

Cover image: Sequential images of inkjet at 3 microsecond intervals. From SD Hoath et al., *J. Non-Newtonian Fluid Mechanics* 223 (2015) 28-36

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## Welcome and Message from the Chair

Welcome to the 2015 edition of the Printing and Graphics Science Group newsletter. We have organised or supported a number of events over the past year and I would like to thank everyone who has been involved with these and contributed reports to the newsletter.

The year saw a number of changes to the PGS Committee. Alan Hodgson and Roy Gray stepped down as Group Chair and Treasurer at the end of 2014 and I would like extend my thanks to both Alan and Roy for their work for the committee over the last four years. Leszek Majewski was elected to the position of Treasurer and we welcomed Emma Talbot to the Committee as Honorary Secretary. I would like to thank both Emma and Leszek for their support over the past year. Trevor Lamborne and Ehab Saleh were also elected to the committee as Ordinary Members. We were sad to say goodbye to Neil Shepherd who left the Group after many years due to his retirement; we wish him all the best in the future.

Our first IOP Research Student Conference Fund bursary was awarded this year. Sarah Dempsey was awarded £300 to present her work on touchscreen sensors at the Electronics Displays Conference in Nuremberg and her report from the event is included later in the newsletter.

You will find details of our forthcoming Group meetings and events in these pages. The next 'Science of Inkjet and Printed Drops' meeting will take place on the 10th November, and there is still time to submit poster presentations for this event. Our annual student conference will again be organised in collaboration with the Knowledge Transfer Network and will take place in London in early December. Details of these and other meetings will be uploaded to our website <http://pgs.iop.org> as they become available. Our Group pages on LinkedIn and Facebook are also regularly updated, as is our Twitter feed. We are always open to ideas for new meetings and events; please feel free to get in touch with myself or another member of the committee.

We are always keen to receive items for the newsletter that may be of interest to our readers. If you have conference reports, details of upcoming events or other material, we would love to hear from you. I look forward to seeing you at future events.

Best wishes,  
Anna

*Anna Fricker*  
*Chair, Printing and Graphics Science Group*

## Committee Membership 2014-2015

### **Chair**

**Ms Anna Fricker**

Imperial College London

[a.fricker13@imperial.ac.uk](mailto:a.fricker13@imperial.ac.uk)

### **Honorary Secretary**

**Dr Emma Talbot**

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### **Treasurer**

**Dr Leszek Majewski**

University of Manchester

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### **Ordinary Members**

**Dr Martyn Cherrington**

Knowledge Transfer Network

**Mr Martin Gouch**

FFEI Ltd.

**Dr Alan Hodgson**

Alan Hodgson Consulting Ltd.

**Mr Trevor Lambourne**

University of Leeds

**Dr Davide Deganello**

University of Swansea

**Mr Roy Gray**

**Prof. Ian Hutchings**

University of Cambridge

**Dr Ehab Saleh**

University of Nottingham

## Reports from Recent Group Events

### **Ultra-High Barriers for Plastic Electronics**

**24 September 2014**

**IOP, London, UK**

<https://connect.innovateuk.org/web/plastic-electronics/events-view/-/events/14588396>

This event was organised by the PGS Group and the UK Knowledge Transfer Network and follows a meeting held in 2008 on 'Gas and Moisture Permeation Measurement for High Barrier Films'. Around 60 delegates attended the meeting and presentation slides for many of these talks are available at the link above.

#### **Markets and requirements for transparent flexible barrier films**

*Khasha Ghaffarzadeh, IDTechEx*

Khasha spoke about the challenges facing flexible barrier films and divided the market into three sectors: OPVs, OLED lighting and OLED displays. While OPVs have good low light and indoor performance, they suffer from issues of lifetime, high cost and poor efficiency. There is also a requirement for suitable encapsulants.

OLED lighting has seen interest from the automotive sector. One of the advantages of OLEDs is that they are cold emitters. They can therefore sit close to the body and are suitable for wearable electronics. OLEDs can also be used in wearable, curved displays, such as TV and flexible devices: Samsung and LG have rigid plastic OLED displays. The cost of OLEDs is due to the encapsulation layer, including adhesives and desiccants.

For all substrates the WVTR is the key parameter, with  $10^{-6} \text{ gm}^{-2}\text{day}^{-1}$  considered to be the holy grail. However it is difficult to measure this. There are three options for substrates: flexible glass, single organic or inorganic layer substrates and multiple layers, with the last considered to be the best solution. Khasha expects that we will start to see fully flexible substrates in 2017/18.

