2018FLEX Europe - Be Flexible

Moore for Medical

R. Dekker
Research
Philips Research, Microsystems, Eindhoven, Netherlands

Abstract
Gradually electronic devices are finding their way towards the human body. Body patches are being designed that provide continuous monitoring. Intelligent catheters assist during minimal invasive surgery, and tiny implants stimulate nerves with the aim to replace traditional medicines. Despite their apparent potential progress is however slow, certainly compared to the non-medical electronic industry. One of the reasons is the lack of scalable open technology platforms. In this presentation a selection of promising emerging in- and on-body electronic will be reviewed. Large European consortia supported by ECSEL and PENTA, are developing and implementing not only the essential open technology platforms, but also the necessary manufacturing infrastructure. The recently established Health.E lighthouse will further promote the open technology platform concept for medical devices to realize the “Moore for Medical” vision.

Biography
Ronald Dekker received his MSc in Electrical Engineering from the Technical University of Eindhoven and his PhD from the Technical University of Delft. He joined Philips Research in 1988 where he worked on the development of RF technologies for mobile communication. Since 2000 his focus shifted to the integration of complex electronic sensor functionality on the

tip of the smallest minimal invasive instruments such as catheters and guide-wires. In 2007 he was appointed part time professor at the Technical University of Delft with a focus on minimally

invasive devices and Organ-on-Chip. He published in leading Journals and conferences and holds in excess of 60 patents.

Multicomponent Assembly on Flexible Material in Reel-to-Reel Process

G. Niklas
Business Development
Mühlbauer GmbH & Co. KG, Business
Development, Roding, Germany

Abstract
Mühlbauer introduces a complete solution for the Reel-to-Reel production of multicomponent products on flexible substrate in the area of LED, active RFID, sensor labels etc. The solution consists of systems that are capable of high-volume manufacturing processes. The upstream production process comprises the production of a flexible circuit, whereas the subsequent process attaches different components to the substrate which is the electronic portion of the final product. The flexible substrate production technology is a completely new development. Starting with the attachment of LEDs, the process was continuously extended to a multicomponent process.
Further progress was achieved in the component attach and curing technologies according to different end
applications and the substrate material selection between aluminum and copper for flexible substrate production in relation to their respective areas of use. For example, with Mühlbauer’s Reel-to-Reel RFID Antenna Production machine ACS 20000, the low cost materials PET and aluminum can easily be transformed into aluminum antennas on PET.

After the launch of the flexible LED production line TAL 15000_LED in 2015, Mühlbauer further developed the assembly process towards a universal system: the Multicomponent Line. Besides the standard jetting of
adhesives, the dispensing of ICPs and solder paste is now also possible. As a result, new curing requirements like the integration of an inline reflow oven, were developed. Furthermore, the component attachment has been simplified and enlarged so that now, a high variety of components can be attached: SMD, sensors, capacitors or even Flip Chips and other electrical components, which meet any future trend in flexible electronics.

Biography
Gerald Niklas is active in the Business Development for Semiconductor Related Products at Mühlbauer GmbH & Co. KG. Mr. Niklas has been with the company for more than thirty years and has been deeply involved in the development & implementation of products in the areas RFID, Flexible Solar, as well as Multicomponent Applications like LED-based Flex production solutions. With his international experience & engineering background, he built a worldwide network of industry related companies, and is globally active for the Mühlbauer Group.

Towards R2R Manufacture of Flexible Hybrid Electronics – Technology Roadmap at Fraunhofer EMFT

C. Landesberger
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Abstract

Sensors and electronics need the functionality of micro-controller ICs for data collection, data processing, digitization and data transfer to a host system. Therefore, any flexible electronic system will require a technical solution for embedding and interconnection of ultra-thin microprocessors in a bendable film based package.

The presentation will first explain the technological requirements for integration of thin IC on or in flexible film substrates. Key elements here are the manufacture of robust thin semiconductor devices, the preparation of very fine line metal patterns and adequate chip bonding and interconnection techniques. Latter topics can be realized in two different ways for chip orientation: face-down (flip chip) or face-up die bonding. In the second case, interconnects must be aligned with respect to I/0 contact pads of ICs. As the distance between two contact pads may be in the range of just 20 µm to 40 µm the resulting alignment accuracy of dies with respect to the interconnect lines has to be less than 5 µm. When using flexible film substrates as integration platform and roll-to-roll (R2R) equipment for manufacture this requirement represents a challenging task due to possible shrinkage or expansion of the film roll.

