

A 1985 vintage optical data storage card under the microscope. The image is from a contact print onto ultra high resolution emulsion designed for holography. An early image storage system capable of a ground breaking 2.8Mbytes per credit card was the objective but never used in that form.

Credit Dr A Hodgson ASIS FRPS FInstP

<http://pgs.iop.org>

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Welcome and Message from the Chair

Another eventful year has been and gone. We reflect on the highlights of 2019 in the annual edition of our PGS Group newsletter.

As usual our annual student conference was a success, with students engaging on a wide range of printing areas and enjoying a tour of the print facilities at FFEI. It is always good to see both academia and industry coming together. Thanks to all our participants for sharing their research with us. We look forward to seeing more in a year's time.

This year we welcomed our new treasurer Dr Dilwyn Jones back onto the committee, who returns after several years away from us. We also warmly welcome two new ordinary members, Dr Fouzia Ouali and Dr Garry Wells who bring their expertise and fresh ideas to the group committee.

In 2019 there will be a host of new events lined up which the PGS group will be involved in. Look out for the History of Printing and Fluids, Droplets 2019 and more. Check out the PGS webpage <http://pgs.iop.org>, group calendar, and social media pages for more information.

Dr Emma Talbot
Chair, Printing and Graphics Science Group
September 2019

Committee Membership 2018-2019

Chair	Honorary Secretary
Dr Emma Talbot Base4 Innovation Ltd.	Mr Martin Gouch Fellow, FFEI Ltd. martingouch@hotmail.com
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Mr James Johnstone Centre for Process Innovation	Dr Leszek Majewski FInstP University of Manchester
Dr Fouzia Ouali Nottingham Trent University	Dr Ehab Saleh University of Leeds
Dr Gary Wells Northumbria University	

Reports from Recent Group Events

Student Conference

18 January 2019

11:40 Session 1

The Annual Student Conference for 2019 was held at FFEI Ltd in Hemel Hempstead. With 20 delegates and 9 speakers who presented over two sessions.

Christina Koutsiaki, *Excimer Laser Annealing of sol-gel Metal-Oxide thin films*, Nottingham Trent University

Printing TFT's on flexible substrates with the use of a film of TCO's and patterning with Pulsed Excimer Lasers to anneal the TCO.

Sudesna Shrestha, *Developing the current printing processes of polymer microneedles*, Swansea University

Printing microneedle arrays used in the delivery of medicines, medical diagnostics and cosmetic procedures was presented. The needles were produced in a multi-pass screen printing process and the characteristics of the needles were examined. A viable quality of needles can be generated with this process.

Nawal H Alghamdi, *Sub nano-molar detection of Caesium by SnO₂ Water Gated Thin Film Transistor*, University of Sheffield

A way of significantly improving the sensitivity for detection of Caesium in water was shown by the use of SnO₂ as the semiconductor in a Water-gated thin film transistor. This not only improves the sensitivity but also improves the stability of detector in water. The SnO₂ is spray coated into the detector after the surface has been prepared with precursors. The sensitivity was shown to be 33pM when the target requirement is less than 7.5nM.

Navid Mohammadian, *Solution-processed polymer transistors using Tantalum Pentoxide dielectric*, Manchester University

A process of producing TFTs with the anodization process with Tantalum Pentoxide deposited in a thin layer with an OTS self-assembled monolayer used to reduce leakage current.

FFEI UK: industrial innovator and manufacturer

FFEI Chief Technology Officer Bob Wilson gave an overview of the company history and business model. The range of innovative and award-winning products in printing and medical diagnostics developed and manufactured at FFEI were described. A short overview of industrial development processes was described with a description of the types of skill sets required of FFEI personnel which includes physicists.



14:00 Session 2

Brent De Boode, *Glassy carbon coatings*, Swansea University
A short history of Glassy Carbon coatings was presented. The printing of 3 to 12 μm thick impregnated Glassy Carbon coatings onto coin cell batteries or 15mm stainless steel disks to protect them from corrosion without impacting their conductivity was presented.



Wendy Balestri, *Musculoskeletal Tissue Interface Development*, Nottingham Trent University

A proposal to experiment on factors to improve the repair of muscles joining to skeletons with 3D printing the experiments for laboratory testing.

