Innovations in Large-Area Electronics Conference

22 - 23 February 2023

Hinxton Hall Conference Centre, Wellcome Genome Campus, Cambridge, UK

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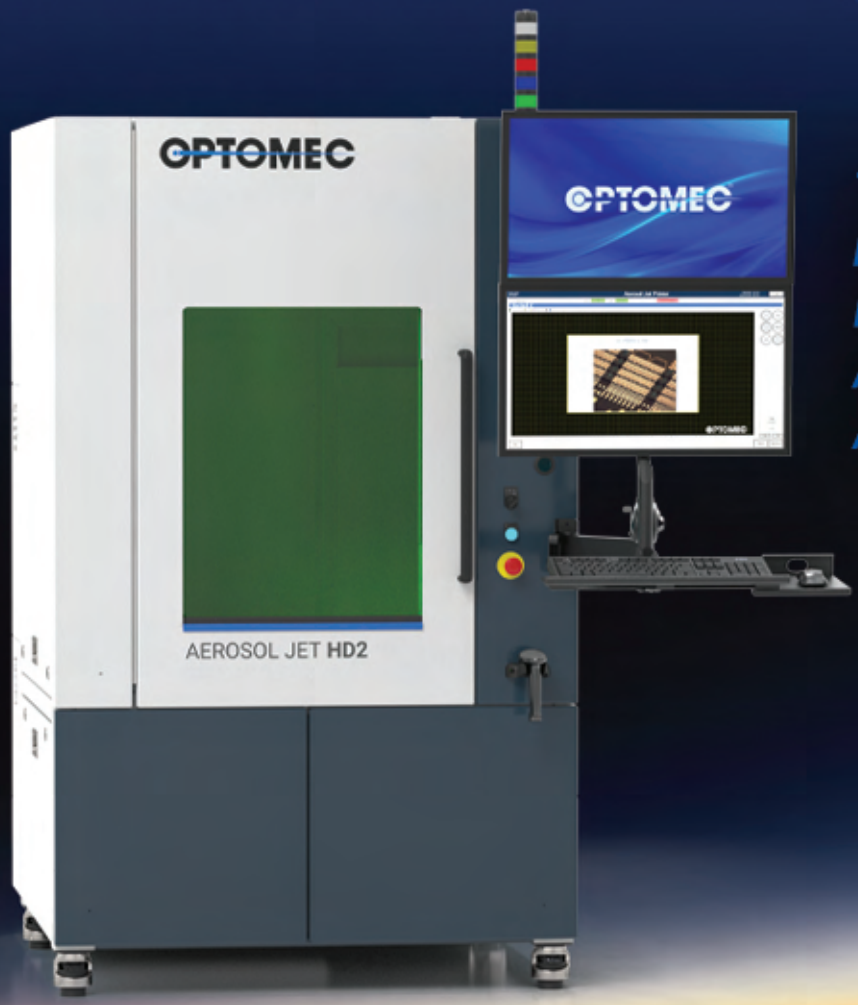

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Day 1 - Wednesday 22nd February 2023

08:00	Registration - Browse the Posters and Exhibition Stands				
09:00	**Session 1**	**(FCA)** Dr Tim Phillips, innoLAE 2023	Welcome to Day 1		
09:05	**Session 1**	**(FCA)** Gold Sponsor Presentation - Optomec			
09:20	**Keynote 1**	**(FCA)** Dr Juha Virtanen, GE Healthcare	Wearable patient monitoring sensors for intra-hospital use		
10:05	Break - Sponsor Exhibitions & Posters				
10:35	**Session 2**	**Manufacturing (FCA)** Chair: Dr Neil Chilton, Printed Electronics Limited		**Session 3**	**Bioelectronics I (RFP)** Chair: Prof George Malliaras, University of Cambridge
	2.1	Prof Daniel Frisbie, University of Minnesota (Invited) Self-aligned, roll-to-roll compatible manufacturing of printed conductors and devices		3.1	Prof Luisa Petti, Free University of Bozen-Bolzano (Invited) Functional materials and devices for emerging bioelectronic interfaces
	2.2	Prof Aldo Di Carlo, University of Rome Tor Vergata (Invited) Scaling-up perovskite photovoltaic to modules and panels		3.2	Prof Elisabetta Dimaggio, Università di Pisa (Invited) Printable and wearable electronics enabled by two-dimensional materials
	2.3	Tammy Sue Wuen Leung, Institute of Microelectronics of Barcelona (IMB-CNM) Novel metal salt decomposition inks for low temperature conductive film development on flexible substrates		3.3	Henrique Leonel, University of Coimbra Low noise organic based devices to access faint signals produced by populations of living cells: applications in anticancer drug screening platforms
	2.4	Zhe Shu, Hahn-Schickard Institute of Microanalysis Systems Direct conductive metal printing for one-step fabrication of hybrid flexible electronics		3.4	Ruben Ruiz-Mateos Serrano, University of Cambridge A wearable cardiac activity mapping system
	2.5	Behnam Madadnia, IMEC Using heat-mask in thermoforming machine for component positioning in thermoformed electronics		3.5	Aimee Sweeney, University of Surrey Cabbage and blackberry for better vision: use of natural dyes for photosensitive organic semiconductor devices towards artificial retina
12:40	Lunch - Sponsor Exhibitions & Posters				
14:00	**Session 4**	**(FCA)** Silver Sponsor Presentation - SiSTEM Technology			
14:10	**Keynote 2**	**(FCA)** Dr Sebastian Meier, ASCA	Photovoltaics reshaped – unlimited design opportunities enabled by printed organic solar cells		
14:55	Break - Sponsor Exhibitions & Posters				
15:25	**Session 5**	**Novel Devices & Systems I (FCA)** Chair: Cathy Curling, Curling Consulting		**Session 6**	**Bioelectronics II (RFP)** Chair: Dr Simon Johnson, CPI
	5.1	Dr Steffen Thrane Vindt, InnoCell (Invited) The next generation of environmentally friendly supercapacitors for energy storage		6.1	Dr Simone Fabiano, Linköping University (Invited) Neuromimicking organic electronics: materials and challenges
	5.2	Prof Harish Bhaskaran, University of Oxford (Invited) Novel nanomanufacturing processes for next-generation devices		6.2	Eleonora Ferraris, KU Leuven Emerging trends in aerosol jet based printing: from printed electronics to bioelectronicsEmerging trends in aerosol jet based printing: from printed electronics to bioelectronics
	5.3	Michael Banach, FlexEnable Ultra-thin and light active liquid crystal cells for optics applications		6.3	Elliot Strand, University of Colorado Printed organic electronic devices for plant health monitoring and precision agriculture
	5.4	Francisco Molina-Lopez, KU Leuven Printed and flexible high-performance thermoelectrics for wearables and other low-scale energy harvesting applications		6.4	Valeria Criscuolo, RWTH Aachen University A novel approach for bioelectronic devices featuring PEDOT:PSS 3D microstructures
	5.5	Douglas Henrique Vieira, São Paulo State University Study of ZnO liquid-gated transistors using honey as electrolytic dielectric layer		6.5	Luís Miguel Pinheiro Sousa, CeNTI Printed insole for risk posture detection in industrial environment
17:30	Networking Reception with drinks & snacks				
19:00	**Coach**	Coach to Robinson College, leaving at 19:00			
19:20	**Gala Dinner**	Gala Dinner at Robinson College			
22:00	**Coach**	Coach back to Hinxton Hall Conference Centre, leaving at 22:00			
	Day 1 Ends				

