



UK & IRELAND CHAPTER

# Number 50 NEWSLETTER December 2014

## Chairman's Report

Dr Alasdair Campbell

Welcome to the latest SID UK & Ireland chapter newsletter.

Firstly, I would like to thank the outgoing Chair Myrddin Jones for all his work and guidance of the Chapter over the last two years. This included the period when the Chapter had to organise EuroDisplay 2013, which is the SID's large primary European meeting. Myrddin stepped down in April this year and I will try and do as good a job as he did at the helm. I would also like to thank the outgoing Secretary Graham Weaver for his vital contribution in helping run the Chapter's activities over the last few years. In particular, organizing committee meetings and taking minutes, as well as his contribution to EuroDisplay

For meetings, we have had a good year in 2014. This included the one-day meeting on Ruggedised Displays at Visteon, the one-day meeting on Organic Electronics for Displays and Lighting at Brunel University London and the two-day Organic Electronics UK 2014 meeting at Imperial College London. I would like to thank committee members Steven Purcell and Poopathy Kathirgamanathan for organising the meetings at Visteon and Brunel, respectively

I was delighted to have Antonio Fchetti as plenary speaker at our organic electronics meeting.

Please send us your nominations for the 2015 Ben Sturgeon Award by 31 March 2015.

[Click for details](#)

Antonio's research work is at the highest level and it is great to see a University start-up such as Polyera making a global impact, pointing to the strength of this area. Another aspect, which struck me at the meeting, was how so many solution-processed semiconductors are now achieving mobilities in the range 1 to 10 cm<sup>2</sup>/Vs, allowing organic TFTs to be used to drive not only LCDs, but also to provide the current necessary for AMOLED displays. This shows great promise for fully flexible and rollable plastic displays.

Having worked in organic electronics since my undergraduate project in the 80's and as a PostDoc at the University of Sheffield in 1996 making my first green polymer OLED with CDT materials. I am also excited

to see large 55" 3D AMOLED televisions finally being available in stores in the United Kingdom for under £2000, as well as AMOLED Tablets for under £400 (you now know what to buy me for Christmas!).



Alasdair Campbell

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# CHAPTER AGM, 2014

and one-day meeting

## RUGGEDISED DISPLAYS

Wednesday, 7<sup>th</sup> May 2014

Visteon Technical Centre, Chelmsford, UK, CM2 5LB

The chapter AGM was held during the one-day meeting on Ruggedised Displays held at Visteon Technical Centre in Chelmsford.

Following the approval of the minutes of the previous meeting, the reports from the Chairman, Treasurer and Membership Secretary were presented.

The following chapter officers were elected to serve for the following year (opposite).

[AGM 2014 unapproved minutes](#)

Dr Sally Day	UK Director
Dr Alasdair Campbell	Chairman
Dr Ben Broughton	Vice-Chair
Dr Radu Sporea	Secretary
Mr Paul Lacey	Treasurer
Mr Paul Lacey	Membership Secretary
Dr John Mansell	Meetings Registrar & Newsletter Editor

## RUGGEDISED DISPLAYS

### Report by Steve Purcell

This technical meeting, held at the Visteon Engineering Centre in Chelmsford, focussed 'Ruggedised Displays'. The use of displays in challenging environments has increased at a significant rate, with demand from the automotive, aerospace, marine, military and industrial markets continuing to grow rapidly. However, such markets have their own specific requirements concerning robustness, reliability, readability and performance.

The meeting started with a presentation from Charlotte Harrison (Plastic Logic), detailing recent developments in Flexible AMOLED displays driven by organic TFT's on plastic substrates and the subsequent challenges faced during their development. Stephan Thaler (Atmel) discussed the use of capacitive sensing technologies and their addressing for emerging HMI concepts in automobiles. The presentation discussed the obstacles that need to be overcome, to achieve accurate detection using

capacitive sensors in noisy environments. Peter Linscott's presentation (Sharp) highlighted recent developments in 'Revolutionary IGZO Displays', providing an interesting overview of this developing display technology and its relative merits. Carl Evans (Visteon) presented the 'Effects of anti-glare films on the perceived quality of automotive display applications'. Robert Hill (Varitronix) presented an overview of touch panel solutions and the challenges faced in the manufacture of such panels for harsh environments. Steve Varley (Ginsbury) discussed the design of LCD monitors for rugged environments. The day closed with a presentation from Steve Purcell (Visteon) providing an overview of the advantages and disadvantages of optical bonding versus the use of emerging anti-reflection films.