#### **Roll to roll (R2R) atomic layer deposition (ALD) for transparent ultra-barrier on flexible substrates**

*Alf Smith, CPI*

Alf described three areas needing flexible ultra barriers: OLED lighting, PTFT and PV. The key requirements for these barriers is that they are thin, robust, flexible,

transparent and low cost. The WVTR of these barriers is also a consideration, with implications for the edge seal thickness and polymer adhesives used. CPI require a WVTR of  $10^{-7} \text{ gm}^{-2}\text{day}^{-1}$  to  $10^{-5} \text{ gm}^{-2}\text{day}^{-1}$ .

Barrier retention over the product lifetime is important and multilayer performance may decline due to saturation. Pinholes, defects, grain boundaries and dust also reduce the WVTR. Alf spoke briefly about three types of barrier layers: Vitriflex, an amorphous barrier layer with no grain boundaries; flexible glass, which is robust but expensive and ALD.

CPI use  $\text{H}_2\text{O}$  or  $\text{O}_2$  plasma for oxidation, with a  $\text{N}_2$  purge to remove  $\text{H}_2\text{O/TMA}$ . The coating is built up one atomic layer at a time, meaning that the thickness is controllable and resulting in a layer that is generally amorphous and free of pinholes. All the work at CPI is on an Al substrate; the coating is approximately 20nm thick and Alf quoted WVTR values of approx  $5 \times 10^{-4} \text{ gm}^{-2}\text{day}^{-1}$  for an extrinsic barrier and  $10^{-6} \text{ gm}^{-2}\text{day}^{-1}$  for an intrinsic barrier. Alf noted that the WVTR is dependent on factors such as the measurement method and temperature. Integrity and low defect level were considered to be more important than thickness.

### **Control of WVTR by understanding of permeation mechanisms**

*Hazel Assender, Oxford University*

Hazel's talk covered the role of defects in permeation. These can take the form of holes, cracks or interfacial delamination and can be caused by handling, arcing, shadowing effects or cracking. It is very difficult to see defects at the nanoscale and equilibrium permeation may only be seen after a long time due to nanodefects filling up. Where there is a low defect density, solubility and diffusivity control permeation. Design considerations focus on reducing the density of microdefects, increasing layer thickness and decreasing diffusivity and solubility.

Oxford use a polymer smoothing layer deposition process to improve barrier layer performance. While the acrylate alone does not contribute to the barrier, the activation energy is increased when it is combined with  $\text{AlOx}$ . The position of oxygen source relative to the drum has been observed to change performance and may be due to the chemical species produced.

### **The NanoMend project**

*Liam Blunt, NanoMend*

NanoMend is a project with the aim of detecting and repairing micro and nanoscale defects on thin films. Liam pointed out that the encapsulation layer is

the most expensive component of a Copper Indium Gallium Selenide (CIGS) device. The project aims to measure and characterise defects, which are classified as holes, projections, undulations or a difference in appearance. The presence of small numbers of large defects correlates with WVTR. Defects less than diameter of 3  $\mu\text{m}$  are tolerated as WVTR is most affected by larger defects. Defects with a lateral diameter greater than 3-5  $\mu\text{m}$  have a strong correlation with WVTR.

Liam also outlined the challenges facing integration into the manufacturing process. These include in-situ calibration, environmental effects and the acquisition of large amounts of data at a high rate. In-process metrology, non-contact measurement and multiple sensors are important factors.

### **Traceable measurements of water vapour transmission rate for high performance barrier layers**

*Paul Brewer, NPL*

Paul spoke about the measurement of WVTR and oxygen ingress. The criteria for permeation is dependent on its application: food packaging has a relatively high requirement of  $1\text{-}10^2 \text{ gm}^{-2}\text{day}^{-1}$  whereas the requirements for OPV are less than  $10^{-4} \text{ gm}^{-2}\text{day}^{-1}$ .

Measurement processes for WVTR include calcium tests, MOCON, which has a  $5 \times 10^{-4} \text{ gm}^{-2}\text{day}^{-1}$  limit detection, mass spectroscopy, radioactive methods with titrated water and gravimetric techniques. Paul also spoke about the need for standards, and referenced ISO TC61. NPL are also looking at traceability.

