Mobility & 3D Structural Electronics

COMPONENTS
“One plus one” equals more than two!
KROENERT and Coatema discuss their alliance

EVENTS
All eyes on Munich
LOPEC 2019 preview
OPE journal is the renowned globally circulated magazine for the organic and printed electronics industry.

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- analyses of the latest market trends
- most recent industry news
- independently researched economic and business reports
- reports on new technologies, methods and processes

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EDITORIAL PREVIEW

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Mobility & 3D Structural Electronics
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OPE journal Issue 27
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Dear Readers,

Can you believe that it has been almost seven years since the inaugural edition of OPE journal? We think that it is time for a little makeover. I hope you like our new cover and layout. In any case, design is important, and our industry also offers products with numerous design benefits. While OLED lighting might be the first application that comes into mind here, we will focus on another aspect: mobility and 3D structural electronics.

This issue includes an insightful interview with representatives from Airbus and Altran, and the message is clear: Printed electronics has also found its way into the sky. Moreover, players such as TactoTek, IEE and New Cable Corporation are featured here with their latest innovations and projects for the mobility of the future.

Recently, I also had the opportunity to visit the excellent innoLAE Conference in Cambridge. In my opinion, it was a bold move by the organisers to highlight the topic of sustainability in a full multi-hour workshop. We barely ever talk about the disposal of the products that are made by PE companies – and considering the urgency that is needed to combat climate change, environmental pollution and ocean plastics, it is about time to change that. Fortunately, I am convinced that this young industry is willing to walk the walk, instead of just talking about change.

We are not only dealing with flexible materials, but we are also more flexible ourselves than more traditional sectors such as automotive or agriculture – and we can use that to our advantage! When an entire youth movement rallies behind climate activist Greta Thunberg, it is not wise to antagonise these future consumers, voters and corporate leaders. Instead, we should play our part in designing sustainable products, energy-saving solutions and a functional circular economy – and we should offer pathways for the above-mentioned traditional sectors to follow our example.

I am certain that we will also have the chance to discuss sustainability at this year’s LOPEC in Munich. Meet the OPE journal team at booth 111 – we are looking forward to hearing about your ideas!

Best regards
Martin Hirschmann
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<td>LOPEC</td>
<td>19-21 March 2019</td>
<td>Messe München, Germany</td>
<td>OE-A, Messe München</td>
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<td>IDTechEx Show! 2019</td>
<td>10-11 April 2019</td>
<td>Estrel Convention Center, Berlin</td>
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<td>Nanotexnology 2019</td>
<td>29 June – 6 July 2019</td>
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<td>20-21 November 2019</td>
<td>Santa Clara Convention Center,</td>
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**THINKING FORWARD**

We at Polytype Converting understand our mission working day-by-day on better solutions for constantly new challenges. This is coating technology for inspiring performance. Our activities are geared first and foremost towards our customers and their products. Polytype Converting is a global supplier of coating technology and coating equipment for the surface finishing of a wide variety of flexible substrates.

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**NEWS FROM OPE-JOURNAL.COM**

**MOBILITY & 3D STRUCTURAL ELECTRONICS**

8 **Exciting perspectives**  
IEE [Member of OE-A]

10 **Making cables flat, flexible, lightweight and resource efficient**  
New Cable Corporation Ltd [Member of OE-A]

12 **The heat is on!**  
KEX Knowledge Exchange AG

13 **Beautiful and durable**  
TactoTek / Geely Design / CEVT

**COMPONENTS**

14 **"One plus one" equals more than two!**  
KROENERT / Coatema [Members of OE-A]

16 **Printing the IoT**  
PARC [Member of OE-A]

18 **Connect everything!**  
Pragmatic [Member of OE-A]

**RESEARCH**

19 **Detecting Phosphorescence**  
Fraunhofer FEP [Member of OE-A]

**EVENTS**

20 **Essential knowledge exchange**  
innoLAE 2019 review

23 **All eyes on Munich**  
LOPEC 2019 preview

32 **Out of academia, into industry**  
“IDTechEx Show!” preview

**MILDNER’S COLUMN**

34 **Printed electronics – spread the news**

**BEYOND THE DESK**

35 **Celebrating failures**  
VTT [Member of OE-A]