Liesbeth Birchall, *Reactive Inkjet of Quantum Dot – Silicone Composites*, University of Nottingham

Inkjet Printing Quantum dots in 2-part cure silicone to produce optical thermometry measurements. Several challenges to printing the quantum dots in a uniform layer with sufficient quantum dot concentration for practical use were described. Explanation and solutions to some of the problems were presented. Issues included agglomeration of the quantum dots and poisoning the platinum catalyst which retards cure of the silicone.

Tanyaradzwa N. Mangoma, *Additive Manufacturing of memristic and neuromorphic devices*, University of Cambridge

The construction of 3D memory gates using ion-based transistor gates which are more similar to the functioning of the brain. This produces slower gates but at much lower power consumption. A functioning array of gates was produced by printing and characterised.

15:45 Conference Awards & Conclusions

Tanyaradzwa Mangoma and Leisbeth Birchall were the award winners for best presentation.

Tour of FFEI facilities

There was a tour of the manufacturing facilities at FFEI and a demonstration of the Label Printing Press based upon Graphium and the PrintBar uncovered single colour inkjet label printing product. There was also a demonstration of the medical pathology virtual microscope DP200.

Report by Martin Gouch

The Abstract for Tanyaradzwa Mangoma's award winning presentation follows:

The brain is a complex and efficient supercomputer capable of real-time processing and learning [1, 2]. Its enhanced operation can be attributed to the nature of the brain's base unit– the synapse, its use of ionic fluxes for communication and the complex 3D connectome structure of the brain [3]. In recent years, researchers have started working on neuromorphic architectures which aim to provide direct hardware implementation of brain-like computing [4, 5]. However, current neuromorphic designs do not fully mimic the functional computation structure of the brain. For instance, current neuromorphic devices are being arranged on rigid substrates that do not resemble the brain's 3D integrated architecture; a characteristic that which adds special functionality to the way the brain learns [3].

This project aims to exploit the design flexibility offered by digitally-enabled Additive Manufacturing techniques to fabricate 3D integrated neuromorphic designs. Once fabricated, an in depth study of the short and long term learning behaviour of the devices is to be carried out. The devices are to be fully fabricated using polymer materials such as polylactic acid extrusion filament and inkjet printable semiconducting poly(3,4-ethylenedioxythiophene)-poly(styrenesulfonate), i.e. PEDOT:PSS.

As such a full study into the evolution of the device geometry and chemistry over time is to be carried out. It is hoped that the findings from this research will pave the way to the realisation of Additive

Manufacturing as a fabrication technique for novel computational devices.

References

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4. Gkoupidenis, P., Schaefer, N., Garlan, B. and Malliaras, G.G., 2015. Neuromorphic functions in PEDOT: PSS organic electrochemical transistors. *Advanced Materials*, 27(44), pp.7176-7180.
5. I, A. Khat, R. Berdan, R. Legenstein, and T. Prodromakis, "Unsupervised learning in probabilistic neural networks with multi-state metal-oxide memristive synapses," *Nature Communications*, vol. 7, p. 12611, Sep. 2016.

Science of Printing Conference

2 November 2018

De Vere West One, London, UK

A successful event organised by the IOP.



Professor Davide Deganello at the lectern.



Photographs by Dr Ehab Saleh, University of Leeds

Advances in Printing technologies

Dr Alan Hodgson, ASIS FRPS FInstP, Printing and Imaging consultant

The IS&T Printing for Fabrication conference was held in Dresden in September 2018. The aim here is to summarise the general printing content and identify the opportunities that could follow in security printing. The conference also included a session specific to Security Printing, sponsored by the new Reconnaissance International conference Digital Document Security and this will be the topic of the following article.

Offset printing

Although offset printing is considered to be a mature technology the community investigating Printing for Fabrication is taking a fresh look at offset, for a number of reasons. Firstly the high number of offset presses established within the printing industry is seen as an opportunity and secondly because of the speed and productivity compared to processes such as inkjet. The interest is that developments within this community could be of use within the secure document space.