### **Rapid helium permeation for ultra high barriers**

*Christine Walsh, Vinci Technology*

Christine described the work being performed at Vinci to look at Helium permeation. He has higher diffusion than water due to its smaller radius, non-polarity and greater compressibility. While the data cannot be used to calibrate WVTR it is possible to compare trends. Vinci have performed some correlation studies with He transmission rate and WVTR. While some give good correlation this is not always the case.

In common with water permeability, the transient state can last for weeks or months before progressing to steady state. He beam induced fluorescence (BIF) is measured and can drop off at higher thickness. There is correlation between the WVTR and He BIF on the same substrate.

**Ultra barrier film screening for flexible OTFT backplanes**

*Barry Wild, Plastic Logic*

Barry spoke about AMOLED technology for touch sensors, which has several advantages compared to Si, LTPS and oxide: flexibility, compatibility with R2R, stability under stress, cost, temperature, mobility and uniformity. Plastic Logic use calcium tests as MOCON doesn't detect lower than  $10^{-4} \text{ gm}^{-2}\text{day}^{-1}$ . The disadvantages to this are cost, speed and sample quantity.

Failure mechanisms are due to poor barriers, edge ingress and handling errors. Their testing criteria include optical transmission, haze, adhesion, flexibility, thermal stability, supply and lifetime. As we heard in the talk by Alf Smith, Barry also pointed out that there are a low number of adhesives to trial and that an edge seal with low width is required for most practical applications.

**Selection and qualification of moisture barriers for 3rd generation photovoltaics**

*Mark Spratt, G24 Power*

Mark spoke about dye-sensitised solar modules and their potential to replace disposable batteries. Tests have found that performance rate is worse with increasing temperature and quoted a water penetration rate of 80% at 18%RH, 38°C, and 5%RH, 65°C. These tests indicate that testing methods need to take temperature into account as performance at 38°C doesn't correlate to performance at 65°C.

G24 have examined colour changes of coupons to determine water ingress over 100 days. The cut-off point for acceptable performance is 80% change. The challenges associated with edges are potentially greater than achieving low barrier permeability.

The invited talks were followed by a discussion between delegates and speakers concerning the topics covered during the day, after which the meeting was closed by Martyn Cherrington from the KTN.

*Anna Fricker  
Imperial College London*



## Science of Inkjet and Printed Drops

11 November 2014

IOP, London, UK

This one-day meeting was the seventh in a series of annual events organized by the Group which started with meetings on 'Dynamics of printed drops' in 2008 and 2009. Since 2010 the scope has been extended to include all aspects of the formation, behaviour and deposition of liquid jets and drops. The six invited speakers covered a wide range of topics, and the meeting attracted a record number of attendees: more than eighty with a good representation from both industry and academia. The extended lunch break provided time for networking and also discussion of the seventeen posters, whose subjects included both modelling and experimental studies of drop impact, internal flows within drops, inkjet-printed structures and capillary jet breakup, as well as standardisation of drop measurement, drop-drop interaction, drying, and inkjet-printed structures.

Herman Wijshoff from TU Eindhoven and Océ Technologies presented a broad overview of the current understanding of drop generation and behaviour in drop-on-demand inkjet printing, drawing on recent work by himself and collaborators to underpin commercial developments of this technology. For successful printing, good models for the interactions of the ink with both the printhead and the substrate are needed, and he demonstrated how these could involve combining both simpler methods (e.g. 1-D wave models for internal motion in the printhead, and the lubrication approximation for the jet) and more complex approaches (via CFD codes) where necessary. To validate these models, sensitive and accurate methods are needed to extract data – high-speed imaging, in both single-shot and continuous framing modes, is valuable. Printheads sometimes fail to operate correctly due to the presence of dirt particles or tiny gas bubbles – it is possible to use the printhead's own piezo actuator as a microphone to sense the presence of such defects and carry out corrective maintenance procedures in real time.

While conventional inkjet printing is limited to drops larger than about 10  $\mu\text{m}$  in diameter, the drops produced by electrostatic methods can be smaller than 1  $\mu\text{m}$ , as discussed by John Stark from Queen Mary University of London. Furthermore, the method can handle liquids with higher viscosities. The mode of operation of electrostatic inkjet printing, in which the ink is exposed to an electric field at the outlet of a capillary tube, depends on the intensity of the field and the flow rate of the liquid – enhanced dripping, pulsating and cone-jet modes are possible.

Examples of applications include the deposition of fibronectin with drops of about 0.1 pL in volume, giving a line thickness of about 8  $\mu\text{m}$ .