**SUPPLIERS DIRECTORY**

**OOB NEWS**

2 **OE-A’s Activities at LOPEC 2019**

3 **OE-A successfully brought the future of printed electronics to CES 2019**

4 **OE-A presented its initiative on sustainability at innoLAE 2019**

5 **First Conference on Organic and Printed Electronics in Dubai**

6 **OE-A at ISPO 2019: Flexible and Printed Electronics for Electrifying Sportswear**

7 **OE-A Calendar of Events**
Providing tools to evaluate pilots’ fatigue state: this is the aim of the Clean Sky project HIPNOSIS. Coordinated by CSEM (Neuchâtel, Switzerland) and under the guidance of Honeywell, the project will combine artificial intelligence (AI) with aeronautics expertise, contributing to the advent of next-generation cockpits. Consisting of smart cameras and wearable electronics, a safety kit will enable the real-time detection of signs of drowsiness, thus improving fatigue-risk management.

Human fatigue is a serious issue affecting the safety of the traveling public in all modes of transportation. Nearly 20 percent of the major US Transportation Safety Board investigations completed between 2001 and 2012 identified fatigue as a probable cause, contributing factor, or a finding. To address this issue, the HIPNOSIS consortium, led by CSEM, aims to improve the evaluation of pilot fatigue by providing innovative monitoring tools – namely, a specific vision-based kit developed by the French startup Innov+, which already commercialises similar solutions for the automotive industry.

“CSEM will also use its know-how in the measurement of physiological parameters to develop a wearable sensor that monitors pilots before and during a flight,” Dunbar adds. “The collected data will be fused with eye-gaze-related measures as well as head pose, observed by the vision system.” The French company SERMA Ingénierie will be in charge of integrating HIPNOSIS into a cockpit prototype for preliminary testing.

Schreiner MediPharm (Oberschleißheim, Germany) in cooperation with Swiss-based Ypsomed developed an NFC-Label that is applied to the Ypsomate autoinjector and transmits stored information about the medication to its electronic add-on – the novel SmartPilot. Thus, the data recorded about the use of the autoinjector logged by the SmartPilot are ideally complemented. The resulting connected device enhances the safety of patients and assists them in the self-administration of medicines in order to better comply with prescribed therapies.
Ynvisible’s displays to be used in the smart labels sector

Ynvisible Interactive Inc. (Vancouver, Canada) has begun work on commercial contracts that are expected to reach market in 2019. The first two contracts are with leading companies in the field of smart labels and related verification and tracking services. In both cases, Ynvisible provides visual indicators to the clients’ smart label solutions. One of the cases focuses on using an Ynvisible patented electrochromic solution and ink for an end application in the electronics sector. In the other case, the electrochromics are printed onto an RFID sensor label aimed at packaging applications for the delivery and handling of sensitive products. These deliveries were the first orders produced in Ynvisible’s new commercial production facilities. Ynvisible and the clients are working together to begin the process of transferring production to the client’s existing manufacturing or dedicated 3rd party infrastructure to achieve significant scalability advantages.

“Has been great to witness the success of technologies like RFID in bringing added value to various intelligent packaging and logistic applications. Combining different sensors makes it increasingly easy to collect vast amounts of data to indicate authenticity or tampering. Collecting data is not a challenge anymore, rather the challenge is to focus on the relevant and important data at any given point of time,” said Samuli Stromberg, head of business development at Ynvisible.

Ubiquitous Energy demonstrates truly transparent solar technology

Ubiquitous Energy (Redwood City, California), a leader in transparent solar technology, has produced the first demonstration commercial window façades using over one square metre of the company’s truly transparent solar technology, ClearView Power. The fibreglass-framed ClearView Power window units demonstrate the transparent photovoltaic technology’s aesthetic beauty, high transparency, and colour neutrality. “These window demonstrations are the result of many years of development and represent the great progress achieved with ClearView Power. Recent advances led to the creation of these prototype façades, which are the world’s first large-area, truly transparent solar window façades,” said Ubiquitous Energy co-founder and CTO, Miles Barr.