Charlotte Harrison

[Organic Electronics](#)   [Displays & lighting](#)  
[Ben Sturgeon](#)   [Presidential Citations](#)  
[EuroDisplay](#)   [Conferences](#)

# SID ORGANICS ELECTRONICS UK 2014

Imperial College, 29<sup>th</sup> and 30<sup>th</sup> September 2014

Report by Dr Alasdair Campbell

The SID organic electronics UK 2014 meeting was held at Imperial College London on Monday the 29th and Tuesday 30th of September. It was the 7th in the series, the meeting having a one year break due to EuroDisplay in 2013. The meeting was held the first time in the Royal School of Mines, a very nice venue on Prince Consort Road.

The conference opened with the Plenary Presentation by Dr Antonio Fachetti, Co-founder and CTO of Polyera, and Adjunct Professor of Chemistry at NorthWestern University, USA. His presentation was entitled *Materials and process development for printed optoelectronic devices*. He described Polyera's latest developments in organic field effect transistors, organic CMOS field effect transistors and circuits, metal oxide devices, and organic photovoltaics. Their NN2200 n-type polymer originally reached mobility values of 0.1 cm<sup>2</sup>/Vs by melting and slow cooling in top and bottom gate devices. By optimizing processing, chain alignment and injection, the polymer has been shown to be ambipolar, achieving a mobility of 0.85 cm<sup>2</sup>/Vs for both electrons and holes, printed arrays allowing the formation of CMOS circuits. Using caesium carbonate and spraying it onto the gold source and drain allows the transistors to be switched from p-type to n-type. Varying the dielectric in a top gate configuration allows the mobility to be changed, tuning the hole mobility to exactly match the electron mobility.

Gravure printed PEDOT:PSS conducting polymer has also been used for the electrodes instead of gold, which with NN2200 achieved fully printed circuits. For metal oxide transistors, they have developed the ability to combine these with soft plastic dielectrics, films typically annealed at 200°C. Organic – inorganic self assembled nano-dielectrics have also been developed.

To deposit metal oxides they have also developed a novel self-combustion chemistry process as an alternative to solve – gel processing. This allows clean, low-temperature processing for both semiconductor and the conducting parts of the transistors.



Antonio Fachetti

Flash memory thin-film transistors operated by using charge trapping have also been developed with a nanoscopic dielectric. Organic photovoltaic solar cells have been developed with the organic layer sandwiched between zinc oxide and molybdenum oxide injection layers. Polyera's high-performance blend material has reached 9% quantum efficiency. Slot-dye coated devices have reached 8%, while their inverted devices have also reached 5%..

This was followed by an invited presentation by Dr Tiziano Agostinelli from Plastic Logic entitled *Plastic TFTs for digital and analogue applications*. Plastic Logic have a Cambridge research and development prototype line, while in Dresden they have a generation 3.5 factory. Tiziano stated that organic electronics is the only route to truly



Tiziano Agostinelli

flexible displays; it is much more bendable than ceramic alternatives, the critical bend radius being much higher for plastics. Plastic Logic have been developing both electrophoretic displays as well as LCDs. These are robust, unbreakable, thin, lightweight and conformal. They have also been developing through one of their partnerships, image sensors and organic photo detector arrays, as well as digital applications such as logic circuits and analogue applications such as smart sensors (e.g. gas sensors). With collaborators Novaled, they've also been working on AMOLEDs. Mobility higher than 10 cm<sup>2</sup>/Vs has

been achieved, leading to significant reduction in power consumption.