A representative from Komori Corporation discussed the background to recent developments in offset press technology, with a particular emphasis on packaging printing. The presentation also covered recent advances in the competitive digital printing technologies with their increasing speed and format capabilities. It was interesting to note that while offset and digital presses could be viewed as in competition a more realistic conclusion would be that they are evolving to serve different specialist market niches. As a result there are now hybrid print engines available that combine both offset and inkjet, a development that could enable us to add variable data in precise registration and at a single pass with offset print.

As this technical conference has an international reach it provides a good opportunity to gain an overview of the direction of development of printing technologies in different geographical groups. For example, an industry / academic collaboration in India showed work on the development of alternative sustainable binders for offset ink. But some of the more interesting developments for our community may again come from the field of printed electronics.

There has recently been a significant amount of activity in novel inks for offset printing by NAITEC in Spain. They have been working on metallic inks for offset printing to produce conductive features on printing paper for

printed electronics – see AN February 2016. As ink formulations have a significant bearing on print conductivity groups like this are placing considerable effort on chemistries which may also be of interest to us. A group from JAPER in Japan have been investigating the use of reverse offset printing to fabricate electrodes for printed electronics applications. It is through investigations like this that future advances in the printing performance of established printing techniques are likely to come. In this case they are using offset printing to deposit a fine mesh of conductive ink lines in combination with other printing techniques to generate functional electrical devices.

We should continue to monitor developments in printed metals for electronics and not just for their electrical properties. The opportunities for metallic inks in security printing were picked up later in the conference and will be covered in a future article.

Textile printing

In AN May 2018 we covered the importance of developments in inkjet printing inks for textile products. These inks have direct relevance to the substrates used in our documents and this conference had substantial coverage of developments in this sector.

There is considerable activity in the field of transfer print media, driven by the textile sector. Companies like Felix Schoeller in Germany were showing their developments in this area with multilayer ink receiving coatings for sublimation printing. For those interested in transfer printing for plastic card production innovation driven by textile printing may be an area to monitor.

It is common within the secure print industry to combine multiple print processes to enhance the security of a document. This model is now being adopted elsewhere but in the case of textile production it is to enhance productivity and functionality. Dye sublimation printing is already seen as a mature technology onto synthetic fibres but water based pigment inks are now making substantial inroads as they are applicable to a wider range of substrates.

As both these ink types are used extensively across security we should watch this sector for further innovation. As an example print engine manufacturer Mimaki is making available inkjet engines loaded with both these inkjet ink types, in addition to the usual colour choices. While these types of combinations could prove to be of interest to our industry we should also be aware that this initiative also enhances this capability in the wider printing industry with a high level of registration of printed layers.

Active research areas

The Dresden area is home to a number of academic / industrial collaborations around textile printing. Learning from these groups may well translate into security printing and we should remain aware of developments in this area. For example, screen printing is still the primary technology for the textile industry and is also extensively applied in our industry.

Textile printing also makes extensive use of pre and post treatments to enhance the nature of the print. This is a model that has already been used in some secure document solutions but has the potential to be more widely applied. Again, research in this area may generate innovations we can use in our industry.

One final area of interest to us came from the Saxony Textile Research Institute in Chemnitz. They are using additive manufacturing techniques to alter the physical characteristics of textile surfaces. This is another model that we could follow, using printing technologies to modify the surface of documents for gloss, encapsulation and fold resistance.

Advances in Additive Manufacturing

In a previous issue of AN (April 2016) we covered the implications of the emerging technologies of 3D printing / additive manufacturing. A keynote presentation from HP Inc. outlined some of the areas that could be of interest to our community from the new HP Jet Fusion™ process. This is an open platform for printing of a variety of plastic powders which could produce some interesting capabilities.

In essence Jet Fusion allows for full colour control of each individual volume element (voxel) that make up the print. As it is an open platform this is now extending outside of traditional printing colours into fluorescent dyes, quantum dot fluorescents and up – converting nanoparticles. The technology also allows for the modification of surface feel and roughness. Jet Fusion is a good illustration of the direction in which this additive manufacturing technologies will take. The capability to dispense multiple materials to produce tactile print features with interesting optical characteristics has been a distinguishing feature of the secure document industry. These types of technologies make these capabilities much more widely available.

