaneous SE, BSE, BF and DF STEM imaging, with nanoscale resolution as well as nanoscale EDX capabilities.

- **Cryo-FIB**
  - Dual-beam FEI Helios G4 CX high resolution monochromated Field Emission Gun Scanning Electron Microscope (FEG-SEM) with precise Focused Ion Beam (FIB), a 150mm2 Oxford Instruments X-Max SDD detector, a Quorum cryo-stage and coating/transfer unit and a range of etch and deposition capabilities for Slice & View acquisition of multi signal 3D data sets and in-situ TEM sample preparation.

- **(NAP)-XPS**
  - Combined UHV/near ambient pressure (NAP) SPECS EnviroESCA X-ray Photoelectron Spectrometer (XPS) system for surface chemical analysis.

- **EBL and cleanrooms**
  - Regional high resolution (< 10 nm) JEOL 6300 electron beam lithography (EBL) system.
  - Class-100 cleanroom for nanoscale device fabrication, including evaporators (thermal and electron beam), sputterers, atomic layer deposition, RIE-ICP etching, PECVD deposition, ion milling, rapid thermal annealing, bonding, dicing, packaging, and associated metrology.

Henry Royce Institute

The Henry Royce Institute (https://www.royce.ac.uk/), the UK's national institute for advanced materials research and innovation, have been installing and using some excellent equipment over the last year, with some funded and subsidised access schemes to help researchers use them. As well as electron microscopy, equipment available includes materials processing equipment, physical and electrical properties characterization, AFM and X-ray tomography, among others. The electron microscopy offering includes the following:

- **National Nuclear Lab, Central lab, Sellafield** – TESCAN XEIA3 Xe plasma FIB and JEOL ARM200CF with Gatan Quantum 965ER, both for active materials
- **University of Manchester** – TESCAN Vega3 Scanning Electron Microscope with EDX for biological material; FEI Titan G2 80-200 ChemiSTEM; FEI Talos F200X TEM with wet stage; Quanta 250 SEM with Gatan 3D EDS 3View in-situ microtome system; ZEISS SIGMA integrated analytical variable pressure SEM with 3View system; Zeiss Merlin FEG-SEM with Oxford EBSD & EDS; FEI Quanta 3D FIB-SEM; FEI HELIOS 660i Nanolab FIB-SEM with Oxford EBSD & EDS system.
- **University of Oxford** – Tescan Mira 3 SEM in glovebox for air sensitive samples; Zeiss Crossbeam 540 FIB-SEM; Zeiss Merlin FEG-SEM with eBruker EBSD; JEOL ARM-200F Cs-corrected STEM; JEOL 2100 LaB6 TEM.
- **University of Leeds** – FEI Quanta 650 FEG-ESEM; FEI Titan Themis G2 300KV STEM; FEI Tecnai F20; JEOL JXA-8230 electron probe microanalyser with EDX & WDX; Hitachi SU8230 dedicated microanalysis SEM; Carl Zeiss EVO MA15 variable pressure SEM.
- **University of Sheffield** – JEOL F200 TEM; JEOL–JSM 7900F SEM with rapid EBSD acquisition; JEOL–JXA-8530F Plus electron probe microanalyser.
- **UKAEA Culham** – Tescan Mira 3 XH FEG-SEM; FEI Helios NanoLab 600i.
- **University of Cambridge** – In-situ EM suite including FEI Tecnai F20 with Gatan OneView 300 camera; Protochips Poseidon continuous flow liquid & electrochemical cell in situ holder; Gatan 648 double tilt vacuum transfer holder.

The **Researcher Equipment Access Scheme** provides funding for researchers, from PDRA to professor, from any UK university (inside or outside the Royce Institute consortium) to access equipment at Royce Institute centres other than your employer, for single well-defined work packages e.g. feasibility studies or one-off small groups of samples. Application is through the Royce Institute website (https://www.royce.ac.uk/researcher-access/). Longer studies must be initiated as collaborations.

The successful Student Equipment Access Scheme is temporarily closed – please email info@royce.ac.uk if you have an application already in progress and require information. The scheme will hopefully reopen in April 2021 after clearing a backlog of work from 2020.

The Small & Medium Enterprise Equipment Access Scheme provides subsidised access for SMEs, and advice on what to use is available from experts. Please apply for this through the Royce Institute website before the closing date at the end of January 2021.

Because of the Covid situation, the Royce Institute is currently operating on a service-only basis, operated by the instrument's on-site trained users.

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:
www.iop.org/about/grants/travel-bursaries/research_student/page_38808.html

BURSARIES REPORTS (2020)

No bursary requests were received in 2020 but funds are available for 2021.

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 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).

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 https://www.eurmicsoc.org/en/funding/scholarships/

ADDITIONAL FUTURE MEETINGS OF INTEREST

Microscopy Characterisation of Organic-Inorganic interfaces
11-12 March 2021 Online
https://www.rms.org.uk/microscopy-characterisation-2021.html

Focus on Microscopy 2021 - FOM2021
28 to 31 March 2021 (Online)
http://www.focusonmicroscopy.org/

EBSD 2021

21 and 22 April 2021, Sheffield (UK)
https://www.rms.org.uk/discover-engage/event-calendar/ebsd-2020.html

PICO 2021 - Sixth Conference on Frontiers of Aberration Corrected Electron Microscopy

02 to 06 May 2021, *Ernst Ruska-Centre in Jülich – Kasteel Vaalsbroek – Netherlands*
https://er-c.org/pico2021/about.htm

QEM 2021 (5th edition) - Quantitative Electron Microscopy

09 to 21 May 2021, *Port-Barcares – France)*
https://qem2021.sciencesconf.org/

ADVANCED WORKSHOP ON CRYO-ELECTRON TOMOGRAPHY

15 to 21 May 2021, Biocenter – Vienna – Austria
https://www.nexperion.net/expertise/cryotomo2021

For more microscopy events see:
http://www.eurmicsoc.org/en/meeting-calendar/calendar/
and
https://www.rms.org.uk/rms-event-calendar.html

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

Group matters: Science Support Officer
Email: groups@iop.org

EMS: European Microscopy Society
Email: 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-events

MSA: Microscopy Society of America, 12100 Sunset Hills Rd., Suite 130, Reston, VA 20190, USA.
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http://www.microscopy.org/

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

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