The effects of the surrounding atmosphere are usually ignored in discussing droplet impact, but James Sprittles (University of Warwick) demonstrated that they can be profoundly important. There is good experimental evidence that the threshold for splashing is strongly dependent on the ambient air pressure, and the presence of a gas film under an impacting drop can also lead to entrapment of a small bubble between the drop and the surface. There are strong analogies with the process of dip coating and the challenges of modelling are similar in both cases: slip at the interface is essential and allows good models for both coating and drop impact to be produced.

With the title 'Watching ink dry', Emma Talbot (University of Durham) demonstrated the complex and sometimes counter-intuitive flow processes which take place inside a small drop of liquid as it evaporates on a solid surface. By tracking small tracer particles in drops of mixed solvents, Emma showed that Marangoni flows, driven by surface tension gradients associated with differential evaporation of the solvent components, can vary with the concentration of solvent vapour in the surrounding atmosphere. Thus, for example, the final distribution of solid material can depend on the atmospheric humidity. By tracking the internal flows and understanding the processes involved, strategies can be developed for controlling the final deposit – it is possible, for example, to design a system which produces a significantly smaller final deposit than the original drop from which it is formed.

Carinna Parraman from the University of the West of England described various novel applications of digital printing methods to the visual arts, including 2.5D printing using UV-curable inks to produce textured surfaces and the use of vector approaches to image description which depart from more conventional half-tone screening and the use of four-colour separation. An example of the latter method involves the design of a mechanical 'painting machine' which can be used to explore the application of pigments in ways which emulate manual painting methods, not in order to make reproductions, but where the relationship between surface deposition and image is integral.

Mike Willis (Pivotal Resources) provided an 'insight into the future' with a fascinating and often amusing survey of the inkjet patent literature. Patents form a very rich source on the details of printhead design and technology, with a predominance of filings from Japanese companies. Novel inkjet-based printing

processes are emerging, for example incorporating the use of a transfer medium to achieve printing at high ink densities on to paper. Inkjet methods are being proposed for many applications, from the decoration of condoms to printing on to concrete, cars and aircraft, including the filling of rivet indentations on aircraft wings. Inkjet printing has even been proposed as a 3-D printing process for making inkjet printheads.

The next of these annual meetings will take place in London on 10 November 2015, and we very much hope to welcome you to it.

*Prof Ian Hutchings  
University of Cambridge  
Meeting organiser*

## **Advances in 3D Printing Technology for Medical and Biological Applications**

**18 November 2014**

**University of Swansea, Swansea, UK**

This IOP PGS conference was held on the 18th November 2014 at the Welsh Centre of Printing and Coating, Swansea University. The conference was intended as a forum for industry and academia to present their interests, expertise and resources in 3D printing for medical and biological applications. Themes of the conference focused on the printing of biomaterials for the following applications:

- Substitution of human tissue
- Assisted healing/smart wound care
- Outside body tissue biofabrication
- 3D Printing for Health Care

The conference was well attended with 32 registered delegates (10 men, 22 women), offering the opportunity of networking with numerous academic experts and industry representatives. The issues of new functional materials, manufacturing methods using 3D printing-based technologies and new applications of 3D Printing for biological/biomedical applications were discussed. Speakers of the day included: Prof. Paulo Jorge Bártolo (Manchester University) on “Biomanufacturing for tissue engineering and regenerative medicine”, Dr. Dominic Eggbeer (Cardiff Metropolitan) on “The Functional Appropriateness of

Computer-Aided Designed / Additive Manufactured Implants”, Dr. Adam Glen (University of Sheffield) on “3D polymer structuring for nerve repair”, Prof. Kenney Dalgamo (Newcastle University) on “Additive Manufacture of Tissue Engineering Scaffolds and Acellular Devices”, Mohammed Hezwani (University of Glasgow) on “Integrated Reactionware Systems for 3D Printed Diagnostics and Biologics”, Madeline Burke (Bristol University) on “A Review of Current Bioprinting Techniques”, Laura Ruiz (Nottingham University) on “Bioprinting of personalised constructs for nasal reconstruction”, Dr. Daniel J. Thomas (Swansea University) on “3D-Printing Calcium Phosphate Composites for Dental System Reconstruction”.

This event was organised by the IOP Printing and Graphics Science Group (PGS) in collaboration with LIMNet, the Advancing Printing Network and the Welsh Centre for Printing and Coating.