Thin chip foil packages with embedded microcontroller ICs were demonstrated successfully by Fraunhofer EMFT using single sheet film substrates. In order to achieve the next major step towards R2R manufacture we are currently setting-up a laser direct imaging (LDI) system for R2R lithographic patterning of interconnects and wiring schemes. Key advantage of such laser imaging system is its capability to correct the UV exposure process locally and, if necessary, individually at any chip position. Such “adaptive lithographic patterning” is supposed to bridge the gap between alignment requirements and geometric distortions in the web substrate. First results will be shown at the conference for the first time.

Biography

Christof Landesberger received the diploma degree in physics from Ludwig Maximilian University in Munich. He joined Fraunhofer Institute in Munich in 1990 and is now heading the research group “Thin Silicon” within the department “Flexible Systems” at Fraunhofer EMFT. He has been working in the field of ultra-thin silicon since more than 15 years and prepared more than 20 patent applications in the field of handling and processing techniques for ultra-thin semiconductors. His current research topics are focusing on packaging technologies for ultra-thin semiconductor devices, including self-assembly and flexible chip foil packages.

Light-assisted integration of electronic components

F. Chiappini
Scientist
Holst Centre - TNO, Hybrid printed electronics,
Eindhoven, Netherlands

Abstract

Following a current consumer trend, the demand for high-performance and highly-integrated multifunctional flexible systems has significantly increased in recent years. This has generated the need to develop hybrid systems in which printed circuitry is combined with silicon-based integrated circuits or surface mounted device (SMD) components. Flip-chip (FC) assembly of (opto)electronic components is a key technology in system packaging and integration because of the advantages it offers over the most commonly used wire bonding technique. With decreasing chip size, the density of interconnects increases, which demands advanced high-resolution interconnection technologies. Furthermore, with large-area flexible electronics on low cost polymer foils gaining significant attention lately, the compatibility of the interconnection technology with the carrier substrate has become more significant than ever.
At Holst Centre, we have developed two complementary technologies that enable fast and high-resolution integration of FC assembly components onto flexible foils using light.
The interconnect material (lead-free solder pastes as well as electrically conductive adhesives) is deposited onto flexible printed circuitries at unprecedented high speed using a laser-assisted digital deposition technology. In this talk, we will present the deposition of an array of 10 000 dots of conductive adhesive (< 100 µm in diameter) within less than a second.
The interconnect process is then completed by soldering the components to the substrate using a novel roll-to-roll compatible soldering technology (photonic soldering), which exploits intense pulsed light generated by conventional flash lamps. In contrast to convection reflow soldering (the industry standard technology), photonic soldering is fully compatible with the integration of components on low-cost flexible substrates such as PET, while reducing the soldering processing time down to few seconds.

Biography

Francesca Chiappini has obtained her PhD from the Radboud University (Nijmegen, The Netherlands) doing research on the electronic properties of graphene.
She then joined TNO (Delft, The Netherlands) working in several projects addressing some of the challenges faced by the semiconductor manufactory industry. In particular, she worked on the topics of contamination control and subsurface AFM imaging.
Currently, she works as scientist at Holst Centre (Eindhoven, The Netherlands) in the hybrid printed electronics domain. She focusses her research activities on novel interconnect technologies for flexible systems.

Laser-Direct-Structuring of Flexible Textile Circuits

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Project manager
Deutsche Institute für Textil- und Faserforschung
DITF, Biomedical Engineering, E-Textiles,
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DEUTSCHE INSTITUTE FÜR
TEXTIL+FASERFORSCHUNG