***** FCA = Francis Crick Auditorium, RFP = Rosalind Franklin Pavilion**

Day 2 - Thursday 23rd February 2023

09:00	**Session 7**	(FCA) Dr Tim Phillips, innoLAE 2023			Welcome to Day 2
09:05	**Keynote 3**	(FCA) Prof Natalie Stingelin, Georgia Tech			Flexible electronics: challenges and opportunities – a materials science view
09:50	Break - Sponsor Exhibitions & Posters				
10:20	**Session 8**	**Novel Devices & Systems II (FCA)** Chair: Dr Dimitra Georgiadou, University of Southampton	**Session 9**	**High Performance Materials I (RFP)** Chair: Prof Cinzia Casiraghi, University of Manchester	
	8.1	Prof Xavier Crispin, Linköping University (Invited) Towards printed lignin-based batteries	9.1	Prof Thuc-Quyen Nguyen, University of California (Invited) Organic semiconductors for application in near-IR photodetectors	
	8.2	Sheng Yong, University of Southampton Zinc ion battery fabricated in a single textile layer	9.2	Emilie Gerouville, University of Southampton Polyoxometalate-based nanoscale electronic devices	
	8.3	Konstantinos Rogdakis, Hellenic Mediterranean University Memristive perovskite solar cells towards parallel solar energy harvesting and processing-in-memory computing	9.3	Bálint Fodor, Semilab Semiconductor Physics Laboratory Comprehensive contactless electrical and optical characterization of perovskite solar cell structures	
	8.4	Alessandro Grillo, University of Manchester Inkjet printed graphene-based diodes	9.4	Tommaso Losi, Istituto Italiano di Tecnologia High mobility solution-processed organic semiconducting blends for high speed and low voltage electronics	
	8.5	Jinxin Bi, University of Surrey A modular flexible photo-rechargeable zinc-ion battery for wearable electronics	9.5	Haoxin Gong, University of Cambridge Degradation in small-molecule transistors: understanding the role of trap states at the metal-semiconductor interface	
12:25	Lunch - Sponsor Exhibitions & Posters				
14:00	**Session 10**	(FCA) Panel Discussion			
14:30	Break - Sponsor Exhibitions & Posters				
15:00	**Session 11**	**High Performance Materials II and Novel Devices & Systems III (FCA)** Chair: Dr Natasha Conway, Paragraf	**Session 12**	**Applications and Sustainability & Energy Efficiency (RFP)** Chair: Prof Krishna Persaud, University of Manchester	
	11.1	Tom Eldridge, CHASM (Invited) CNT hybrid transparent conductive films; enabling a safer, more connected world	12.1	Prof Clara Santato, Polytechnique Montréal (Invited) Printed organic electronics from biomass	
	11.2	Dr Matthew Dyson, IDTechEx Opportunities for thin film and flexible photovoltaics	12.2	Jerome Joimel, Isorg (Invited) OPD roadmap – how printed electronic creates innovative imaging applications and products	
	11.3	Tahereh Nematiaram, University of Liverpool On the largest possible mobility of molecular semiconductors and how to achieve it	12.3	Joana Pronto, CeNTI Printed sensors on thermoformed eco-sustainable foam for automotive application	
	11.4	Xinkai Qiu, University of Cambridge Photosystem I: from ensemble junctions to functional devices	12.4	Evangelia Founta, University of Southampton Towards flexible and sustainable energy storage: molecular-scale understanding of nanocellulose/graphite battery electrodes	
	11.5	Guilherme Mendes Ferreira, Nova University Lisbon Smart IoT electronic paper for interactive security applications	12.5	Tom Askew, CPI Advanced light-weight battery systems optimized for fast charging, safety, and second-life applications (ALBATROSS Project)	
17.05	**Session 13**	(FCA) Speaker Prize Sponsored by Optomec & Poster Prize sponsored by SiSTEM Technology			
17.25	Conference Ends				

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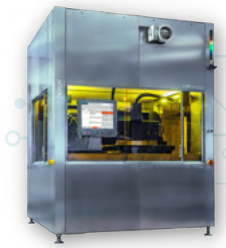

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SESSION 1: KEYNOTE

1.1 Wearable patient monitoring sensors for intra-hospital use

Dr Juha Virtanen, GE Healthcare

Continuous monitoring is expected to improve patient outcome in general wards. Data quality and patient comfort are key factors in the acceptance of a new monitoring modality. Patient safety and compliance with medical standards set the bar high for new products entering the market. Wireless, wearable sensors, making use of printed electronics, hold promise of unique functionality, industrial design and manufacturability. This talk will address key technical challenges specific for vital sign monitoring inside hospitals.

Juha Virtanen is Principal Engineer at GE Healthcare, where he works on wearable sensors for monitoring vital signs in hospitalised patients. Juha received his PhD in biomedical engineering from Helsinki University of Technology in the late 90s. His experience is mostly in biomedical instrumentation, including magnetic resonance imaging, transcranial magnetic stimulation and various physiological measurements. Over the years, he has also studied brain research, human physiology, IC design and haptic feedback.