Packaging printing

One other area we should remain aware of is the advances being made in packaging printing. As these systems are being designed for printing onto

cardboard, they use aqueous inkjet inks that are also applicable to paper documents. A keynote presentation from Heidelberger Druckmaschinen illustrated a commercial 7-colour inkjet press that added green, violet and orange to the traditional CMYK inkset.

While these presses are being positioned as an alternative to offset litho the output is readily distinguishable under a 10x lens. With printed dot sizes of around 28 microns the structure in the print is easy to spot. However, the spot colour capabilities could still prove a trap to the unwary as it will be an enabling technology for effective rainbow printing.

White ink

White ink printing is a technology we have covered in AN June 2017. One of the issues in producing practical white inks has been that particles big enough to give a high whiteness and covering power are so dense that they sediment out of a dispersion formulated as an inkjet ink. This has been a topic of further innovation and was also covered at this conference. A paper from work done by Ricoh took the approach of creating hollow nanoparticles of titanium dioxide, combining a high refractive index for whiteness with a low density for reduced sedimentation. In addition to their use in white ink it would be interesting to see this technology applied to the modification of optical features due to their high refractive index capability. This is another example of a technology that could have wider implications for our community.

In conclusion

Technical conferences such as Printing for Fabrication serve as an accessible showcase of the continued evolution of the technologies that underpin much of the secure document industry. Having an understanding of the future developments of printing and fabrication technologies will allow us to plan for the security features of the future. With offset and screen printing being further adopted by industries such as textile and printed electronics it will be important to remain appraised of these developments.

This report on the IS&T Printing for Fabrication conference originally appeared in **Authentication News** November 2018..

Advances in Security Printing

Dr Alan Hodgson, ASIS FRPS FInstP, Printing and Imaging consultant

The IS&T Printing for Fabrication conference was held in Dresden in September 2018. This article attempts to summarise the Security Printing session, sponsored by the new Reconnaissance International conference Digital Document Security.

Security Printing conference papers

Each year this conference features a session devoted specifically to Security Printing. In the recent past this has been sponsored by Reconnaissance International and this year it was supported by the new Digital Document Security conference. It was a good fit for this year's session as a number of the papers explored the interface between digital and physical documents.

Smartphone authentication

It was my task this year to present a joint paper with HP Labs on the use of smartphone imaging for document examination. The work consisted of an investigation of the use of periodic print features (overt and covert) to register both the distance and orientation of the smartphone with respect to the document, all at full video frame rates. This has the potential to aid and guide a smartphone app in the recognition of specific security features.

This presentation served to illustrate the opportunities for a combined approach between print and electronic imaging communities to bring forward a new generation of features. However, it also showed that the different rates of secure document and smartphone product development cycles bring tensions that have yet to be resolved. These are both topics that will feature at the Digital Document Security conference in May 2019. We should also recognise that interest in smartphone authentication extends much further than secure documents. As this conference attracted the smart packaging community there was also interest in the use of smartphone interaction with pharmaceutical packaging. We should watch these developments with interest as this work could influence the future of items such as tax stamps.

HP Labs also presented further work on the use of smartphones with their progressive barcode concept, reviewed last in Tax Stamp News™ December 2016. Progressive barcodes are an extension of Data Matrix codes where coloured elements are progressively added through the

manufacturing or supply chain with the aim of better identifying the location of illicit intervention. One interesting innovation in this work was the use of a smartphone app to facilitate a wireless link to a PC, extending capability in areas without cellular phone coverage.

Additive Manufacturing (3D printing)

With the rise in interest in Additive Manufacturing (AN January 2016) print authentication now extends into the fabrication of 3D objects. This is an area of interest to our community as it has the potential to extend authentication to the object as well as the label or tax stamp. HP Labs presented a number of papers in this area and this would be an interesting topic to review in the future.

This interest stems from the fact that as Additive Manufacturing (3D printing) becomes established in industrial production it will be important to authenticate 3D printed parts in order to maintain trust. This will be of particular importance for high value parts being used in critical applications such as automotive and aerospace where authenticity could be a critical safety issue. As a result the ability to maintain copyright, detect counterfeits and trace failed parts and batches will become a necessary capability.