*Dr Davide Deganello  
University of Swansea  
Meeting organiser*

## **UK Plastic Electronics Research Conference**

**22 April 2015**

**Museum of Science and Industry, Manchester, UK**

This year the annual PGS student conference saw the Museum of Science and Industry host a day of presentations from research students working in the area of printed electronics. For the second year the conference was organised by the PGS Group and the KTN.

The keynote was given by Alan Hodgson, Chair of the TC119 committee who spoke about the work of the TC119 working group to produce and develop standards for printed electronics. IEC TC119 consists of members from 21 countries working in the areas of terminology, equipment, materials, printability and quality assessment. Their work has wider applicability to the development of standards in other areas, including TC110 (electronic display devices), TC113 (graphene standardisation) and wearable technology.

Miles Morgan from Swansea University discussed the importance of considering shear thinning in the rheology of printing inks. Miles is using capillary break-up extensional rheometry (CABER) to examine the change in filament diameter over time. He has been focusing on the sheer thinning behaviour of PVA and aims to relate his findings to the uniformity of flexo prints. Javier Ledesma from

Nottingham University then spoke about his work on the jetting of conductive pastes for printed electronic applications. This work involves high viscosity jetting of a carbon paint and requires a gap of less than 1mm between nozzle and substrate to obtain a uniform drop. Javier has used this technique to form pillars from consecutive layers of carbon and is looking at the effect of drying time on the uniformity of these pillars. The final talk before lunch was given by Ben Mogg from the University of Swansea who is investigating methods of improving the quality of flexographically-printed thin films. Both CSC and CSX plates have been used in this work to reduce defects in the resulting film. Film quality was improved by the use of additional treatments including UV and ozone. Ben is now looking to extend this work to larger area printing.



*Coffee break at the UK Plastics Electronics Research Conference*

The afternoon session was opened by Davide Deganello, Lecturer and Deputy Director of the Welsh Centre for Printing and Coating (WCPC) at the University of Swansea. Davide gave an overview of the developments in flexo and inkjet printing over the last 20 years and discussed the differing requirements between graphics printing and printed electronics. Particular focus was given to colour in printed electronics, and how the sintering of nanosilver particles can affect the colour, resistance and particle size.

Matt Dyson from Imperial College London discussed the effect of processing parameters on polymer blends, in this case P3HT and PEO. Increasing the temperature causes a colour change as a result of changes in the aggregation behaviour due to phase separation and concentration. Matt is looking to apply this work to solution-processable lasers. Sheida Faraji from the University of Manchester then spoke about her work on using a nanocomposite to create ultra-low voltage OFETS. The nanocomposite incorporates nanoparticles to modify the

surface behaviour and is coated with a PVP layer to reduce the surface energy and the leakage current density. Sheida is aiming for around 1 V.

The third talk of the afternoon explored the future cost of OPV. Ajay Gambhir from Imperial College London discussed the performance, cost and production scale of OPV compared to current PV technologies and predicted that OPV is likely to be competitive in the next few years. Ajay believes that device stability will be important for cost considerations. Biosensors and OFETs were the subject of the final talk of this second session. Jesse Opoku from the University of Manchester is looking to tailor organic materials for specific electronic and optical properties. This work uses ultra thin anodised  $\text{Al}_2\text{O}_3$  (5.2 nm) which has been treated with a self-assembled monolayer (SAM). Jesse is using modified PMMA blended with PBTTT to create a sensor for TNT which can sense to 1.3 ppb in air.

The final session of the conference started with a talk from Thomas Cosnahan from the University of Oxford about gravure patterning processes in roll-to-roll systems. The work uses Cu and Al to pattern the substrate using an in-vacuum process with a sacrificial oil system. Thomas is testing for heat stability, printing reliability and residual oil, and is looking to use a PDMS cylinder in future work. Sakulrat Foulston from Swansea University then spoke about his work on the characterisation of open cell anilox rolls. Accurate measurements are difficult to achieve and depend on the measurement methods, operator and software. Sakulrat has used white light interferometry to characterise cells and noted that changing the light intensity alters the measurement, indicating a need to standardise measurement methods. The final talk of the day was given by Pei He from the University of Manchester. Pei is using inkjet printing to deposit black phosphorous inks onto a paper substrate. This work is looking to create flexible photodetector devices and a decrease in the current is seen on exposure to light. One of the limitations of this process is that it is very sensitive to water and Pei is looking to measure the moisture response with FTIR.