SESSION 2: MANUFACTURING

Session Chair: Dr Neil Chilton, Printed Electronics Limited

2.1 Self-aligned, roll-to-roll compatible manufacturing of printed conductors and devices
Prof Daniel Frisbie, University of Minnesota (Invited)

Printed electronics has a number of significant challenges, including spatial resolution, pattern registration, and printed circuit performance. This talk will describe a patented liquid-based fabrication approach developed at Minnesota (with colleague Lorraine Francis) that we term SCALE, or Self-Aligned Capillarity-Assisted Lithography for Electronics.

2.2 Scaling-up perovskite photovoltaic to modules and panels
Prof Aldo Di Carlo, University of Rome Tor Vergata (Invited)

Halide Perovskite photovoltaic technology can be scaled to large area modules and panels using printing processes and laser patterning. Here, I will present the progress made to scale up from small area solar cells to modules and panels up to a dimension of 0.5 sqm and the realization of a solar far where 9 of these panels have been tested for one year in outdoor conditions. In particular, I will show the importance of two-dimensional materials combined with halide perovskite to improve stability and efficiency of cells and modules.

2.3 Novel metal salt decomposition inks for low temperature conductive film development on flexible substrates
Tammy Sue Wuen Leung, Institute of Microelectronics of Barcelona (IMB-CNM)

Inkjet printing is a promising technique for the development of printed electronics, however there is a lack in variety of nanoparticle inks which has historically been focused on silver. Here we present novel metal salt decomposition (MSD) inks that when combined with atmospheric plasma sintering allows for the development of highly conductive films at near room temperature (~33 °C). This method allows for direct printing of Au, Ag, and Pt films onto a wide range of substrates including polymers, papers, and textiles.

2.4 Direct conductive metal printing for one-step fabrication of hybrid flexible electronics
Zhe Shu, Hahn-Schickard Institute of Microanalysis Systems

In this contribution, we introduce a direct molten metal printing technology - StarJet technology for printing conductive traces, interconnecting inkjet-printed functionalities, and direct solder and bond silicon-based electronic components (e.g. microcontrollers, sensors). StarJet printheads can be used to print molten metals such as solder and aluminum with reservoir temperature up to 950 °C. Thanks to the pneumatic actuation, no thermally limited piezoelectric actuators are required, which are widely used i.e. for inkjet printheads. A constant rinse gas flow provides an inert gas shielding of printed molten metal. Consequently, StarJet technology provides a novel one-step, non-contact metallization from molten metal.

2.5 Using heat-mask in thermoforming machine for component positioning in thermoformed electronics
Behnam Madadnia, IMEC

For several years, 3D-shaped electronics have been rising, with many uses in home appliances, automotive, and the manufacturing industry. One of the biggest challenges in the fabrication of 3D shaped electronics, which are made by thermoforming, is repeatable and accurate 3D spatial component positioning. Typically there is little or no control over the final position of the component on a 3D thermoformed surface. This paper aims to address this issue and presents a reliable approach for guiding the electronic components to the desired place during thermoforming.

SESSION 3: BIOELECTRONICS I

Session Chair: Prof George Malliaras, University of Cambridge

3.1 Functional materials and devices for emerging bioelectronic interfaces
Prof Luisa Petti, Free University of Bozen-Bolzano (Invited)

Thanks to the extraordinary advances recently experienced in the field of materials, manufacturing processes, device designs and architectures, and system integration, it is now possible to realize electronic devices featuring not only standard electrical properties, but also more unique and novel capabilities, such as flexibility, stretchability, twistability, or biocompatibility and biodegradability. Here, our most recent work on printed (and bio-printed) materials and devices for emerging bioelectronic interfaces – spanning from wearable devices to plant bio-hybrids - will be discussed.

3.2 Printable and wearable electronics enabled by two-dimensional materials
Prof Elisabetta Dimaggio, Università di Pisa (Invited)

In this talk I will address the main open issues in printable and wearable electronic applications, while showing that two-dimensional materials (2DMs) can represent the enabling technology due to their excellent mechanical and electrical properties they have demonstrated. The goal is to obtain in the mid-short term the same functionalities and performance of electronic systems fabricated on rigid substrates, but on flexible ones. In the presentation, I will show recent results on this topic, while addressing the main issues and potentials this technological option is currently facing, and providing performance projections through a purposely devised theoretical approach.

3.3 Low noise organic based devices to access faint signals produced by populations of living cells: applications in anticancer drug screening platforms
Henrique Leonel, University of Coimbra

In contrast with the extensive research on devices that explore neuron-neuron communication, the electronic technology to measure long-range communication in non-electrogenic (or non-nervous) cells is still in its infancy. In this contribution, we present and discuss the sensing electrode specifications, namely the geometry, the design as well as the type of electroactive materials that can minimize the intrinsic electrical noise in the millihertz frequency range.

3.4 A wearable cardiac activity mapping system
Ruben Ruiz-Mateos Serrano, University of Cambridge

Cardiovascular diseases (CVD) account for approximately 32% of global mortality, making it the undisputed leading cause of death worldwide. The early diagnosis of CVD is essential to reduce the impact on global healthcare. Body surface potential mapping (BSPM) has been proposed as an alternative technique to achieve non-invasive and continuous cardiac electrical activity measurements with high spatial resolution by measuring surface ECG signals across the entire thorax. A newly developed method for fabricating electrophysiology arrays using mm-size, low-impedance conducting polymer electrodes is expanded from its original high-density electromyography (EMG) application and employed to achieve unprecedented spatial resolution on BSPM.

3.5 Cabbage and blackberry for better vision: use of natural dyes for photosensitive organic semiconductor devices towards artificial retina
Aimee Sweeney, University of Surrey

Vision loss due to the degeneration of photoreceptor cells in the retina occurs in millions of people every year worldwide through diseases such as retinitis pigmentosa and age-related macular degeneration. We demonstrate that natural dyes extracted from various berries and vegetables, such as raspberry and cabbage, are excellent chromophore candidates for colour-specific organic devices with similar absorption spectra to those produced by human rod and cone cells.