The last invited talk of the opening session was by Dr Aurelie Meneau from Merck entitled *Solution-*

***processable organic materials for flexible electronics.***

Merck Advanced Technologies are working on materials for OLEDs, lighting, organic photovoltaics and fuel cells. Their target is to develop material solutions for the customer, developing formulations which are solution processable for coating and printing. They now have small molecule polymer organic semiconductors which can reach a mobility of 1 to 5  $\text{cm}^2/\text{Vs}$  in TFTs. Polymer organic semiconductors can be processed at temperatures below  $100^\circ\text{C}$ . Transistors with these polymers are stable for over 492 days stored in air at room temperature. Very uniform mobility was achieved with a scatter of less than 10%. They have also developed inkjet printing and photolithographic patterning techniques to pattern the semiconductor, which has greatly reduced the off current in top gate and bottom gate devices.

The meeting then broke for a buffet lunch.

After lunch, the meeting reconvened with an invited talk by Professor Arto Maaninen from VTT entitled ***Recent achievements of printed electronics at VTT.*** Arto works at the VTT Centre for Printed intelligence. They have four different roll-to-roll pilot lines. In ambient they have MAXI, PICO and ROKO. They also have NICO, which is a R2R system in an inert gas atmosphere. They are also using reverse offset printing tools, which can achieve  $5\ \mu\text{m}$  wide metal lines. They have made R2R printed organic photovoltaics on Corning Willow Glass. This is as well as fully printed transparent organic light emitting-diode (TOLED) stacks. There are also developing a multistep R2R pilot line for biobatteries. They have also done R2R self-aligned organic field effect transistors. They're also looking at hybrid system integration, integrating organic LEDs with organic electronics, and have also developed the PrintoCent Industry Centre.

This was followed by a contributed talk by Dr Kang-Jun Baeg from Korea Electrotechnology Research Institute entitled ***Development for Organic Flash Memory.*** Dr Simon Ogier from the National Printable Electronics Centre then gave an invited talk on ***Scaling up of fabrication processes for high mobility organic transistor***



Aurelie Meneau

***production.*** The National Printable Electronics Centre has developed a TFT pilot line. Mobility targets are  $10\ \text{cm}^2/\text{Vs}$  for OLEDs,  $1\ \text{cm}^2/\text{Vs}$  for LCDs, and  $0.1\ \text{cm}^2/\text{Vs}$  for electronic paper. They have achieved a 5 mask transistor process flow involving a small molecule organic semiconductor in a high k binder. Mobility achieved was  $5\ \text{cm}^2/\text{Vs}$ , with very uniform device performance and little scatter. This is for p-type logic devices and AMOLEDs and AMLCDs. The devices have a 1 mm bend radius. He commented that LTPS and oxide transistors will never achieve this bend radius. They process  $8''$ ,  $12''$  and generation 2 substrates in a class 100 clean room. They also use spool as opposed to roll-to-roll processing, and are also developing an R2R digital lithography tool and barrier film production

After the tea break, the meeting continued with an invited talk by Professor Malte Gather from the University of St Andrews entitled ***Recent Progress in Understanding and Improving the Optical Properties of Organic Light-Emitting Diodes.*** He has been developing and modelling top emitting organic light emitting diodes with a corrugated bottom electrode. The corrugation has a horizontal pitch of  $1\ \mu\text{m}$  forming a shallow grating to a depth of 70 nm. With the small corrugation you get strong spectral changes in the output of the OLED. He then investigated a deeper grating with a depth of 144 nm. The emission is best described by mode interference involving a coupled cavity-grating

mode. Using a 2-dimensional grating, he was able to increase the outcoupling by factor of 2 to 3. He then investigated internal scattering within the substrate. The effervescent tail extends into the substrate, guided modes propagating 2 to  $20\ \mu\text{m}$ . Extraction of these modes requires strong scattering. He put titanium dioxide particles into the OLED substrate. A pixel with an external outcoupling film improved its power efficiency from  $30\ \text{lm/W}$  to  $62\ \text{lm/watt}$ . There was also a dramatic improvement in colour stability. Using molecular orientation one can also improve the outcoupling efficiency. Having all the emitting dipoles horizontal to the substrate as opposed to isotropically orientated improves emission by 1.5. He also used silver nanowire electrodes to scatter and out



Arto Maaninen



Simon Ogier

couple light, improving OLED performance from 30 to 54 lm/W.