This was a very interesting day of talks around current research in printing and printed electronics. Our next student conference is scheduled for December 2015 and we hope very much that you will join us there.

*Anna Fricker  
Imperial College London*

## Reports from Other Events

Sarah Dempsey, a PhD student at Durham University was awarded a Research Student Conference Award to attend the Electronics Displays Conference in Nuremberg and present her poster on the development of a pressure sensitive touchscreen. Her report on the event is below.

### Electronic Displays Conference

**25-26 February 2015**

**Nuremberg, Germany**

<http://www.electronic-displays.de>

The conference was held in the Nuremberg Conference Centre (NCC). There were an estimated 200 attendees at the Electronic Displays conference, most of whom came from a background in industry. Attendees were present from a number of high-profile companies, including Bosch, Porsche, Jaguar-Landrover, IDTechEx (a market research company specialising in printed technology, touchscreens, displays etc.) and LG Display.



*Keynote session*



*Poster boards*

Keynote talks were delivered by representatives including those from Meko, Bosch and Merck. These gave a wide industry-led perspective of the challenges and driving forces for innovation in electronic displays and applications, including the future of LCD screens, the future of display technology in the automotive sector and challenges for usability and user experience. The parallel sessions covered a host of topics, from measurement of the optical properties of displays, OLED displays and automotive applications for displays. Of particular interest was the parallel session devoted to touchscreen technologies. Here, the talks

addressed topics including the integration of (capacitive) touchscreens into a device and the future of resistive type touchscreens.

The poster session contained 10 posters, for which the level of interest was very high. There was a 40 minute poster session, however posters remained on the boards for the duration of the conference. My poster, entitled “A Novel Pressure-Sensitive Transparent Touchscreen containing Nanocomposite Granules” was very well received, as during the poster session there was a steady supply of questions. The questions ranged from the general type (explain your research) to pointed questions from delegates from companies who were interested in the technology behind the research, to the optical performance and the durability of the touchscreen.

Overall, the conference was very useful to me. As I am approaching the end of my studies, I have to consider what I want to do next and I have long decided that I would like to be involved in the R&D of new technologies within the fields of display and touchscreen technology. This conference gave me the chance to learn about and network with companies who specialise in this field. I made many new contacts who have given me insight into what it is like to work for a technology firm producing the latest innovations in electronic displays and touchscreen technologies. Furthermore, the Electronic Displays conference was run simultaneously with the Embedded World Exhibition, the largest exhibition and conference for embedded systems and technologies worldwide. At the exhibition there were over 900 exhibitors, including from well-known companies such as Microsoft and Intel. As a conference delegate I also had access to this exhibition, which gave a fascinating insight into the embedded technology market.



*The Embedded World Exhibition*

*Sarah Dempsey  
PhD student  
Durham University*



## Forthcoming Group Events

### **Advances in Photovoltaics**

**29 September 2015**

**IOP, London, UK**

**Organised by the IOP Ion and Plasma Surface Interactions Group and co-sponsored by the PGS Group**

<https://www.iopconferences.org/iop/722/home>

This one day meeting provides a forum to help assess the current state of the art in solar cells. It brings together a list of distinguished invited speakers whose expertise covers the range of photovoltaic technologies.

The conference programme and registration details are available at the link above.

### **Science of Inkjet and Printed Drops**

**10 November 2015**

**28 Portland Place, London, UK**

<http://sipd15.iopconfs.org/home>

This annual meeting will cover all aspects of the generation, deposition and behaviour of liquid droplets, together with applications in graphical printing as well as printed electronics, novel materials processing and 3-D printing. The conference programme consists of six invited talks and a poster session, details are available at the link above.

#### **Poster presentations**

Authors wishing to submit an abstract to be considered for poster presentation can view the abstract guidelines on the website. Abstracts should be submitted via the website. The deadline is **13th October 2015**.

#### **Registration**

Register at the above link before the 6th November 2015. The early registration deadline is 14th October 2015.

## **Printing and Plastic Electronics Student Conference**

**December 2015**

**London, UK**

**Organised jointly by the PGS Group and the Knowledge Transfer Network**

The IOP Printing and Graphics Science Group's annual student conference will again be organised in collaboration with the KTN.