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4.1 Photovoltaics reshaped – unlimited design opportunities enabled by printed organic solar cells

Dr Sebastian Meier, ASCA

The ability to translate thin photoactive films into any shape and their integration into any kind of surface is a game changer and creates a paradigm shift in the energy sector as energy can now be generated and consumed directly at the point of use. The talk will focus on ASCA's pioneering work in the commercialization of OPV and the numerous projects realized within the latest years that showcase the market readiness of the technology.

Sebastian Meier is Vice President Corporate Development & Technology at ASCA. He has many years of industrial experience in the field of organic light-emitting devices and photovoltaics. He graduated with a Diploma in Materials Science, and as a Doctor of Philosophy in Engineering from Friedrich-Alexander-University of Erlangen-Nuremberg/Germany.

SESSION 5: NOVEL DEVICES & SYSTEMS I

Session Chair: Cathy Curling, Curling Consulting

5.1 The next generation of environmentally friendly supercapacitors for energy storage
Dr Steffen Thrane Vindt, InnoCell (Invited)

In our pending transition towards renewable energy, energy storage is perhaps the biggest obstacle. What is common for most renewable energy sources are an intermittent energy production, which means that the need for energy storage is rapidly increasing to ensure reliable energy systems. The goal of this transition is to ensure that our future energy is sustainable, but we should not forget that our energy storage technology should be sustainable as well. To make this happen, new materials technologies are essential. In this talk, I will present some of the new developments in the materials technology of supercapacitors; one of the dominating technologies for the high-power energy storage segment.

5.2 Novel nanomanufacturing processes for next-generation devices
Prof Harish Bhaskaran, University of Oxford (Invited)

Whilst manufacturing in electronics is largely dominated by integrated circuit-led high-throughput, high resolution lithography, the need for more flexible, lower cost, medium throughout nanomanufacturing has grown. This is particularly in relation to higher value future devices that may use novel, highly functional, non-CMOS compatible nanomaterials for new devices and/or for processes that spew less waste. In this talk, I will touch on some of my group's research in this novel area of research, done as part of EPSRC's WAFT programme as well as through EPSRC funded Fellowships in Manufacturing over the last decade.

5.3 Ultra-thin and light active liquid crystal cells for optics applications
Michael Banach, FlexEnable

Liquid Crystal Optics (LC cells) are devices that actively manipulate the path of light passing through them via a variety of mechanisms. Depending on the selection of LC material and architecture, LC Optics can steer, modulate and even focus light passing through the cell, either globally or locally. LC cells have been made on glass for years, but for many applications glass cannot be used because of its weight, thickness or lack of conformability. Thinner and lighter LC cells are needed, where they can be 3D formed or stacked together to create powerful and combined functions. In this presentation, the structure and unique benefits of flexible active LC cells will be explained and some of their key applications discussed.

5.4 Printed and flexible high-performance thermoelectrics for wearables and other low-scale energy harvesting applications
Francisco Molina-Lopez, KU Leuven

Owing to the recent swift development of new flexible/stretchable electronic materials, wearable electronics are increasingly packing more functionalities. The increase in functionality comes along a stronger need for power. In our research group, we are working towards the development of high performance (in)organic TE materials which can be directly printed on flexible substrates. The process simplification introduced by printing techniques can potentially reduce the material waste and cost of thermoelectric generators.

5.5 Study of ZnO liquid-gated transistors using honey as electrolytic dielectric layer
Douglas Henrique Vieira, São Paulo State University

Liquid-gate transistors (LGTs) have attracted a lot of attention due to their low cost of fabrication, and the possibility of use in applications such as biosensors connected with Internet of Things (IoT). Honey, naturally produced by bees, is a supersaturated liquid that exhibits promising electrical characteristics for its use as electrolyte in LGTs. Here, we studied the performance of a honey-gated transistor (HGT), using ZnO as active layer, ITO as source-drain interdigitated electrodes, and graphite as top gate, highlighting their main electrical characteristics in terms of the transistor's figures of merit (FOMs) and its potential in applications.

SESSION 6: BIOELECTRONICS II

Session Chair: Dr Simon Johnson, CPI

6.1 Neuromimicking organic electronics: materials and challenges
Dr Simone Fabiano, Linköping University (Invited)

In the future, brain-computer interfaces will require electronic circuits that can process signals in a localized and highly individualized manner within the nervous system and other living tissue. However, traditional neuromorphic implementations based on silicon have limitations in bio-integration due to poor biocompatibility, circuit complexity, and low energy efficiency. Organic mixed ionic-electronic conductors (OMIECs) are an emerging technology that has the potential to overcome these limitations. In this talk, we will explore the use of OMIECs to develop organic electrochemical neurons and synapses with ion-modulated spiking capabilities.

6.2 Emerging trends in aerosol jet based printing: from printed electronics to bioelectronicsEmerging trends in aerosol jet based printing: from printed electronics to bioelectronics
Eleonora Ferraris, KU Leuven

Aerosol jet printing (AJP) is a direct printing technique introduced by Optomec, mainly for printed electronics (PE) applications on free form substrates. In this contribution, recent trends in aerosol jet printing are reviewed. The focus is on 3D microstructuring, bioelectrical applications along with biocompatibility study of commercial inks, and high-resolution collagen AJ printing. Material, methods and results are reported and the potential of AJP as enabling technology for the development of integrated in vitro devices for diagnostic and personalised treatments (lab-on-chip, tissue-on-chip, in vitro cell culture, etc.) is critically discussed.

6.3 Printed organic electronic devices for plant health monitoring and precision agriculture
Elliot Strand, University of Colorado

Low-cost, flexible, and lightweight electronic biosensors offer an exciting pathway to future products for environmental and plant health monitoring. Organic electrochemical transistors (OECTs) are particularly favorable sensing platforms due to their high sensitivity, low power requirements, and use of soft, biocompatible materials. This presentation will describe the development of fully printed, flexible OECTs that can accurately detect a suite of analytes (e.g., nutrients, pH, temperature) that are relevant to plant health.