Abstract
Textile conductive substrates are drapeable, highly flexible, and more insensitive to reversed bending fatigue compared to conventional rigid or flexible printed circuit boards. Despite this the surface mounting of microelectronic devices is not solved retaining the textile properties. Textile Circuits using conductive yarns are limited by textile patterning, printing of conductive inks often does not meet mechanical properties. Using LPKF-Laser Direct Structuring Process (LPKF-LDS) user defined circuits can be structured on the surface of special polymers, usually on injection Moulded Interconnect Devices (MID). Here textile fabrics made from LDS-polymers, the following metallization with the LDS-process, and the mounting of SMD was studied. Integrated Circuits on textile sheets preserving textile properties have been manufactured with LDS technology. For this purpose multifilament yarns have been produced by melt spinning of LDS modified polymers. These yarns have been processed to woven textile bands. These could be surface activated by laser. The activated areas could be copper plated chemically. These conductive circuits can be mounted with e.g. with SMD by soldering. In this study we could show that LDS-yarns can be produced with a special spinning process which can be processed with textile technologies. The LPKF-LDS-process can be applied to the fabric forming conductive circuit structures. The solderability and functionality of electronic parts on LDS-textiles was shown. The textile properties could be retained. The application as flexible circuit especially for the design of interfaces between hard and soft substrates shall be explored in future.
Financial support (Laserstrukturierte textile Schaltungsträger) from the BMBF, grant number 16SV5064, is gratefully acknowledged.

Biography
Degree in Mechanical Engineering with focus on precision engineering and biomedical engineering at the University of Stuttgart.
Since 1994 research assistant and project manager at DITF in the research group for biomedical engineering with focus on textile implants, micro-injection moulding of bioresorbable polymers.
Since 2000 additional in "Smart Textiles", textile and textile-integrated sensors for the monitoring of physiological parameters e.g. in Sensory Baby Vests, Ambient Assited Living and Sensory Protective Clothing.

Polyester Film Substrates for Flexible and Formable Electronics

T. Gough
Business Development Manager
DuPont Teijin Films UK Ltd, Marketing, Redcar,
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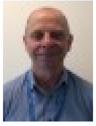
Abstract
Developments in flexible electronics technologies in application areas such as OLED displays, OPV modules, In-Mould-Structural-Electronics, HMI (Human Machine Interface) and sensors, have presented challenges to device manufacturers relating to the properties of flexible substrates. To improve yield and efficiency there is a need for materials that exhibit excellent dimensional stability and clean defect-free surfaces, and in some applications a requirement for additional functionality such as UV stability and Flame Retardancy.
Proposed solutions to these issues include the use of novel co-extrusion techniques, optical modification of surfaces, and the incorporation of non-halogen flame retardant materials into a polymer matrix.
Increasing interest and activity in flexible hybrid systems, foldable displays, and wearable devices, will require further modifications to substrate properties, and drive the development of flexible materials with new diverse properties and specifications.

This presentation will review the latest developments in polyester film processes and technology, including an update on substrates designed for ultra-high barrier use in Displays and OPV applications, and thermoformable films for use in In-Mould-Structural-Electronics.

Biography
Thane is a Business Development Manager in DuPont Teijin Films. He has worked in the polyester films market for nearly 40 years, in a range of roles including R&D, Technical Support,and New Product Development in Packaging Films. He is now responsible for the development of polyester substrates that meet the needs of emerging applications in printed and flexible electronics.

Wireless Embedded Circuits for Intelligent Composites



S. Johnson
Electronics Integration Manager
Centre for Process Innovation, Sedgefield, United Kingdom

Abstract

In this paper we present the results of a study into the successful development of wireless flexible sensor circuits for embedding into carbon fibre composite materials.
There is significant interest in many industrial sectors in the use of ultra-thin and flexible sensor circuits for structural health monitoring as well as process and environmental monitoring. The challenges of this requirement include (inter alia) the provision of power to the embedded circuits, the accessing of sensor measurements and the impact of the sensors on the structural integrity of the composite.
Development work at the Centre for Process Innovation and the National Composites Centre in the UK has created a number of hybrid flexible circuits which utilise a printed strain gauge and COTS solid state components to monitor strain within a carbon fibre composite. The circuits developed use inductive power transfer combined with RF communications to provide measurement of strain and this could be extended to include other structural parameters such as pressure and temperature. Demonstrator circuits have been assembled into carbon fibre composites and power and data transfer functionality have been successfully demonstrated. The results of the testing of these assemblies will be presented.
Mechanical stress testing of the assembled circuits has been performed and the results show that the effect of the embedded circuit is measureable but this can be mitigated by careful selection of the approach to integration.
This work has shown that the embedding of wireless sensor circuits within carbon fibre composites is possible providing embedded sensor capability for a wide range of applications.