Presentations are sought at postgraduate level on any subject related to printing, plastic, organic and large area electronics. Potential topics could comprise, but are not restricted to, recent developments in applications, materials and processing. Examples include OLEDs, OPVs, smart packaging, printed biosensors, developments in printing technologies and research into the underpinning physics of printing.

The conference will be an opportunity for students to present their work and meet others from around the country who are working in similar fields. As a gathering of leading industry and academic contributors, it will offer potential for professional development and possible collaborations.

Funds are available to cover basic travel expenses for speakers. Further details are on the PGS website.

## **IS&T Archiving 2016 Conference**

**19-22 April 2016**

**Washington, DC, USA**

**Organised by the Society for Imaging Science and Technology and co-sponsored by the PGS Group**

<http://www.imaging.org/ist/conferences/archiving/>

The IS&T Archiving Conference is an annual event aimed at the imaging science and the cultural heritage communities. The conference brings together imaging scientists and technicians with those working in the cultural heritage community (curators, archivists, librarians, etc.), government, industry, and academia to discuss the latest research and issues relating to the digital preservation and stewardship of hardcopy, audio and video.

There is still time to submit a paper for this conference. The deadline is **4th October 2015**, please visit the website for further information.

## Other Events of Potential Interest

### **IARIGAI 42<sup>nd</sup> Annual Conference**

**6-9 September 2015**

**Helsinki, Finland**

<http://iarigai-helsinki.vtt.fi/>

### **31<sup>st</sup> International Conference on Digital Printing Technologies and Digital Fabrication (NIP31)**

**27 September - 1 October 2015**

**Portland, Oregon, USA**

<http://www.imaging.org/ist/Conferences/nip/index.cfm>

### **11th Colour Conference**

**10-11 September 2015**

**Milan, Italy**

<http://www.gruppodelcolore.it>

### **Plastic Electronics Conference**

**6-8 October 2015**

**Dresden, Germany**

<http://www.semiconeuropa.org/node/2981>

### **23<sup>rd</sup> Color and Imaging Conference (CIC23)**

**19-23 October 2015**

**Darmstadt, Germany**

<http://www.imaging.org/ist/Conferences/cic/index.cfm>

### **AIMCAL Web Coating & Handling Conference**

**25-28 October 2015**

**Naples, Florida, USA**

<http://www.aimcal.org/events/web-coating-handling-conference-usa/2015/conference/overview.aspx>

## **Printed Electronics USA 2015**

**18-19 November 2015**

**Santa Clara, California, USA**

<http://www.idtechex.com/printed-electronics-usa/pe.asp>

## **RPS Good Picture 2015: Imaging Illuminated**

**12 December 2015**

**London, UK**

<http://www.rps.org/events/2015/december/12/good-picture-2015--imaging-illuminated>