6.4 A novel approach for bioelectronic devices featuring PEDOT:PSS 3D microstructures
Valeria Criscuolo, RWTH Aachen University

In bioelectronic device applications, the cell-device interface plays a crucial role for an effective electrical coupling between the cell and the device. The conductive polymer poly (3,4-ethylenedioxythiophene): poly (styrene sulfonate) (PEDOT:PSS) is one of the most used materials in bioelectronics thanks to its properties such as flexibility, transparency, conductivity, biocompatibility, thermal and environmental stability. In this work, a fabrication approach for the realization of PEDOT:PSS 3D structures is proposed, presenting high aspect ratio and that can be also employed to obtain patterns with complex architectures.

6.5 Printed insole for risk posture detection in industrial environment
Luís Miguel Pinheiro Sousa, CeNTI

Despite the trend in automation at industrial sectors, many workers are still exposed to physical workloads that increase the risk of developing musculoskeletal diseases. To lower the risk of such problems significant research has been made in wearable devices for human enhancement either for upper-body or lower-limb. To increase their accuracy and to provide truthful guidelines for posture correction, these devices must be equipped with several sensing mechanisms to evaluate when a corrective action is necessary. In the scope of the Augmented Humanity project PPS1-E, the development of a real-time ergonomic monitoring system, a printed insole able to measure foot plantar pressure was developed by screen-printing.

GALA DINNER

Gala Dinner at the Old Hall, Robinson College, University of Cambridge

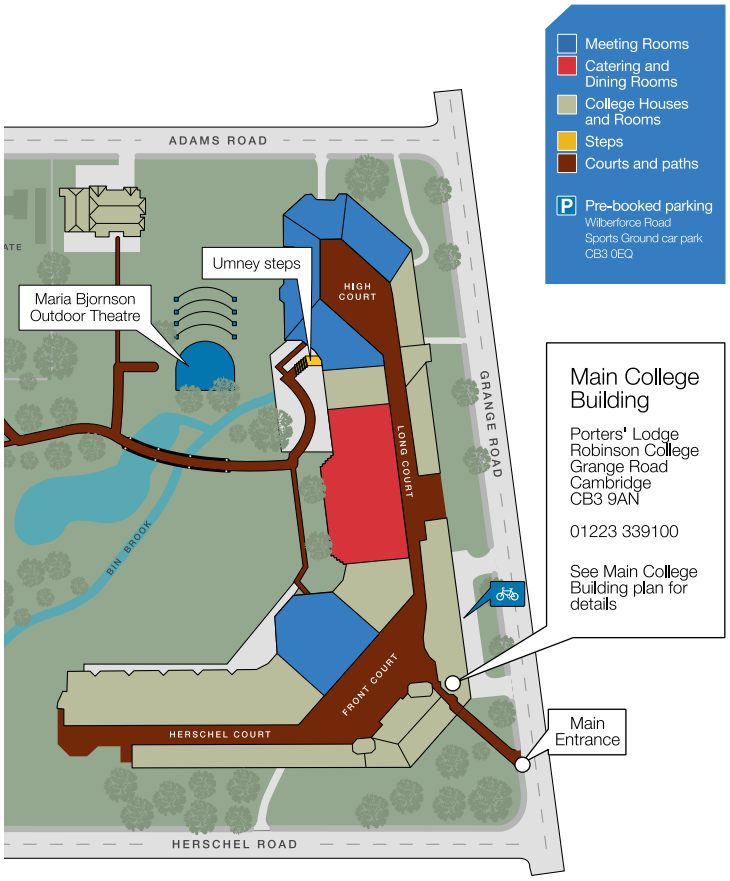
Continue networking and unwind in true Cambridge style at the conference gala dinner - hosted in the Old Hall at Robinson College.

*Please note that this is only available for those who have registered to attend the gala dinner.

We will be providing transport from the conference centre to Robinson College and back. The coach to the gala dinner will be leaving the conference centre at 19:00, so please make sure you are ready 10 minutes before we are due to leave.

We will be leaving the gala dinner at 22:00, returning to the conference centre.

The innoLAE Gala Dinner always receives positive feedback as this dinner gives you an excellent opportunity to indulge in the rich history of Cambridge, enjoying a delicious three course meal and continue to network in a relaxing atmosphere.



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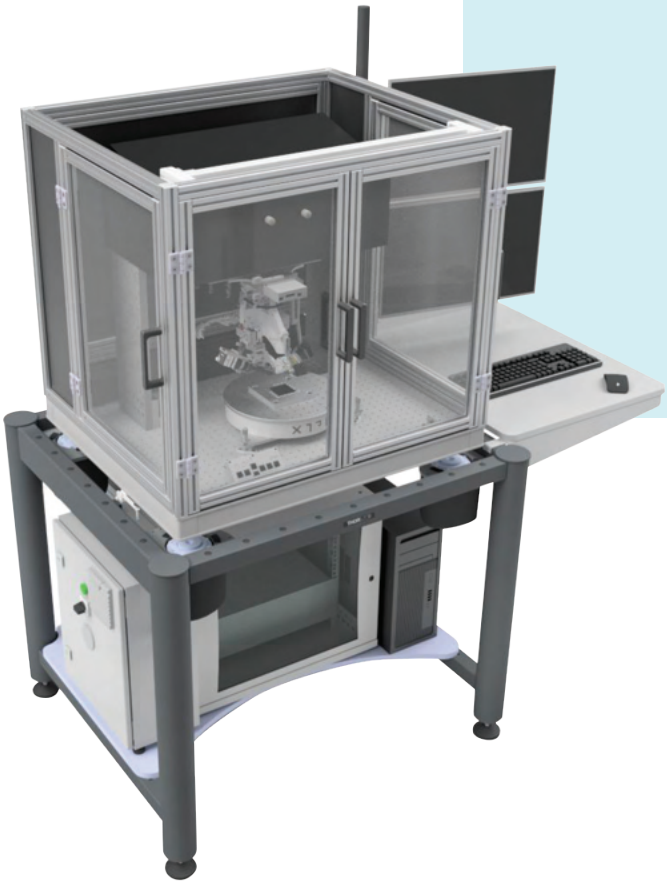

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7.1 Flexible electronics: challenges and opportunities – a materials science view

Prof Natalie Stingelin, Georgia Tech

In recent years, immense efforts in the flexible electronics field have led to unprecedented progress and to devices of ever increasing performance. Despite these advances, new opportunities are sought in order to widen the applications of organic-based technologies and expand their functionalities and features. We discuss here challenges and opportunities, with focus on the use of multicomponent systems for, e.g., increasing the mechanical flexibility and stability of organic electronic products, or introducing other features such as self-encapsulation and faster mixed ion-electron transport. One specific strategy is based on blending polymeric insulators with organic semiconductors; which has led to a desired improvement of the mechanical properties of organic devices, producing in certain scenarios robust and stable architectures. Here we discuss the working principle of semiconductor:insulator blends, examining the different approaches that have recently been reported in literature. We illustrate how organic field-effect transistors (OFET)s and organic solar cells (OPV)s can be fabricated with such systems without detrimental effects on the resulting device characteristics even at high contents of the insulator. Furthermore, we review the how blending can assist in the fabrication of more reliable and versatile organic electrochemical transistors (OECT)s.