Biography

Simon studied Physics at undergraduate level, a Master of Engineering in IC Design at Durham and a PhD in IC Failure Mechanisms. He has worked as an IC Design Engineer and spent over 20 years as an academic at Durham University researching various aspects of IC design (including test and reliability, neural-electronic interfacing, self-reconfiguring processors) while teaching electronic devices and circuits. He setup and ran a technology start-up for 7 years which developed and sold an educational audio system for young children, and has worked in electronics instrumentation for radiation detection in industry before joining the Centre for Process Innovation in the UK. He runs an experienced team of electronics and software engineers who work on application for printable electronics at CPI.

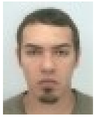
Printing high aspect ratio narrow silver lines using nanoparticles

Z. Zhang
Senior Research Officer
National Research Council Canada, Advanced Electronic and Photonic Research Center, Ottawa, Canada

Abstract
In printable electronic device, narrow metal lines with low electrical resistance are essential. Commercial gravure, flexography or inkjet systems on the market can produce 30-100 µm wide lines by properly choosing the ink and substrate, this feature size is still about one order of magnitude larger than what is required in many electronic device applications. Other R&D printing technologies like high throughput gravure, reverse-offset printing, and electrohydrodynamic jet printing can achieve a linewidth of 1-5 µm at the expense of line thickness, which is normally characterized by a very low thickness-to-width aspect ratio, often far less than 0.05. Currently, it is very challenging to print narrow metal lines with high thickness-to-width aspect ratio and thus low resistance. In this work, we report a method of obtaining 4.6 µm wide printed silver lines with an elliptical cross-section and an aspect ratio of 0.7. The silver lines were obtained by jetting a silver nanoparticle-based ink onto an SU-8-coated PET substrate to form well-defined silver lines, and then heating the lines to transform them into high aspect ratio narrow lines through ink dewetting and receding. The simultaneous dissolution and redistribution of SU-8 by the ink results in a concave structure, which prevents the lines from bulging and allows the lines to sink into the SU-8 film. The sheet resistance of the obtained 4.6 µm lines was measured to be 0.05 ohm/□, and using special pattern designs, the method can also be used to get 0.5 µm wide silver lines, with an aspect ratio of 1.0. The obtained wires are suitable for printing high-performance electrical devices.

Biography
Dr. Zhiyi Frank Zhang received his Ph.D. in polymer chemistry from Zhongshan University. He worked with universities and companies before joining National Research Council Canada. His previous research included polymers and polymer composites, sol-gel, polymer-gas systems, photonic components and packaging, biomicrofluidics, sensors. In recent 6 years, he is working on printable electronics with a focus on materials, process, sensors and electronic devices.

Flexo printing and selective sintering of metal based inks on paper – Optimization of RFID-HF loops for mass production



V. Thénot
Research Engineer
Arjowiggins Creative Papers, Voiron, France

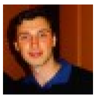
Abstract

This work examines the potential of paper for the production of printed NFC tags. Paper characterization demonstrates high temperature tolerance and very low roughness enabling the electrical performance of conductive inks to be fully developed.
Flexo process was considered for the printing of low-cost electronic devices. Moreover, the electrical performances of silver based inks are studied according to the size of their particles. Indeed, the use of metal nanoparticles can facilitate the activation of atomic diffusion mechanisms. In parallel, microparticles are cheaper. In any case, the coalescence of the metal particles after printing cannot be initiated without a thermal sintering treatment.
Sintering is usually carried out in an oven, temperature must therefore remain below the tolerance of the substrate. This leads to limited electrical performances for long duration. To fit with industrial constraints of large-scale production and to achieve the best electrical performance in a short time, deployment of emerging near-infrared (NIR) and intense pulsed light (IPL) photonic technologies is considered. These latter are based on the absorption of light energy by the ink thus causing rapid heating. The important absorption differential between the inks and the substrate allows high heating selectivity which makes it possible to limit the degradation of the substrate while the ink temperatures may be greater than 300 ° C. For each sintering process, the influence of the various parameters on the final electrical performance has been studied by using an in-situ resistance monitoring, allowing sampling frequency up to 250 kHz.
Finally, RFID-HF loops were printed, sintered and characterized while an estimate of the production costs was carried out. The obtained results demonstrate the potential of paper, coupled with flexographic roll-to-roll process and NIR technology, enabling the large-scale production of RFID-HF tags at a material cost of the order of 5 euros cents.