One way to do this would be to add features such as the 2D barcodes discussed above to the product. But as the parts are made through a printing process they already possess intrinsic 3D physical signatures that could be used for this purpose. This is similar to the approach already in place for paper documents where the individual signatures differ for each sheet can be qualified based on the random nature of the cellulose fibres on a micro scale.

Thermal transfer printing

A paper from HID followed the evolution of thermal printing technologies from 300 to 600 dpi and the resultant change in image quality and print speed. The work compared and contrasted the different attributes of thermal transfer print processes for plastic card personalisation, illustrating why the printing density of resin transfer is useful for black text and barcode visibility but the colour and greyscale capability of dye sublimation is attractive for photo quality portraits. It is this greyscale capability that allows dye sublimation to provide photographic image quality equal to inkjet prints of much higher apparent resolution.

Functional ink formulations

Security Printing applications are significant users of functional

formulations such as thermochromic and photochromic inks plus light emitting fluorescent and phosphorescent compounds. Until recently thermochromic and photochromic formulations in particular were limited to impact (analogue) printing techniques. However, as illustrated by a presentation from VTT of Finland inkjet printable formulations are possible which allow the printing of part or all of 2D barcodes that are only visible under certain lighting and temperature conditions.

There is an active collaboration from South Dakota that is working on upconverting nanoparticles for security printing and they presented 2 papers at this conference. The first of these concerned the chemistry issues that are involved in stabilising these nanoparticle dispersions in an inkjet ink that has realistic shelf life for secure applications. The second paper presented some of the characteristics of the upconverting nanoparticles themselves, and the possibility to design them to provide some interesting near infrared (NIR) capabilities.

Most upconverting nanoparticle applications in security printing concentrate on NIR to visible conversion but this group is looking into phosphors that produce NIR to (shorter wavelength) NIR effects. This is in part for biological applications but there is the potential for further covert features using this technology. The South Dakota Centre for Security Printing and Anti-Counterfeiting Technology (SPACT) appears to have significant capabilities in this area.

The printing industry is growing capability in the printing of metallic features, notably for conductive tracks for Printed Electronics (AN February 2016). Some of these metallic features can have substantial mirror-like reflectivity, making them applicable to the reflective security features which were shown at The Holography Conference 2017. I presented an update on this technology as a joint paper with an equipment supplier as this capability is now production ready through a number of printing techniques.

Neural Networks

A paper from Purdue University on extraction of print signatures from inkjet prints described work on dot placement, aimed at identifying the print engines used to counterfeit currency. The interesting aspect of this work is that they have constructed a Neural Network machine classification system to recognise specific features that characterise the behaviour of certain desktop inkjet printers. This type of technology is one we could scale to verify a wide variety of fabricated security features.

A further paper from pulp and paper research groups from China examined the potential of neural networks to tune spot colour matching in

flexographic printing. By training the network with various combinations of cyan, magenta, yellow, green and white ink mixtures the authors showed that efficient colour matching can be achieved in this fashion. While this is a potential productivity gain for print production we should also be aware that this could become another potential tool to aid the illicit copying of coloured security features.

The potential of colour science to augment and/or duplicate security features should not be ignored. Science in this area is still developing and is the topic of a specific annual conference, entitled "Color and Imaging". The 2018 meeting took place in Canada and will be the subject of a separate article.

Conclusion

Technical conferences such as Printing for Fabrication are exploring the issues around the physical and digital interface of printed features, particularly where a smartphone platform is used for verification. Reconnaissance International will take this one step further with their new Digital Document Security conference. The first of these was held in Berlin May 2019 and the Conference review is now available.

<https://www.reconnaissance.net/digital-document-security/about/2019-review-berlin/>

This report on the IS&T Printing for Fabrication conference Security Printing session also appeared in **Authentication News** January 2019.

Report on 15th International Conference on Web Handling

Stillwater, Oklahoma, USA. 10 - 13 June 2019

Dr Dylwin Jones, Consultant

The 15th two-yearly conference in this series was hosted by the Web Handling Research Center (WHRC) at Oklahoma State University. It covers the engineering science behind moving continuous sheets of any solid material through process machinery. Substrates in roll to roll processing present a particular challenge of maintaining registration. Film and paper manufacturers face challenges as widths (10 m) and speeds (2000 m/min) are pushed higher. Most speakers at the conference presented new research on speed and tension control systems, modelling web response in forward and lateral directions and frictional contact with rollers, winding systems, and the causes of defects such as wrinkles and curl. 11 papers presented WHRC projects and a similar number came from external speakers, mostly US-based. Attendance was rather disappointing at just under 60.