Each façade is made of six insulated glass units (IGUs) that are each 14 inches by 20 inches in size, totalling over 1m² of ClearView Power glass. The windows produce solar electricity in sunlight that can provide power to buildings for a wide range of applications including lighting, while simultaneously maintaining the performance of standard commercial window glass: over 50% transparency, neutral in colour, and low emissivity (low-E) for energy efficiency. The lightweight, fibreglass window frames representing the latest and best in lightweight and high insulation framing were custom created by Alpen High Performance Products.

“With support from our partners, we are excited to be closing in on the realisation of our vision to commercialise this technology for broad adoption within the $100B+ architectural glass market,” said Ubiquitous Energy CEO, Keith Wilson. The company plans to begin pilot installations of the demo size window units in 2019.

Flex appoints new CEO

Flex (San José, California), a sketch-to-scale solutions provider that designs and builds intelligent products globally, announced that Revathi Advaithi, 51, has been named CEO to the board of directors at Flex.

“The board conducted an extensive and thorough search, considering both internal and external candidates,” said Michael Capellas, chairman of the board of directors for Flex. “Revathi’s depth and breadth of capabilities from engineering to manufacturing to advanced supply chain management coupled with her exceptional leadership and proven track record make her the ideal choice to lead Flex. We are confident that she will lead Flex to realize its full potential.”
It all started with an automotive OEM customer’s request to IEE, one of their long-term suppliers and development partners: “We need your expertise in printed and hybrid electronics for our new battery pack developments. Over the past 30 years your technology has proven its robustness and reliability in demanding safety sensors. We are confident that together with IEE, we can develop applications that will make our battery packs less complex, more efficient and easier to assemble.”

IEE rose to this challenge, and quickly set up a dedicated team of material science, development and manufacturing experts. Together with the customer, the team defined requirements for several printed and hybrid electronics products, designed and built prototypes. In this way, an entirely new product range was born.

One of the products originating from these activities is a candidate for this year’s LOPEC awards. The cell tap sensor provides printed connections between the battery management ECU and the terminals of each cell in a battery pack. Its main use is the voltage measurement of every cell and the conduction of the corresponding balancing currents. The cell tap sensor replaces complex wiring with a lightweight, compact foil. The design freedom offered by this solution allowed IEE to tailor the foil to the battery pack design, and to the automated assembly process used in the battery pack manufacturing. Taking further advantage of the possibilities of printed electronics, IEE integrated SMD components, such as temperature sensors and fuses, and provided products with several connection technologies. For the customer it resulted in fewer parts with more functionality, a weight gain and less assembly complexity – all at a very competitive cost.

High Integration – fewer design space requirements simplify assembly of battery packs

Another use for IEE’s printed technology was quickly identified. In modern battery packs, thermal management is a key factor for performance and longevity. Enabling thermal management requires precise knowledge of temperature distribution inside a battery pack, thus a high number of temperature sensors in relevant locations. In these applications, hybrid electronics can play their advantages: adding SMD temperature sensors to a foil enables a cost-effective and flexible way to implement temperature sensor in locations where otherwise they could not be placed. By sliding temperature measuring foils in between cells, a temperature profile across the cells is provided to the BMS ECU. IEE’s cost effective printed & hybrid electronics capabilities allow a high degree of integration. Voltage sensing, temperature sensing, cell balancing and battery pack heating, can all be embodied in one single component. While cooling of the battery packs is on the mind of every engineer who works in this domain, a lesser known but equally important...
challenge is the heating due to the fact that low temperatures prevent rapid charging and discharging. Therefore, for both charging and regenerative breaking, battery packs need to be heated. This is often done by adding an electric resistance heater into the liquid cooling circuit. This is a cost-effective, yet highly inefficient solution. The liquid needs to be heated, then the heat must be transferred from the liquid to the cells. It leads to long heat-up delays and comparatively little of the invested energy actually reaching the cells. The solution to this problem is to use printed heater foils which can be applied directly to the cells, delivering the heat exactly where it is needed. Apart from the “regular” foil heaters, IEE also offers SafeHeat PTC (Positive Temperature Coefficient), whose resistance increases with temperature. As a result, areas on the heater which have reached their target temperature reduce the heating power, while cooler areas still get the heat they need. A SafeHeat foil heater needs no thermostat or temperature regulating circuit due to its material properties.