## **Electronic Imaging 2016**

**14-18 February 2016**

**San Francisco, California, USA**

<http://www.imaging.org/ist/Conferences/ei2016/index.cfm>

## **Large-area, Organic & Printed Electronics Convention (LOPEC)**

**5-7 March 2016**

**Munich, Germany**

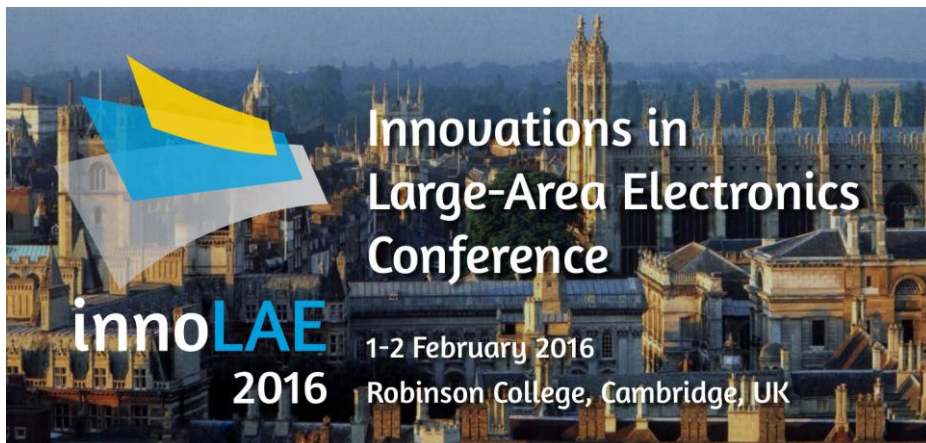
<http://www.lopec.com/>

## **Printed Electronics Europe 2016**

**27-28 April 2016**

**Berlin, Germany**

<http://www.idtechex.com/printed-electronics-europe/europe.asp>



Large-Area Electronics (LAE), including printed, plastic, organic and flexible electronics is a new way of making electronics, which is enabled by new materials that can be processed at low-temperatures and by new manufacturing processes. LAE is opening up new markets for electronics as well as growing existing markets with products having new form factors, new cost structures and the capability for customisation with applications in high growth industrial sectors such as FMCG, healthcare, automotive, the Internet of Everything, and wireless wearable electronics. The new form factors that are possible with LAE are allowing electronic systems to be deployed in a wide variety of non-traditional situations: on paper and plastic, on clothes, in furniture, cars and buildings, as well as on packaging and even in and on the human body.

Leading UK and international researchers and industrialists active in LAE technology will meet at the 2nd annual Innovations in Large-Area Electronics (innoLAE 2016) conference at Robinson College, Cambridge on the 1st and 2nd of February 2016. Call for Papers is now open and interested contributors are invited to submit a short abstract (1 page in length, including figures), as well as a brief biography (up to 10 lines) to [info@largeareaelectronics.org](mailto:info@largeareaelectronics.org) by 31 October 2015. For more details, visit [www.innolae.org](http://www.innolae.org).

## Awards

### PGS Group Awards

The PGS Group makes two awards each year.

#### Student Presentation Prizes

These prizes are open to all research students currently undertaking work at a university in the UK or Ireland, leading to a PhD or Masters degree, who present their work at the annual Printing and Graphic Science Group Student Conference. The Group will award two prizes of £50 for the best Student Presentations.

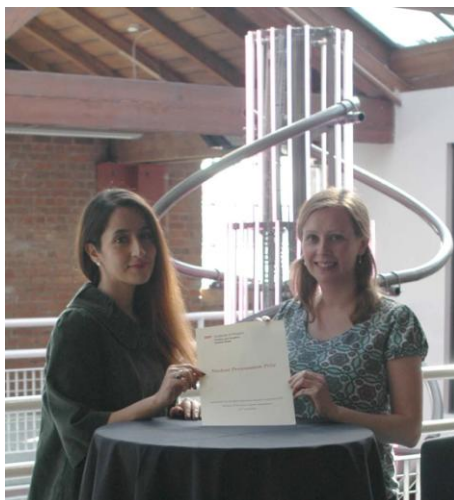
All presentations given at the Group's Student Conference will be considered for this year's prizes. For more information on this year's conference please see our group calendar. The 2014 Student Presentation Prizes were awarded as follows.

Javier Ledesma Fernandez, University of Nottingham

*Jetting of conductive pastes for printed electronic applications*

Sheida Faraji, University of Manchester

*Low-voltage, flexible organic transistors using novel solution-processed nanocomposite dielectrics*



*Javier Ledesma Fernandez and Sheida Faraji receiving their prizes at the UK Plastic Electronics Research Conference*

## Group Prize

The Printing and Graphics Science Group of the Institute of Physics awards an annual prize to an individual or organisation that has contributed a significant theoretical or practical application of physics in the area of printing and graphics science.

## Research Student Conference Fund

**Supporting research students**



# Research Student Conference Fund

Providing financial support to research student members, to attend international conferences and major national meetings.

Apply for up to £300 during the course of your PhD.

Applications are considered on a quarterly basis and should reach the Institute by: 1 March, 1 June, 1 September or 1 December

For further information see [www.iop.org](http://www.iop.org) or contact [supportandgrants@iop.org](mailto:supportandgrants@iop.org)

**IOP** Institute of Physics

## Other Information

### **PGS Group on LinkedIn, Facebook and Twitter**

The Group has pages on the LinkedIn, Facebook and Twitter social networking sites which are regularly updated with news items and details of upcoming events. We look forward to seeing you there.

#### **LinkedIn**

<http://goo.gl/B0mds>

We can be found by searching for the 'Printing and Graphics Science' group on LinkedIn or by following the link above. You will need to be a member of LinkedIn to view the page.

#### **Facebook**

<http://goo.gl/vX0kC>

We can be found by searching for the 'Printing and Graphic Science Group' on Facebook or by following the link above. There is no need to be a Facebook member to view the page.

#### **Twitter**

[https://twitter.com/PGS\\_IOP](https://twitter.com/PGS_IOP)

The PGS Group is now on Twitter @PGS\_IOP.

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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.

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