Natalie Stingelin is a Full Professor at the Georgia Institute of Technology and Chair of the School of School of Materials Science & Engineering. She hold prior positions at Imperial College London, UK, at Queen Mary University of London, UK; the Philips Research Laboratories in Eindhoven, The Netherlands; the Cavendish Laboratories, University of Cambridge, UK; and the Swiss Federal Institute of Technology (ETH) Zürich, Switzerland. She is the Director of Georgia Tech's Center of Organic Electronics and Photonics, and was elected a 2021 Fellow of the U.S. National Academy of Inventors, a 2019 Fellow of the Materials Research Society; and is a Fellow of the Royal Society of Chemistry since 2012. Her research interests encompass the broad area of functional polymer materials, polymer physics, organic electronics & photonics, and bioelectronics.

SESSION 8: NOVEL DEVICES & SYSTEMS II

Session Chair: Dr Dimitra Georgiadou, University of Southampton

8.1 Towards printed lignin-based batteries
Prof Xavier Crispin, Linköping University (Invited)

The concept of zero-energy device for internet-of-things requires electronics, energy convertor and storage devices. To bring that concept to the internet-of-everything, the materials should also be low-cost, recyclable, safe and environmentally friendly. All the components (electrode and electrolyte) must be printable to ensure low-cost manufacturing. We summarize our recent results focusing on two material concepts for organic batteries: (i) a new class of electrolyte working in the regime of "water-in-polymer salt electrolyte", (ii) producing low-cost lignin electrodes by either combining with conducting polymers or carbon based nanoconductors.

8.2 Zinc ion battery fabricated in a single textile layer
Sheng Yong, University of Southampton

Energy storage devices such as batteries are important in e-textile/wearable electronics that are typically powered by conventional secondary battery packs that are neither flexible nor require special design to be integrated into an e-textile system This talk reports the design fabrication and characterization of a flexible and rechargeable textile zinc ion battery (ZIB) fabricated in a single layer of polyester-cotton wipe.

8.3 Memristive perovskite solar cells towards parallel solar energy harvesting and processing-in-memory computing
Konstantinos Rogdakis, Hellenic Mediterranean University

Organic-Inorganic Halide Perovskites (OIHPs) have attracted vast research interest due to their outstanding semiconductor properties. OIHPs offer merits such as facile solution processing under low temperatures, rendering them suitable for flexible substrates. A single printable material stack fabricated with low manufacturing cost at low temperature that combines efficient solar energy harvesting and memristor operation would constitute a transformational breakthrough. In this study, we demonstrate a perovskite solar cell based on an inverted geometry that harvests energy with an average efficiency of 17% and exhibits stable bipolar resistive switching characteristics.

8.4 Inkjet printed graphene-based diode
Alessandro Grillo, University of Manchester

Graphene is a strong candidate for the next generation of flexible electronic and optoelectronic devices. 2D materials can be easily made into formulations, enabling low cost and scalable technologies, such as inkjet printing, to be used for device fabrication. We will demonstrate printed graphene-silicon Schottky diodes with on/off ratio of about three orders of magnitude in the ±2 vrange with a marked photovoltaic effect when exposed to white light, large-area pixeled photodetectors and compatibility with back-end-of-line fabrication processes and fully printed diodes on flexible substrates.

8.5 A modular flexible photo-rechargeable zinc-ion battery for wearable electronics
Jinxin Bi, University of Surrey

Wearable and flexible electronics have become an attractive research field due to their promising applications. As a crucial component in these smart devices, the energy storage devices should provide a continuous energy supply without frequent recharging or component replacement. We provide a compelling platform for simplifying high-performance flexible battery fabrication processes and also achieve a solar cell with energy storage in a monolithic, all-in-one design approach to enable a self-charging system. The use of inkjet printing as part of the fabrication process enables the production of the photo-rechargeable battery in any shape and size, making the devices easily scalable and compatible with roll-to-roll industrial processes and offering a facile solution towards autonomous wearable electronics.

SESSION 9: HIGH PERFORMANCE MATERIALS I

Session Chair: Prof Cinzia Casiraghi, University of Manchester

9.1 Organic semiconductors for application in near-IR photodetectors
Prof Thuc-Quyen Nguyen, University of California (Invited)

Organic semiconductors (OSCs) are a class of carbon-based materials comprising of alternate single and double bonds (conjugated pi-bonds). They can be synthesized to have band gaps from the UV to the near infrared regions of the electromagnetic spectrum. OSCs have been implement in commercial products such as displays and lightings and have potential applications in transistors, solar cells, photodetectors, thermoelectrics, ratchets, sensors, neuromorphic computing, and bioelectronics. In this talk, I will discuss the development of OSCs for applications in near IR photodetectors.

9.2 Polyoxometalate-based nanoscale electronic devices
Emilie Gerouville, University of Southampton

Polyoxometalates (POMs) are a class of inorganic, ionic (usually anionic), nanometer-sized metal oxide molecules. They have many attractive properties, such as chemical stability in a wide temperature range, ease of processing using water-based solvents, structural diversity through facile functionalisation, and rich redox properties, which render them particularly attractive to be used in memory devices. More specifically, because POMs can accept or donate electrons in a reversible manner without much structural change, they support controllable change in the junction resistance when placed in a two-terminal device structure. Herein we demonstrate resistive switching behaviour at low voltages for $H_3PMo_{12}O_{40}$ -based Al/POM/Au coplanar devices.