The conference started with a full day of "Advice From the Experts: Best Practices". 5 consultants in the field gave hour-long reviews of key topics in web handling: lateral registration and guiding, wrinkling and spreading, air entrainment and traction, longitudinal registration and tension control, and finally winding. The key ideas were backed up by demonstrations in the WHRC laboratories.

The two keynote talks gave senior scientists from Kimberley-Clark Corporation and The Procter and Gamble Company the opportunity to explain how they see trends in society and their response to them. Sustainability was a common theme, decreasing the use of energy and water resources and waste to landfill. Both companies are looking to exploit artificial intelligence, the Internet of Things, Industry 4.0, with increased collection and use of data during manufacture and in products. Both saw value in the increased personalization and customization of products. Web handling continues to be an essential feature of their operations, but we heard little about any engineering challenges they may be facing.

The final session of the conference contained 3 papers, all from South Korea, on roll-to-roll processes and product applications. It was a little

disappointing that no other papers on the advertised theme of roll-to-roll manufacturing were submitted. Hopefully the authors and their fellow delegates from Korea (12 in total) found their visit useful.

The contributed papers can be viewed for free online at <http://www.shareok.org/>, by selecting “Oklahoma State University” community and then “International Conference on Web Handling”. The 15th Conference papers are available now, and earlier conferences will be uploaded in due course. In the meantime, earlier papers and hardback proceedings can be purchased from <http://www.webhandling.okstate.edu/>

We learned during the discussion periods that the Web Handling activity at OSU will be scaled down. Some equipment is being removed and the WHRC Director, Prof. Keith Good, is coming up to retirement with no successor in place. The WHRC was set up in 1986 as an Industry – University Cooperative Research Center by the National Science Foundation. There are now only 6 sponsoring companies, and for the first time there was no sales pitch to potential new sponsors at the conference. Amongst all this gloom, it was pleasing to hear that there were several volunteers to try and keep the conference running. So keep a look out for the 16th Conference in 2021!

Forthcoming Group Events

Advanced Materials for Fabrication

30 March - 1 April 2020

Manchester, UK

Sponsors - Henry Royce Institute, Institute of Physics PGS Group, Manchester Bioelectronics Network, The Royal Photographic Society, Reconnaissance International. Web. www.imaging.org/Manchester

General Chair - Leszek Majewski, University of Manchester

This conference has four tracks with the common theme of materials.

These are: Advanced Materials, Degradation of Materials, Materials for Security Printing & Institute of Physics PGS Group Student Conference

Advanced Materials

will play a key role in the future applications and processes of device fabrication. Topics include: - Materials for Additive Manufacturing, Biomaterials, Bioelectronics, Bio-applications, Use cases

Degradation of Materials.

This track offers a bridge between communities active in the art and science of photography and gallery conservation. It also explores how issues related to degradation are emerging concerns in Printed Electronics and Security Printing. This conference is held in association with The Royal Photographic Society. Topics include: Photograph conservation, Photo gallery display and storage, Degradation of materials in emerging applications, International Standards from ISO TC 42 (Photography)

Materials for Security Printing This track examines the materials for physical documents and the novel characteristics required for security. This track includes the PGS Student Conference. (See below)

Student Conference (Part of the above)

30 March 2020

Organised by the PGS Group.

Hear from advanced student and postgraduate researchers on their work in all aspects of printing applications and processes. This annual conference is organised by the Institute of Physics **Printing & Graphic Sciences Group.**

Other Events of Potential Interest

IS&T Archiving 2020 Conference

Digitization Preservation, and Access

IS&T Archiving Conference

Date: 2020-5

Venue: Washington DC, Washington DC, United States

Organised by the Society for Imaging Science and Technology.

