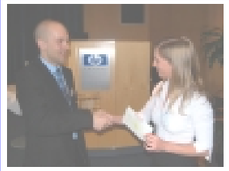
SHARP-SID AWARD 2008

The Sharp-SID Award 2008 has been won by Eero Willman of University College, London. He received his award from the chapter chairman, Dr Richard Harding, Merck Chemicals Ltd and was presented with the cheque by Dr Lesley Parry-Jones, Sharp Laboratories of Europe at a technical meeting held recently at Hewlett-Packard Laboratories in Bristol. During the meeting, he presented a paper on his work entitled, 'Three-dimensional finite-element modelling of bistable LC devices with grating structures'.

Eero is carrying out the research for his PhD in the Department of Electronic and Electrical Engineering at UCL under the supervision of Dr Aníbal Fernández and Dr Sally Day. He is aiming to submit his thesis this summer.



Erro receiving his award cheque from Dr Lesley Parry-Jones

His work involves developing a three-dimensional finite-element program for modelling the hydro-dynamics of nematic liquid crystals with a variable degree of order, using the Landau-de Gennes/Qian-Sheng theories. Some of the features of the program include a three elastic coefficient description of elasticity, the flexoelectric effect and weak anisotropic anchoring of the LC to solid surfaces. He then used the program for modelling the operation of bistable LC devices with grating surfaces in three dimensions (PABN, ZBD).

BEST POSTER AWARD 2007

The award for the best poster at the poster session which took place as part of the meeting on organic electronics at Imperial College in September 2007 was won by Ms Boon Kar Yap. Her presentation was based on the work she was carrying out for her PhD on the electrical and thermal stability of PLEDS.

Boon Kar receiving her award from Dr Richard Harding, Chapter Chair

Boon Kar did her Bachelors Degree with Honours in Electrical and Electronic Engineering in Malaysia. She then came to Imperial College under the same scholarship programme, sponsored by the Malaysian Government to do an MSc in optics and photonics in 2002. Following that, in 2004 she started her PhD with a studentship from the Sumitomo Chemical Company, Japan

Nominations called for:

BEN STURGEON AWARD 2009

http://www.sid.org/chapters/uki/ben_sturgeon.html

SHARP-SID AWARD 2009

http://www.sid.org/chapters/uki/sharp.html

by 31 December 2008

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SOCIETY FOR INFORMATION DISPLAY

UK & IRELAND CHAPTER

Number 43 # NEWSLETTER **August 2008**

Chairman's Report

Richard Harding

I hope you enjoy the latest Chapter Newsletter. It is approximately three months since the AGM meeting where I was re-elected as your Chairman and a good time to reflect on our activities.

At the AGM, we introduced two new members to the committee; Masahiko Ando, from Hitachi Cambridge Laboratory and Tim Wilkinson from University of Cambridge. Since the AGM, we have further expanded our committee and I hope you join me in welcoming our two newest members; Myrddin Jones from OLED-T and Paul Lacey from Raymarine.

I would like to take this opportunity to highlight the forthcoming SID Organic Electronics and Photovoltaics meeting which will be at Imperial College on 16-17th September. Last year, this meeting concentrated solely on **Organic Electronics** and was very successful. Therefore, this year we have kept the meeting style similar to that of last year, the seminar will again be a mixture of key-note, invited speakers and student oral contributions along with a poster session**. Merck will again provide the prize of £500 for the best poster**. However, one important difference this year is that we will broaden the topic slightly to include **Photovoltaics**, since this area is quite topical and there is certain amount of synergy with organic electronics work.

Looking back over the year, we have already held meetings covering a variety of topics.