The last talk of the day was an invited presentation by Dr Luigi Occhipinti from the University of Cambridge on the *Manufacturing challenges of Large-Area Electronics and Smart Systems*. He discussed how there are a lot of opportunities in the flexible organic larger area electronics (OLAE) area, such as displays, lighting, organic photovoltaics for off-grid power generation, flexible solar panels, and organic transistor logic circuits. Devices such as active matrix organic photodetectors have a performance which can rival silicon CMOS photodetectors, but are printable and flexible. The Centre for Innovative Manufacturing for Large-Area Electronics has a range of activities. It includes integration of printed electronics with silicon; printed energy modules based on energy harvesting; also high-speed testing for large area electronics, and high resolution patterning processes. He discussed the cost reduction in moving from vacuum deposition to large area coating to printing. They have a range of projects involving both roll to roll and sheet to sheet processing. They are also looking at biochemical sensors, such as a contact lens to treat glaucoma, and stretchable sensors.

This was followed by the Poster Session with drinks and nibbles. There were 15 posters covering a range of topics across the whole area of organic electronics. The winner of the SID Best Student Poster prize was Philip Bridges of Imperial College London. The title of his poster was *Nanopinbowling using a 2-dimensional diffraction grating*. He was awarded £200 sponsored by the SID UK & Ireland Chapter. The runner-up was Madeleine Morris, also from Imperial, with a poster entitled *Effect of internal electric fields on charge carrier dynamics in ferroelectric materials for solar energy systems*.

The first talk of the second day was an invited presentation by Professor Martin Heeney from Imperial College London on *Conjugated Polymers for FET applications*. He discussed making materials for transistors by fluorination of the backbone. DFT calculations suggest that for a thiophene oligomer fluorination will make it more planar with deeper LUMO and HOMO levels. He was able



Luigi Occhipinti

to synthesise three different fluorinated polythiophenes with varying ionisation potential and varying solubility. Fluorination was found to promote aggregation in all three polymers, but X-ray diffraction shows that they are less ordered in thin films. There is therefore a significantly higher barrier to rotation in these materials. Using these polymers he was able to achieve a TFT mobility of 0.8 cm<sup>2</sup>/Vs. A second case was using a polythienothiophene material. As the polymer is fluorinated, the aggregation and melting point are increased and the crystallisation temperature reduced.

X-ray diffraction shows it is more ordered in thin films and the mobility also increases from 0.06 to 0.2 cm<sup>2</sup>/Vs. He also found that increasing the regio-regularity made the material become even more ordered, allowing them to achieve mobilities up to 4.6 cm<sup>2</sup>/Vs. This was followed by a contributed talk by Elisa Collado-Fregoso from Imperial College London on *Increased Exciton Dipole Moment Translates into Charge-transfer Excitons in Thiophene-fluorinated Low-bandgap Polymers for Organic Photovoltaic Applications*.



Elisa Collado-Fregoso

After the coffee break, Dr Richard Wilson from CDT gave an invited presentation entitled *Progress in Materials for Organic Electronics*. CDT are working on organic photovoltaics, organic photodetectors, organic transistors and printed organic light emitting diodes. Areas of interest are displays, lighting, integrated printed electronics, and new technologies. In the parent company Sumitomo, they also work on organic synthesis, device development, and materials for connect electronics. CDT have developed OFETs with a top gate fluoropolymer dielectric and bottom contacts using metals such as gold or silver. Devices are processed and tested in ambient with no encapsulation. New semi crystalline materials are very tolerant to solvent drying variations and have given a mobility of 2.5 cm<sup>2</sup>/Vs. They are now focusing on reducing contact resistance, as it lowers the mobility in short channel devices. They've also been working on OPVs and OPDs involving polymer-polymer and polymer-fullerene blends, and Sumitomo and UCLA have achieved a 10% efficient OPV. OPDs have a lower dark current compared to silicon devices as well as an improved



Richard Wilson

quantum efficiency in the blue. They also benefit from freedom of design, shape, size and flexibility. They are also working on a light emitting electrochemical cell (LEC). They estimate cost in mass production at \$0.1 per square centimetre. They can print all parts of the device, making them very low cost and disposable