9.3 Comprehensive contactless electrical and optical characterization of perovskite solar cell structures
Bálint Fodor, Semilab Semiconductor Physics Laboratory

The optical and electrical characterization of perovskite type solar cells is of vital importance to understand the underlying phenomena influencing the efficiency and long-term stability of such solar devices. We present a method combining spectroscopic ellipsometric (SE), Eddy-current test (Eddy) and microwave photoconductive response (μPCR) measurements of single thin layered (perovskite on glass) and multilayered (perovskite/NiO/FTO on glass) type perovskite samples. Combining the SE, Eddy and μPCR metrologies supplements each other to give a wide range optical and electrical characterization of perovskite type samples possible.

9.4 High mobility solution-processed organic semiconducting blends for high speed and low voltage electronics
Tommaso Losi, Istituto Italiano di Tecnologia

IoT (Internet of Things) is thought to be one possible key-aspect for a future technological revolution, in which specific functionality are cost-effectively integrated in daily objects, creating an extended network of interacting devices via wireless communication. In this work it is demonstrated the successful integration of a solution-processable poly-crystalline high mobility organic semiconducting blend C8-BTBT: C16-IDT-BT in downscaled organic field-effect transistors characterized by low channel length and overlap capacitances, operating at 5V.

9.5 Degradation in small-molecule transistors: understanding the role of trap states at the metal-semiconductor interface
Haoxin Gong, University of Cambridge

Here, we report the systematic study on a series of OFETs comprising p-type asymmetric [1]benzothieno[3,2-b]benzothiophene derivative, Ph-BTBT-C10, to uncover the impact of OSC/electrode interfaces in the device degradation induced by gate bias.

SESSION 10: PANEL DISCUSSION

Panel Discussion: Topic to be confirmed

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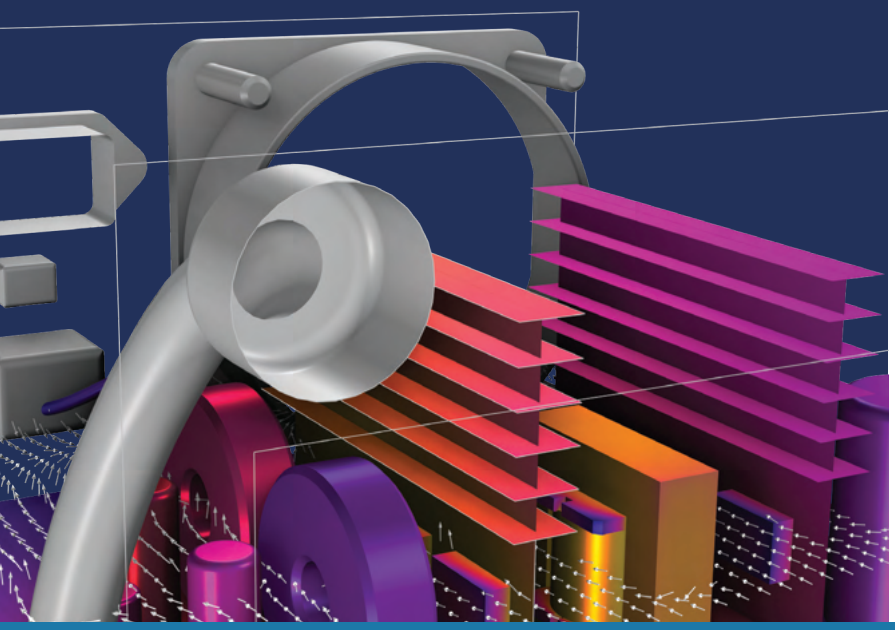

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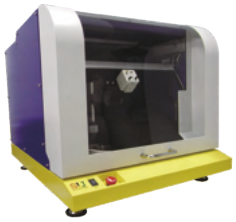

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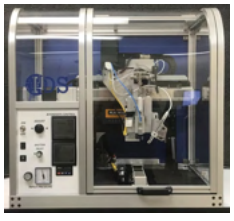

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SESSION 11: HIGH PERFORMANCE MATERIALS II AND NOVEL DEVICES & SYSTEMS III

Session Chair: Dr Natasha Conway, Paragraf

11.1 CNT hybrid transparent conductive films; enabling a safer, more connected world
Tom Eldridge, CHASM (Invited)

5G networks are poised to address increasing demand for data consumption and more reliable coverage, but the next generation wireless technology inherently brings challenges of shorter broadcast distances and network dead zones. CHASM's CNT Hybrid technology is providing transparent antenna and transparent heater solutions to solve these trends and challenges for a safer and more connected world.

11.2 Opportunities for thin film and flexible photovoltaics
Dr Matthew Dyson, IDTechEx

Thin film photovoltaics (PV) have garnered interest in recent years due to its versatility. Featuring properties such as light weight, flexibility, and semi-transparency, thin film PV can target many applications to which conventional silicon PV is not well suited due to its weight, size, and rigidity. Thin film alternatives such as organics, perovskites, among others, present numerous advantages to overcome these limitations and cater to emerging applications. This talk will discuss the latest developments and opportunities in thin film photovoltaics – a market that is expected to grow to $6.1 billion by 2033.

11.3 On the largest possible mobility of molecular semiconductors and how to achieve it
Tahereh Nematiaram, University of Liverpool

Transparent conducting materials are an essential component of optoelectronic devices. It is proven difficult, however, to develop high-performance materials that combine the often-incompatible properties of transparency and conductivity, especially for p-type-doped materials. In a recent work,[1] we have employed a large set of molecular semiconductors extracted from the Cambridge Structural Database to evaluate the likelihood of transparent conducting material technology based on p-type-doped molecular crystals.

11.4 Photosystem I: from ensemble junctions to functional devices
Xinkai Qiu, University of Cambridge

Emerging challenges in microelectronics are driving research into the simple synthesis of materials that are amenable for rapid fabrication strategies. Photosystem I (PSI) is a functional nano-device that is produced by and readily isolated from photosynthetic organisms. Here, we introduced the self-assemblies of fullerene (C60) derivatives on to PSI junctions to i) mitigate the series resistance created by the tunnelling barrier between the PSI and the electrode, and ii) amplify the rectification on those junctions for practical application, e.g., logic circuits. By controlling the self-assembly process, all-protein logic circuits can be printed with yields approaching 90%, and operate at a speed of at least 3 kHz.