Biography

Victor THENOT was born in Paris, France, in 1989. He graduated from PAGORA, the International School of Paper, Print Media and Biomaterials (Grenoble-INP) in 2013. He joined the Arjowiggins group (leading producer of specialty papers in Europe) in 2011 as an engineering apprentice during which time he worked on the development of PowerCoat® paper, a specially designed substrate for the printed electronics market. He received the Ph.D. degree in 2017, for his work on printed RFID tags on papers carried out in partnership with two laboratories: the French Laboratory of Pulp and Paper Science and Graphic Arts (LGP2) based in Grenoble, and the Microelectronics Center of Provence (CMP), part of the Ecole Nationale Supérieure des Mines de Saint-Etienne. His current research is in the area of printed electronics on flexible substrates with a particular focus on printing, sintering and RFID tags design and manufacturing on paper substrate.

Flexible electronics: From lab to fab to the next generation of products



H. Vandekerckhove
Research Engineer
FlexEnable Ltd, Research, Cambridge, United Kingdom

Abstract
Flexible electronics will play a pivotal role for enabling flexible displays and sensors that will break form factor constraints and unlock new product use cases. The transistor is the fundamental building block for electronic devices, so a flexible transistor is the first step to turning this vision into a reality. Organic-based transistors (OTFT) have always been seen as the most flexible transistor option, and this talk will explain how the performance of OTFT has now exceeded amorphous silicon ensuring that product designers no longer need to compromise performance to achieve flexibility. For example, in terms of mobility, manufacturable OTFTs are now at least three times better than amorphous silicon, whilst having leakage currents nearly 1000X lower – both of which bring direct performance benefits to the device electro-optical performance alongside the benefits of flexibility.

In particular, OTFT technology opens a new avenue for flexible displays and sensors on commodity plastics – it enables glass-free, thin, light and conformable devices, combined with a low manufacturing cost that is driven directly by the uniquely low temperature process (sub 100°C) afforded by OTFT. The process has been designed so it can be easily transferred into existing display factories providing a quick route to high production capacity and yields.

FlexEnable is now working across the supply chain to establish the infrastructure necessary to bring the next generation of products to the market.

Biography
Herve Vandekerckhove is a Research Engineer at FlexEnable. He is responsible for the scouting, characterization and integration of novel materials for OTFTs performances and stability enhancement for use in active matrix backplanes. His main expertise is in the thin film deposition of Organic Semiconductor and Dielectrics while supporting the development of a baseline manufacturing process for Technology Transfer in Far East facilities.

Herve has an MSc in Chemistry and Physics, with emphasis on Nanotechnologies, from the ENSCBP (The Graduate School of Chemistry Biology and Physics), Bordeaux, France.

The scale-up of OTFT backplanes: The long journey from the R&D lab via prototyping lines to the a-Si fab

B. Brown
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Abstract
During the last decade, market demand for higher performance organic thin film transistors has driven the rapid development of higher mobility and improved stability organic semiconductor materials. The short-term expectation is for OTFTs to be introduced into fully depreciated α-Si lines enabling their mass production and use in displays, sensors and printed circuits. From the R&D laboratory, impressive OTFT performance metrics are reported in the scientific literature where mobility values exceeding 5-10cm2/Vs are becoming almost routine. Whilst it is impressive to demonstrate champion OTFT data on small area substrates (10 x 10 cm), the technical challenges of transferring and retaining this performance across to an existing α-Si production line are multitude and varied.
During this period, it has also become apparent that the development of a high performance organic semiconductor material should be considered merely as the starting point on the road to industrial scale manufacture of OTFTs. To realise the high performance of the organic semiconductor and the organic transistor backplane requires that materials companies develop a customised stack of interlayer inks specific to their respective semiconductor. In parallel to developing the interlayer materials stack, the compatibility of the materials must be demonstrated for existing processes used in display manufacture including exposure to plasma, to aggressive photoresist strippers and developers to name but a few. The organic materials must deliver performance and processing benefits at acceptable cost which in turn introduces further R&D challenges such as developing an OTFT stack set having a reduced number of mask steps.
The discussion set out to describe some of the key scale up challenges including; the impact of a range of factors from semiconductor purity to the effects of plasma sputtering on OTFT performance and proposes a range of industrially relevant technical solutions.