This was followed by a contributed talk by Jorge Costa Dantas Faria from Imperial College London on ***Fluorene Copolymer Bilayers for Emission Colour Tuning in Inverted Hybrid LEDs.***

This was followed by an invited presentation by Professor Yong-Young Noh from Dongguk University entitled ***Development of high performance ambipolar polymer IC.*** Many organic semiconductors now show ambipolar transport with a mobility greater than  $1 \text{ cm}^2/\text{Vs}$ . Ambipolar semiconductors are very easy to process because one can have simple CMOS creation by blanket coating methods. To produce n- and p- type devices he used three methods: the first is changing charge injection; the second is balancing hole and electron mobilities; and the third issue is dealing with the large leakage currents. Selective spray coating of oxides and carbonates on gold contacts can be used to vary injection. Caesium carbonate and caesium fluoride can be used to improve the electron mobility, vanadium oxide can be used to improve the hole mobility, while mixed interlayers can be used to vary the electron and hole mobility continuously. He can also change operation from ambipolar to unipolar by selective chemical doping, and n-type doping can create a very thin (few nm thick) Schottky barrier at the contacts greatly improving injection. A polymer blend dielectric of P(NDF-TrFE) and PMMA has been used to switch mobilities by increasing hole accumulation for one component (PMMA) and increasing electron accumulation for the other component (P(NDF-TrFE)). The deeper the polymer OSC ionisation potential, the larger the effect. They have also been using bar coating of the semiconductor to increase crystallinity. Very thin semiconductor films improve mobility and you can go down to 1 to 2 nm. However a proper practical limit is



Jorge Costa Dantas Faria

5 nm otherwise full coverage will not be achieved. He has also developed fully functioning, ambipolar integrated circuits on plastic. The meeting then broke for a buffet lunch.

After lunch, the meeting reconvened with an invited talk by Professor Franco Cacialli from University College London entitled ***The skill lies in the blending: examples from white to NIR LEDs.*** He discussed the tendency of organic semiconducting molecules to form cofacial H aggregates, impacting emission. Blends is one approach to control this type of packing. He has instead taken a supramolecular approach using tube-shaped rotaxanes to surround

a polymer chain. In a blue and green light emitting polymer blend, there is efficient energy transfer to the green polymer; with the rotaxane system blue emission was not quenched by energy transfer to the green emitting polymer. Cyclodextrin encapsulation suppresses energy transfer, and allowed white electro-luminescence to be achieved. He has also developed linear and cyclic porphyrin hexamers for near infrared OLEDs. Using a hexamer:F8BT blend he has achieved NIR OLEDs with an efficiency of 0.1% at 900 nm emission wavelength. Using a hexaozatri-naphthylene:TFB blend he was also able to get OLED emission at 816 nm. This was followed by two contributed talks. The first was by Jasvir Bhamrah Harley from Imperial College London entitled ***Harnessing the Molecular Route in Plastic Electronics.*** The second was by Antony Sou from University of Cambridge entitled ***Functional Integrated Plastic Systems.*** The meeting was then closed by the Conference Chair, the SID Best Student Poster prize winner was announced, and speakers and audience thanked.



Yong-Young Noh



Franco Cacialli

## BEN STURGEON AWARD 2015

Nominations to be submitted  
by 31<sup>st</sup> March 2015  
[Details on chapter website](#)

[Rugged Displ.](#) [Displays & lighting](#)  
[Ben Sturgeon Citations](#)  
[EuroDisplay Conferences](#)

# ORGANIC ELECTRONICS FOR DISPLAYS AND LIGHTING

Brunel University, 27<sup>th</sup> May 2014

Report by Prof. Poopathy Kathirgamanathan

The half-day meeting on Organic Electronics for Displays and Lighting was organised at Brunel University London on behalf of SID-UK and Ireland and the Society of Chemical Industries, UK and was attended by nearly 30 delegates including three SID members. Prof. Paul O'Brien (POB) of Manchester University gave the first talk on the synthesis and application of quantum dots in flat-panel displays and photovoltaics, generating considerable discussion and excitement amongst the industrial participants. Prof. Poopathy Kathirgamanathan (PK) gave a presentation on OLEDs, PLEDs, QLEDs and RELEDs with a demonstration of OLED lighting panels manufactured at Brunel.