Interactive & Mobile Displays were covered at Knebworth, where we found out about Sharp's sensor displays, the latest touch-screen products from 3M, USA, Liquavista's electrowetting displays and the use and control of various laser-projection systems for mobile displays. The winner of the Alfred Woodhead Best Paper Award was Ian Underwood, from MicroEmissive Displays, for his paper on *Mobile see-through and multimedia applications.*

Following this, we had a second day meeting at Knebworth on **Display Drivers & Interfacing Techniques,** where we heard about the many different driving requirements of different LCDs from Epson, Germany and Sitronix, Taiwan. We also learned the latest addressing techniques utilised for Bistable (ZBD) and OLED (CDT, Total Matrix Addressing) displays as well as a summary of the evolution of interfacing to LCDs from DigitalView. The winner of the Alfred Woodhead Best Paper Award was Cliff Jones, from ZBD, for his paper on *Addressing zenithal bistable diplays.*

In June, we were hosted by HP Labs, Bristol for **Bistable Displays & Applications**. This meeting covered bistable devices for small/medium displays, through to billboard applications. As well as glass-based displays, there was a theme of fabrication and use of these devices on plastic substrates enabling flexible and e-paper applications. On this occasion, the winner of the Alfred Woodhead Best Paper Award was Alex Henzen from iRex Technologies BV.

Our **Student Initiative** continues to attract new student members to our Chapter. We were also impressed by the quality of work submitted for the **Sharp-SID Award** and we are pleased to report (see P4 of this newsletter) that Eero Willman, from UCL was this year's winner, for his work on 3D modelling of Bistable devices using grating structures. Eero gave a presentation of his work and collected his award at the Bristol meeting. The award comprises a trophy and £500 prize funded by Sharp.

SID also teamed up with Display Masters and UKDL to provide a short introductory course on Displays at Nottingham Trent University from 1st to 3rd April. The foundation course was quite successful and discussions are ongoing to rerun the course.

Finally, I would like to highlight that we are continuing to collect electronic copies of presentations from our meetings, which can be found on the Chapter website (http://www.sid.org/chapters/uki.html) by pressing 'Past meetings' from the left-hand menu bar and and logging in or from the main SID website (www.sid.org), logging in and then in both cases, pressing 'UKI Past' from the left-hand menu

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Report on the two-day meeting at Imperial College, London on 17-18 September 2007 by Alexander Guite

SID ORGANIC ELECTRONICS FOR DISPLAYS 2008

Imperial College, 16-17 September 2008

Reflecting the expanding research activity on organic electronics, the first two-day SID meeting in the UK on organic electronics for displays was held at Imperial College London.

Welcoming attendees to the meeting, Professor Donal Bradley, Imperial College gave an overview of current work in organic electronics. He noted that much of the material development over the last ten years had focused on materials for OLEDs and stressed the need for more research to optimise materials for solar cell and OFET applications. As an example, he highlighted the work to create materials with high mobility and high photoluminescence quantum efficiency (PLQE) for use as laser gain media. The two properties are often thought to be mutually exclusive, but in poly (9,9-dioctylfluorene) (PFO) by substituting a side group, it is possible to achieve high mobility and PLQE. Professor Bradley also explored current research on replacing Indium Tin Oxide (ITO) as the electrode material of choice in organic devices. There are several problems with ITO: its cost has increased more than ten fold since 2001, it has an undesirable work function for most uses and is liable to crack when bent. Possible replacements include TiO2, carbon nanotubes or PEDOT:PSS.

Prof Donal Bradley

Dr Iain McCulloch from Merck explained their ambition to increase the mobility of polymers to compete with the best small molecules (μ~1 cm^2/V.s). This has led to the development of new polythiophene-based polymers: for instance pBTCT which exhibits good environmental stability and pBTTT the structure of which favours interdigitation of chains and thus forms more crystalline solids.

A third approach to organic electronics, using neither small molecules nor polymers, was offered by Prof Mary O'Neil from the University of Hull. She explained that nematic semiconductors (locked into the nematic phase by crosslinking) can be photographically patterned to form RGB pixels or even colour blends. Echoing the comments of Prof Bradley, she said that new research was moving away from OLED applications towards, for instance, thin films for transistors.