Biography
Bev Brown received her doctorate in Chemistry from The University of Glasgow in 1986 and has held several senior research management roles developing advanced specialty materials within multinational chemical companies. She joined SmartKem Ltd as CTO in 2013 and has since managed the company’s innovative materials development programme.
During the late 1990s she became interested in the emerging field of organic semiconductor materials and was involved from the outset in developing the concept of using blends of amorphous semiconducting polymers in combination with polycrystalline small molecules.
In SmartKem, her research is focused on the topics of developing still higher mobility, improved stability organic semiconductor formulations and supporting industrial scale-up of these materials. As end-users began to industrialise organic semiconductor materials in applications such as thin film transistor back planes for display drivers it became evident that a complete set of interlayer materials would have to be offered. She has managed the successful development of an industrially relevant materials stack for thin film transistor arrays. Dr Brown has co-authored several OSC materials research papers and holds over 12 patents.

Paper electronics with printed Poly-Si TFTs

R. Ishihara
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Japan Advanced Institute of Science and Technology, Nomi, Japan

Abstract

Paper electronics has emerged as a game-changing platform for future applications in display, healthcare, and environmental monitoring devices. The low-cost of paper combined with scalable manufacturability of printing technologies of electronic devices will allow production of a trillion of systems for IoT. Due to its biodegradable and fully-recyclable properties, the paper system paves a way for low carbon footprint and less environmental damages.
The technical challenge in the paper electronics lies in the printing of electronic devices. Organic and metal-oxide semiconductors can be printed at low-temperature and hence on a paper substrate. However, carrier mobility and reliability of thin-film transistors (TFTs) using those materials are still much inferior than those for silicon. Silicon as the base material, on the other hand, has advantages in terms of high-mobilities for the both of electron and holes, chemical and electrical stability, and low-power consumption by CMOS circuit configuration. The biocompatibility of silicon makes a good match with paper for the substrate.
Silicon can be printed using liquid silicon ink, which is a mixture of polymerized cyclopentasilane (CPS) and a solvent]. Thermal annealing higher than 350oC of this material, however, was necessary, to convert it to solid silicon, which prevented its usage on inexpensive substrates with a limited thermal budget.
In this presentation, we review a novel method that we developed for forming polycrystalline silicon (poly-Si) patterns directly on paper using the same liquid silicon with doctor-blade coating and local irradiation of excimer-laser with room temperature process. We review also the process and electrical properties of poly-Si TFTs fabricated on the paper. This technique will break-though the printed electronics by enabling applications such as fast printed electronics that are inexpensive, fully-recyclable, biodegradable and even edible.

Biography

Ryoichi Ishihara is an associate Professor and head of the Quantum Integration Technology in the Quantum and Computer Engineering department in Delft University of Technology (TUDelft). He is currently a principal investigator in QuTech and a member of Kavli Institute of Nanoscience. He is also a visiting professor of Japan Advanced Institute of Science and Technology and a specially appointed associate Professor in Tokyo Institute of Technology.
He received the PhD in Physical Electronics from Tokyo Institute of Technology (1996). After moving to TU Delft in the same year, he has established new activity of large area electronics using thin-film transistors (TFTs). He has done and continues research on single-grain and printed silicon TFTs for 3D integration and biodegradable/flexible electronics. His current research in QuTech is growth and integration of diamond nitrogen center qubit for scalable quantum internet and computer applications.
He is a co-author of more than 85 journal papers and 120 international conference papers and a co-inventor of 13 granted patent families.

Future Directions for Phosphorescent OLED Displays

M. Hack
VP of Business Development
Universal Display Corporation, Ewing, United States

UNIVERSAL DISPLAY CORPORATION

Abstract
OLED displays are now in commercial production for a range of products from cell phones, tablets, UHD TV's, and newly emerging applications such as AR/VR headsets and wearable devices. OLEDs offer excellent visual performance, and through the use of phosphorescent OLED (PHOLED) technology, lower power consumption than AMLCDs. OLEDs possess novel features such as transparency and flexibility, which will further increase their market potential over the next few years, and provide a much greater differentiation from current technologies. UDC is a pioneer in the development and supply of phosphorescent OLED technology and materials for both display and lighting applications. In this talk we will review the current status of OLED technology and discuss its potential for exciting new products over the next few years.