He also presented all vacuum based processing of perovskite solar cells.

The third talk was given by Prof. Jun Yeob Lee (Dankook University, Korea) on 'Mixed Hosts Systems for Highly Efficient Phosphorescent OLEDs'. This highlighted the continuing industrial need for good single host so that the processing time could be reduced by manufacturers. The last lecture was given by Dr S. Bohm of Tata Steel (Sheffield) on large-scale manufacturing of graphene(s).

We thank Brunel University for providing the lecture theatre free of charge.

## BEN STURGEON AWARD 2014

The Ben Sturgeon Award for 2014 has been awarded to Dr Stephen Morris of the Department of Engineering Science, University of Oxford..

The award was made for his contribution to the understanding as well as the development of liquid crystal materials which exhibit the flexoelectro-optic effect. This work included working with LG Display in the development of a new LCD which uses the flexoelectro-optic effect. In 2006, he worked in collaboration with an SME in Cambridge on the development of a hybrid display which used an electroluminescent backplane in conjunction with an LC shutter



*Dr Ian Sage receiving his award from President, Brian Berkeley*

## PRESIDENTIAL CITATIONS 2014

Dr Sally Day

It was with great pleasure that I was asked to collect two awards of the total of five given to SID UK & Ireland Chapter members at the recent display week in San Diego. The presidential citations were given to Ian Sage and Graham Weaver for their work organising the successful EuroDisplay in London last year; to Alasdair Campbell as Programme Chair of Eurodisplay; to John Mansell for his many years of work to the UK & Ireland Chapter as Newsletter Editor and as meetings registrar, tirelessly making sure that delegates to our meetings are registered and have all the information they need to attend the meetings. Also recognised with a citation by the President of SID was Tony Lowe who, amongst all the other things he has done for the Society, was recognised for his work on the SID book series with Wiley, which has now reached a total of 24 books under his leadership. The UK's Ian Sage has taken over the role and is looking forward the commissioning many more books of importance to those developing, researching and using displays.

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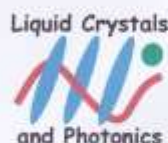


Save the date

# Eurodisplay 2015



Ghent, Belgium  
21-23 September 2015



**Venue**

Conference center  
Het Pand  
Onderbergen 1  
Ghent, Belgium

**Organized by**

SID Mid-Europe Chapter  
Ghent University

Centre for Microsystems Technology  
Liquid Crystals and Photonics Group

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**Organizing committee**

General Chair Herbert De Smet  
General co-Chair Kristiaan Neyts  
Executive Chair Jeroen Beeckman  
Advisory co-Chair Ian Sage  
Program Chair Dieter Cuypers  
Program co-Chair Jan Genoe  
Exhibit & sponsorship Chair Stefan Riehemann  
Business Chair Jutta Rasp  
Academic advisor Youri Meuret  
Industrial advisor Joerg Winkler  
SID-ME Chair Jens Osterodt  
SID-ME Vice Chair Armin Wedel

[www.sideurodisplay.org](http://www.sideurodisplay.org)

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## CONFERENCE CALENDAR



<http://www.sid.org/Chapters/uki/UKIForthcomingMeetings.aspx>

Advances in Flat Panel Displays  
6 February 2015  
Costa Mesa Country Club, CA

<http://www.sid.org/Chapters/Americas/LosAngelesChapter/Symposium.aspx>

**Display Week 2015**  
**International Symposium, Seminar and Exhibition**  
**May 31-June 5, 2015, San Jose, California**  
**Exhibition: June 2-4, 2015**  
**San Jose Convention Center**  
[www.displayweek.org](http://www.displayweek.org)

**EuroDisplay 2015**  
**21-23 September 2015**  
**Het Pand, Ghent, Belgium**  
[www.sideurodisplay.org](http://www.sideurodisplay.org)

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