Dr Jonathan Halls presented work from CDT on an interlayer material for use in PLEDs (sandwiched between PEDOT:PSS and the emissive layer) which has the effect of inhibiting electron injection and shifting the recombination zone away from PEDOT:PSS. He reported good progress towards fabricating PLEDs which meet HDTV specifications in the green and red, but cautioned that further work would be required in the blue. High resolution inkjet printing of PLEDs has been pioneered at CDT, with positional accuracy of 15 μm achieved. To demonstrate the abilities of this technique, a 160 ppi PLED display was printed at CDT driven by an a-Si backplane. Dr Halls argued that the next step for high resolution printing of electronic devices would be to extend current technologies to large areas.

DrJonathan Halls

Work on phosphorescent metal complexes at Brunel University was presented by Dr Paolo Coppo. Adding different groups such as fluorine or calcium fluoride to iridium was found to alter the colour of emission. It has therefore been possible to tune the emission of iridium compounds to form RGB pixels.

Unreproducible polymer synthesis and the complex device structures required for small molecules led Stuart Stevenson of the University of St Andrews to investigate the use of dendrimers for LED applications. By optimising the dendrimer design, efficiencies of up to 15% have been achieved.

Prof Henning Sirringhaus from Plastic Logic argued that there is an excellent market opportunity for organic electronics as the driving circuitry for flexible e-ink displays. The demands on transistor performance are not high but existing silicon technology is incompatible with plastic substrates due to high processing temperatures thereby opening a niche for organic transistors. Fabrication is much easier than with LCD displays and a 150 ppi display was recently demonstrated. Prof Sirringhaus also noted that it is much easier to integrate a touch screen on a plastic display than a glass display. Construction on a purpose built production facility in Dresden is in progress and Plastic Logic aim to fabricate one million display units per year

A 240x320x3 (RGB) pentacene TFT array was fabricated by Dr Masahiko Ando and colleagues from Hitachi to drive a five inch LCD display. The pentacene, gate dielectric and passivation films were all solution processed. By optimising the pentacene cast process, the TFTs were found to show stable bias-stressed operation, which were almost as good as commercially available amorphous-Si TFTs.

Dr Masahiko Ando

In order to fabricate an all-polymer display it will be necessary to replace silicon driving circuitry with organic integrated circuits. Dr Thomas Anthopoulos from Imperial College has built a seven stage ring oscillator based on C60 OFETs with a switching time of 1 ms, sufficiently fast for many applications. However, further challenges remain with processability and environmental stability. Building on this, he demonstrated an air-stable complementary logic circuit using a p-type material. Using ambipolar materials, which can act as p or n type depending on the drain bias, it is possible to make complementary like logic circuits.

The second day of the meeting started with a talk by Dr David Lidzey from the University of Sheffield who presented a novel LED fabrication technique using laser ablation. Although inkjet printing offers high resolution patterning it has a fairly low throughput so the aim of patterning by laser ablation is to achieve both high resolution and high throughput. The polymer is patterned using picosecond laser pulses to explosively remove unwanted material from the surface without damaging the remaining polymer. An excimer laser (wavelength of 248 nm) was chosen since polymers have a high absorption coefficient at this wavelength. However in PVA the absorption is much lower so can be used as a sacrificial laser resist to pattern RGB pixels in a multistage process.

Dr Ian Sage from QinetiQ argued that printed electronics can compete on cost for large-area displays, but that one of the main challenges will be to improve resolution beyond 50μm. To do this, he suggested using soft lithography to complement printing, especially for the fine source and drain electrodes in a transistor. He reported that it has been possible to pattern 'sub-micron' features, although because the electrode solution is either highly acidic or basic it severely limits the choice of gate insulator material. A way forward is to use an epoxy insulator and in doing so it has been possible to fabricate a transistor with an ON/OFF ratio of 106 and a mobility of 0.2 cm^2/V.s.