In addition we would like to report on our recent work to develop a solvent-less, mask-less printing technology for depositing patterned small molecule organic materials to manufacture large area side by side R-G-B OLED displays. Commercial manufacture of large area (TV), side-by-side RGB OLED displays is currently challenged by lack of a suitable methodology for the patterned OLED deposition. Fine metal masks used for mobile OLED displays have not been proven to scale to greater than Gen 8, and scanning smaller shadow masks across a large area has not provided acceptable yield. Inkjet technology has been in development for many years and has yet to provide sufficient performance for volume manufacturing. Organic Vapor Jet Printing (OVJP) has been developed to print patterned OLED layers for large area displays, while avoiding issues arising from the use of fine metal masks and use of solvents.

In this presentation we outline how we are ensuring that our PHOLED technology meets the ever more demanding performance requirements of future products, and we will outline how our technology can further improve their performance and lower cost.

Biography
Dr. Michael Hack, is Vice-President of Business Development at Universal Display Corporation. He is responsible for developing and commercializing advanced high efficiency next generation OLED products, with a special focus on flexible display applications and solid-state lighting. Prior to joining UDC in 1999, he was associated with dpiX, a Xerox Company, where he was responsible for manufacturing flat panel displays and digital medical imaging products based on amorphous silicon TFT technology. Dr. Hack received his Ph. D. degree from Cambridge University, England in 1981 and in 2007 Dr. Hack was elected a Fellow of the Society for Information Display. In 2014 Dr. Hack was nominated to serve on the board of the U.S. OLED Lighting Coalition to promote the advancement and commercialization of OLED lighting.

Fully Roll To Roll Printed 2-Bit Controller For Inexpensive Nfc Sensor Tag

K. Shrestha
Researcher
Sunchon National University, Printed Electronics,
Suncheon, South Korea

Abstract

Youshin Kim, Bijendra Bishow Maskey, Hyejin Park, Prince Weseley, Sajjan Parajuli, Pravesh Yadav and Gyoujin Cho*

Sunchon National University, Printed Electronics Engineering Department, Suncheon-si, South Korea

Presenting author: Kiran Shrestha *Corresponding author: gcho@sunchon.ac.kr

An inexpensive NFC-sensor tag has been highly demanded as a smartphone can communicate with packaged items via NFC (13.56 MHz) carrier. The NFC-sensor tag can host one or a couple of sensors such as thermistor, pH, gas, humidity, salt, etc. for real-time monitoring the quality of items in the packaging. To put the NFC-sensor tags on all packaging, a cost issue is always drawback for its practical realization of a smart packaging. In this presentation, we would like to present a way of developing the inexpensive NFC-sensor tag by replacing expensive Si chip controller by simplified all R2R gravure printed 2-bit controller where optimized logic circuits, all electronic inks and R2R gravure system to integrate all printed transistors on plastic roll will be introduced as well.

Biography

Kiran Shrestha is a second-year Printed Electronics Graduate student at the Sunchon National University in South Korea. He received a bachelor's degree in Electronics and Communication engineering in 2014 from Tribhuvan University in Nepal. His current field of research is dedicated to design and optimization of the printed electronic devices. He is interested in design, optimization and simulation of the digital electronic systems.

Highly customizable process for fast manufacturing of thin flexible polyimide based circuit carriers and its application for a flow sensor using low-cost passive components

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Research Associate; M. Eng.
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Hahn Schickard
Visions to Products

Abstract
Commercially available flexible printed circuit boards are manufactured by using adhesives for bonding thick copper foil on polyimide in a lamination process. For realization of thin foil systems without adhesives we present a highly customizable, additive process using polyimide foils, PVD technology and a maskless direct imaging process to manufacture flexible polyimide based circuit carriers in short time and small lot sizes. First, polyimide foil is used as substrate for sputtering a thin Cr/Cu metal layer. Then photoresist is applied on the metalized foil by conformal coating. Structuring of the resist is carried out by direct imaging and subsequent developing of the resist. After applying of copper electroplating for enhancing the opened tracks, the mask is stripped off and the metal layer is etched until the base PVD metallization is completely removed. Finally a suitable metal finish for assembly processes is applied on the copper tracks by electroless plating of nickel and gold. With these base substrates a thermal direction sensitive mass flow sensor element was realized using low-cost passive SMD components such as a resistor as a heater and NTCs as temperature sensors on both sides of the resistor. The development of the read-out circuit as well as the characterization of the low cost flow sensors are in progress. The presented process chain combines the advantage of maskless lithography with its short preparation time on one side and batch processing for an industrial approach on the other side. The process offers thin, flexible and individualized sensor elements with easily scalable size and configurable layout without additional adhesives.