<https://www.showsbee.com/fairs/66234-IST-Archiving-Conference-2020.html>

Note: The website needs updating 'bigly' The IS&T Archiving Conference is an annual event for the imaging science and the cultural heritage communities. It enables scientists, technicians and 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 for this conference if it goes ahead.

15th Colour Conference

2019 date passed. Check <http://www.gruppodelcolore.it>

Printed Electronics USA 2019

November 20 - 21, 2019

Santa Clara Convention Center, CA, USA

<https://www.idtechex.com/printed-electronics-usa/show/en/>

Printed Electronics Europe 2020

13 - 14 May 2020

Estrel Convention Center, Berlin, Germany

<https://www.idtechex.com/printed-electronics-europe/show/en/>

RPS Good Picture 2019: Imaging Revealed

14 December 2019

University of Westminster, 309 Regent Street, London, UK

<http://www.traveugroup.rps.org/events/2019/december/14/good-picture-2019-imaging-revealed>

Electronic Imaging 2020

26-30 January 2020

Hyatt Regency San Francisco Airport, Burlingame, California

http://www.imaging.org/site/IST/IST/Conferences/EI/Symposium_Overview.aspx

Large-area, Organic & Printed Electronics Convention (LOPEC)**March 25–26, 2020 | Exhibition****March 24–26, 2020 | Conference****Messe München, Germany**

OE-A and Messe München together host LOPEC, the world's leading International Exhibition and Conference for the Printed Electronics Industry. It is the business-oriented platform for end-users, engineers, scientists, manufacturers, and investors. Submit abstract by 25 Oct if presenting.

<https://www.lopec.com/conference/information/index.html>

Reconnaissance International Digital Document Security**No date beyond “Autumn 2020” set.****No venue set beyond “somewhere in Europe”.**

The Call for Papers for this conference remains open through October.

www.digitaldocumentsecurity.com

Awards

Selwyn Award

Introduced by The Royal Photographic Society in 1994 and given to those 35 years and under who have conducted science-based research connected with imaging.

2018 Recipient: Dr Emma Talbot (Present Chair of the PGS Group)



Emma Talbot receiving The Royal Photographic Society 2018 Selwyn 35 Years and Under award from the President of The Society. The award was presented on 8 Nov 2018 at the ceremony in The Royal Society rooms in Pall Mall.

Photo credit Nick Scott FRPS/Royal Photographic Society.

Dr Talbot received her PhD in Chemistry from the University of Durham in 2014, with a focus on high speed photography of flows inside drying inkjet droplets to predict drying times and to look at oscillation frequencies

following impact on different surfaces. The findings have been presented in publications and at conferences and are supported by a major global player in the chemical industry where inkjet printing is seen as a potential dispensing and patterning technique. Talbot successfully continues to use imaging in her science-based research to produce work of both academic and industrial relevance.

PGS Group Awards

The PGS Group award student presentation prizes each year. These prizes are open to all UK or Ireland university research students, currently towards a PhD or Masters degree, who present their work at the annual Printing and Graphic Science Group Student Conference. The Group awards £50 for the two best Student Presentations.

All presentations given at the Student Conference are considered for prizes. For information on next year's conference please see our group calendar. The 2019 Student Presentation Prizes were awarded as below.



Leisbeth Birchall an award winner for best presentation, Reactive Inkjet of Quantum Dot–Silicone Composites

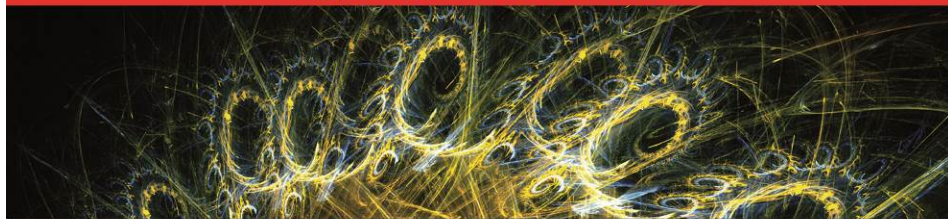


Tanyaradzwa Mangoma an award winner for best presentation, Additive Manufacturing of memristic and neuromorphic devices

Research Student Conference Fund

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

Supporting research students



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For further information see www.iop.org or contact 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

The PGS Group is now on Twitter @PGS_IOP.

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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