11.5 Smart IoT electronic paper for interactive security applications
Guilherme Mendes Ferreira, Nova University Lisbon

Nowadays economies and societies are experiencing fast digitalization., However, this comes at a cost, namely electronic waste (e-waste), which is not easily recyclable. For instance, paper which is one of the most available and sustainable raw materials is currently being exploited for flexible smart electronics due to its low-cost, lightweight, flexibility, and recycling properties. In this context, paper-based self-powered devices are the need of the hour for future and next-generation electronics. Herein we have presented an ultrathin (~0.18mm) self-powered paper-based prototype as a touch-interactive tag for the next-generation Internet of Things (IoT), enabling smart security applications.

SESSION 12: APPLICATIONS AND SUSTAINABILITY & ENERGY EFFICIENCY

Session Chair: Prof Krishna Persaud, University of Manchester

12.1 Printed organic electronics from biomass
Prof Clara Santato, Polytechnique Montréal (Invited)

We will discuss together the opportunities and the challenges associated to the use of biosourced materials for application in large area electronics. If abundance, avoidance of critical chemical elements, biocompatibility and biodegradability at the device end-of-life are undoubtedly opportunities, biosourced materials feature complex chemical compositions (since they often include salts present during their biosynthesis) and a wide range of supramolecular aggregation modes.

12.2 OPD roadmap – how printed electronic creates innovative imaging applications and products
Jerome Joimel, Isorg (Invited)

In this presentation, we will cover the different technical challenges we have to overcome to develop the different applications from proof of concept to commercial products. We will describe our development activity of large area Fingerprint on Display (FoD) and introduce our strategy to integrate OPD and OLED on the same TFT backplane (in-cell structure). We will present how Isorg achieves mobile flat biometric module based on OPD Technology for fingerprint and vein imaging. Finally, we will describe the progress in OPD on CMOS substrate to build Short-wave Infrared (SWIR) camera enabling new imaging applications integrated behind display.

12.3 Printed sensors on thermoformed eco-sustainable foam for automotive application
Joana Pronto, CeNTI

Advanced lightweighting materials are becoming a major trend, reaching many industrial sectors such as automotive. Over the last few years, the quest for lighter vehicles led to extensive R&D in material sciences and process technologies. Reducing vehicle weight and aerodynamic resistance, using lighter materials, creates a simple structure and innovative design, associated with a good cost-effectiveness ratio. InnovThermoforming project focus on developing a new production process through a combination of innovation and production technologies, namely printed electronics, and thermoforming, using eco-sustainable foams. The final products will be used in electric, hybrid, and intelligent cars, resulting in added-value products with new features.

12.4 Towards flexible and sustainable energy storage: molecular-scale understanding of nanocellulose/graphite battery electrodes
Evangelia Founta, University of Southampton

The recent proliferation of Internet of Things, for example in healthcare and commercially available wearable devices, urges the design of safer and more sustainable energy storage solutions. Battery electrodes based on organic materials, have emerged as a promising way towards fulfilling prevalent ecological and resilience requisites to power the electronics of the future, due to their abundance and versatility. Herein, we demonstrate the fabrication of hybrid nanocellulose/graphite electrodes and we present a rigorous study of the underlying, molecular-level, ion transport mechanisms.

12.5 Advanced light-weight battery systems optimized for fast charging, safety, and second-life applications (ALBATROSS Project)
Tom Askew, CPI

Electric vehicles (EV) are playing a key role due to their zero emission and efficient energy usage. They are equipped with a large number of battery cells which need an effective battery management system (BMS) while they are providing the required power ensuring battery charging, discharge rate, state of charge, state of health and cell voltage, temperature and current are operating in optimal condition. In this talk, we summarise three key elements of CPI's contribution to the development of novel sensing and control capability in partnership with PST to enable precise control of individual battery cells.

Throughout the conference our Programme Committee of industrial and academic experts will be reviewing the presentations and posters and we will be awarding a prize for best speaker and a prize for best poster.

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SESSION 13: POSTERS

13.1 Manufacturing

13.1.1 **Evangelos Moutoulas, University of Southampton**
Fast response on-chip temperature sensors

13.1.2 **Jongsu Lee, Sunchon National University**
A measurement method to quantify the shape of functional pattern and its quality

13.1.3 **Chung-Hwan Kim, Chungnam National University**
Development of evaluation system for printability of printed electronics patterns

13.2 High Performance Materials

13.2.1 **Elliot Goldberg, University of Cambridge**
The effects of strain on the properties of rubrene single crystals

13.2.2 **Chris Madden, University of Southampton**
Morphology in photoelectric perovskite memory devices

13.2.3 **William Wood, University of Cambridge**
Revealing contributions to conduction from ordered and disordered transport in highly doped conjugated polymers through analysis of temperature-dependent Hall measurements

13.2.4 **Tahereh Nematiaram, University of Liverpool**
Feasibility of p-doped molecular crystals as transparent conductive electrodes via virtual screening

13.3 Novel Devices & Systems

13.3.1 **Andras Bojtor, Semilab Semiconductor Physics Laboratory**
Light biased Hall measurements of novel thin-film semiconductor layers using parallel dipole line technique

13.3.2 **Niloufar Raeis-Hosseini, Cranfield University**
Flexible and sustainable memristive system for novel memory applications

13.3.3 **Navid Hussain, Karlsruhe Institute of Technology**
Direct writing of liquid metals for printed electronics

13.3.4 **Emma Spooner, University of Manchester**
Air-knife assisted spray coating of organic solar cells

13.4 Bioelectronics

13.4.1 **Dr Maxim Shkunov, University of Surrey**
Seeing beyond visible spectrum: conjugated molecules pixelated devices for visual prosthesis

13.5 Applications & Energy Efficiency

13.5.1 **Alexandre Fonseca, CeNTI - Centre for Nanotechnology and Smart Materials**
Printed sensors to monitor critical parameters in smart buildings

13.5.2 **Luciano Rietter, PIEP - Innovation in Polymer Engineering**
3D printed prototype with selective metallisation as a validation approach in product development of the automotive sector