Biography
Florian Janek received his Master degree in Microsystems- and Nanotechnology from the University of Applied Sciences Kaiserslautern, Germany, in 2015. His interest is in the field of functionalized and sensorized flexible systems made of foil and textiles. After his studies he began working for Hahn-Schickard and joined the group of Prof. Dr. Zimmermann as a PhD candidate in the laboratory for systems-in foil applications at the University of Stuttgart, Germany, in 2016. His research is focused on embedding ultra-thin chips into flexible packages forming system-in-foil applications.

Ultra-Thin, solid-state rechargeable battery with vertically integrated solar cell

B. Berland
Chief Science Officer
ITN Energy Systems, Littleton, CO, United States

Abstract

ITN Energy Systems and ENrG Inc. have developed and demonstrated a promising new thin, flexible solid state lithium rechargeable battery (SSLB) for flexible electronics, smart wearables, and medical devices. Combining ITN's SSLB technology with ENrG's ultra-thin flexible ceramic solves the capacity and packaging issues that have thus far limited the thin film battery technology to limited niche markets. With a capacity greater than 20 mAh in a thickness less than 250 microns, including hermetic packaging, the new SSLB enables energy density greater than 1,000 Wh/l while maintaining the long recognized benefits of enhanced safety and durability provided by the all solid state chemistry. Results are also presented for a new Flexible Integrated Power Pack (FIPP) that add in-field solar recharging by combing the SSLB with Lucintech's high efficiency CdTe solar cells. The new SSLB and FIPP products support operation across a wide range of duty cycles including high current pulses required for many wireless, display, and medical device applications. Results are presented for the battery and FIPP performance, including environmental and safety compliance testing.

Biography

Dr. Brian Berland, Chief Science Officer— Dr. Berland serves as the Chief Science Officer for ITN Energy Systems. In this role, he directs both technology and business development activities with a focus on moving technologies from the lab to commercialization. Over the last twenty years, he has led research and development activities in flexible electrochromic and low-e window films, flexible lithium solid state batteries, redox flow batteries, alternate energy generation and storage materials, environmental barrier coatings, as well as gas and liquid separation membranes.

In his time at ITN, he has been an integral member of a team to successfully bid and execute over $30M in R&D programs with corporate and government partners, including leading teams commercializing ITN's SSLB with leading worldwide corporate partners. He has been active in all aspects of product development for these technologies including cost-modeling, development of strategic partnerships, and definition of product performance requirements/market identification to support successful commercial transition and scale-up. Prior to joining ITN Energy Systems, Dr. Berland was a postdoctoral research associate at the University of Colorado in the labs of Professor Steven George, a world leader in ALD chemistry. He holds a BS in Chemistry from Carleton College and a Ph.D. in Chemistry from the University of Colorado.

Development, Upscaling and Production of Printed Supercapacitors

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Abstract
There is an ever-growing interest in sustainable and renewable energy sources such as solar, wind and water power. The rapid development in this field will require new ways of storing and balancing this energy. The power output from solar cells not only varies with the 24-hour rhythm of the sun, but also on shorter timescales with the passage of clouds. The intensity of wind also varies on different timescales, and this leads to large power fluctuations in the grid. To balance the power grid, intermediate energy storage on massive scales is necessary. This energy storage must not only have high enough power density to smoothen the power spikes, but it should also be environmentally friendly and sustainable, just as the renewable energy sources.
We have developed a scalable paper-supercapacitor system based on the conductive polymer PEDOT:PSS and cellulose. The cellulose forms a large surface area for the conductive polymer to self-organize onto, as well as a porous network which facilitates high ionic conductivity. We have also shown how the charge storage capacity can be further enhanced by organic forest-based redox-molecules. Furthermore, we have developed new methods of producing the active material, as well as the other device components, in a large area and high throughput manufacturing processes capable of satisfying the future demand for green energy storage.

Biography
Jesper Edberg received his Ph.D. in applied physics at the Laboratory of Organic Electronics at Linköping University, with the thesis title 'Flexible and Cellulose-based Organic Electronics'. He started working at RISE Acreo in 2017 at the department of Printed and Organic Electronics where he is working on cellulose-based electronics and energy storage devices.