The theme of printing was continued with a talk by Keng Hang-Yim from the University of Cambridge who discussed the difficulties of fabricating well-defined organic-organic interfaces for optoelectronic devices. It has been possible to develop a thin film of poly(-dinoctylfluorene-alt-benzothiadiazole) (F8BT) by transfer printing which has almost the same photoluminescence efficiency as a spin-coated film. The aim now is to attempt to print multilayers to create a functional device.

The mechanical 'toughness' of the organic semiconductor poly(3-hexylthiophene) (P3HT) was identified by Dr Natalie Stingelen-Stutzmann of QMUL, as a potential barrier to its use in applications such as e-books which will require very robust materials . She has created blends of P3HT and polystyrene (PE) which have significantly enhanced toughness: a 10:90 blend of P3HT:PE can be stretched to six times its original length, well above the limit of pure P3HT. The electrical properties of these blends compare favourably to that of pure P3HT and when used in a transistor a lower OFF current was recorded.

Bulk charge transport in these blends and copolymers of P3HT and PE was considered by Dr Theo Kreoizis, also of QMUL. He probed charge transport in orthogonal directions using Time of Flight measurements and by extracting the mobility from field-effect transistors. In a blend of 35:65 of P3HT:HDPE (high density polystyrene) ambipolar charge transport was observed.

Particularly for the development of OFETs as sensors, real time monitoring of OFET parameters will be required said René Dost of the University of Sheffield. He and colleagues have developed a low-cost setup to extract the mobility and threshold voltage from an OFET by applying a square wave across the source and drain while the gate is grounded. In tests on typical OFETs they found their method gave excellent agreement with conventional characterisation techniques, even with very low mobility devices. More details can be found in J. Phys. D: Appl. Phys. 40, 3563 (2007).

Dr Laura Herz

Dr Laura Herz of the University of Oxford explained how femtosecond spectroscopy can be used as an analytical probe for organic materials and devices. These techniques can be used to reveal information about charge separation at heterojunctions, charge trapping at interfaces, energy transfer and the dynamics of excitons. These measurements provide insight into molecular packing geometries and disorder. In polymer FETs, prolonged device operation was found to increase the density of trapped holes in the channel, suggesting that pFET degradation arises from hole trapping, rather than changes in the mobility of free holes.

The importance of understanding the physics of organic-organic semiconductor interfaces in devices was highlighted by Annamaria Petrozza of the University of Cambridge. Her work focussed on understanding the photophysical processes operating at the interfaces of F8BT of varying molecular weights.

Work at the University of Strathclyde on novel materials for organic optoelectronic devices was presented by Min Wu. Soluble star-shaped oligofluorenes based on a truxene-core were found to be highly fluorescent with quantum efficiencies of up to 60%. The material is well suited to device applications: it is reported to have excellent environmental stability was well as good processing and film-forming properties.

Professor Andrew Holmes, from the University of Melbourne, reported work on minimising long wavelength emission in poly-fluorenes. He found that homo and co-polymers based on biphenyl derivatives showed reduced aggregation and better photoluminescence efficiency.

'The world's smallest TV', measuring just 5x6 mm with an RGB pixel size of 15x15 μm, was presented by Dr Alastair Buckley of MED. It used a CMOS active matrix backplane to drive a polymer white emitting material with integrated colour filters and encapsulation. To view an image, it is necessary to use near-eye optics and could be well suited for use in video glasses. Dr Buckley argued that it will be necessary to develop a more complete display lifetime testing methodology to simulate consumer use, rather than simply using the time for a display to halve its output as a figure of merit. Most displays are switched on and off by the consumer whereas half life testing assumes continuous use. A more representative test would be to subject the display to a series of known on/off cycles. Furthermore, half life testing provides no information about the decay profile and in many cases the output at t0.55 is about twice the output at t0.50.