Printed electronics and mobility of the future

Electric vehicles face another “thermal management” issue: cabin heating. The heat must be generated from energy taken from the battery since there is no more combustion engine to provide the heat. As a result, it decreases the driving range of the vehicle. Cabin heating must provide a comfortable climate for the passengers at the lowest possible energy consumption. IEE’s heating foil offers this benefit: due to its thinness, large surface and flexibility, it can be integrated with little effort into trim parts. They are even robust enough to be integrated into floor mats. Instead of heating the air, as it is done in a car with a combustion engine, it is doors panels, armrests, lower instrument panel and other interior components that radiate warmth. While electrical mobility offers many exciting opportunities for printed and hybrid electronics, the potential applications appear to be virtually endless. The sensors are making their way into numerous applications such as ambient lighting, human machine interface, and capacitive gesture recognition. There is a lot more in store for printed and hybrid electronics and it will be fascinating to see how this technology will be integrated into the fabric of everyday life of the future.

Image sources: IEE S.A.
Making cables flat, flexible, lightweight and resource efficient

New Cable Corporation Ltd launches a printed 7-layer shielded flat flexible cable (SFFC)

The Finland based start-up company New Cable Corporation Ltd uses printing technology to manufacture shielded flat flexible cables (SFFCs) – suitable for mass production. The SFFCs are manufactured using roll-to-roll (R2R) processing – including screen printing and etching technology. Copper-clad polyethylene terephthalate (PET) laminates are attractive from a functionality and scalability perspective and serve as substrate material. Printed electronics enables lightweight products, allows for easy integration, improved packaging ability, and it is cost effective to produce functionalities for various applications.

7-layers of flat

New Cable Corporation’s standard product, an ultrathin etched and screen printed SFFC, is illustrated in Fig. 1 (a). The cable is 17mm wide and measures ~175μm in thickness. The contact pad areas with stiffeners are 0.3mm thick. The cable is composed of seven layers, as seen in Fig. 1 (b), including four layers above the PET substrate (1) such as the copper conductors (2), insulator (3), silver top shielding (4) and a top coating (5), and two layers below the PET substrate which are the silver bottom shielding (6) and a bottom coating (7). PET as substrate material allows a maximal use temperature of ~150°C, whereas a more typical temperature range is from -25°C to 85°C. The minimum bend radius, defined as the smallest radius the cable is allowed to be bent around, is here ten times of the overall cable thickness. Bending times can be designed from one time bend (during the installation) to many millions as required by automated machines. The 35μm thick copper has a current rating of 0.8 Ampere for one trace (in total there are 16 traces) and the voltage rating is 60 Volt. The SFFC is compatible to most commercially available connectors. The Hirose FH12-series connector is one example of compatible connectors.

Material resource efficiency

The growing awareness of the environmental impacts of materials production and processing within the European Union amongst others asks for innovative solutions. One strategy toward material resource efficiency is to design products with less material, without compromising their technical performance. This is the approach New Cable Corporation has taken on and is reflected in their lightweight SFFC. Fig. 2 shows a chart comparing the material weight distribution of (a) a traditional multicore round cable and (b) New Cable Corporation’s SFFC, with both cables exhibiting similar technical performance. Here, the traditional cable weighs in total 90 grams per meter, whereas the standard industrial SFFC has only 6.7 grams per metre. This shows, besides weight and space savings, about 92% savings in total materials and about 98% less usage of plastics. Particular numbers regarding material weight for a traditional round and the printed flat cable, respectively, are for plastics (46g/m vs. 1.2g/m), copper (43g/m vs. 3.5g/m) and the silver shielding (1g/m vs. 1g/m) as illustrated in Fig. 2.

Fig. 3. Example photograph of New Cable Corporation’s shielded flat flexible cable (SFFC). It is ultrathin (175μm) and therefore allows to be routed in between a standard box seam
Applications
New Cable Corporation’s SFFCs offer a wide range of applications, from automotive and aerospace to consumer electronics. Besides material savings, a decrease in the cable weight and volume of a vehicle (ground/water/air) allows for longer ranges to travel and/or more weight/volume to transport. For instance, in the case of fuel consumption, about every extra 50kg of e.g. wiring increase fuel consumption by 0.2 liters for each 100km travelled for an average well-tuned vehicle. With respect to the automotive sector, especially the expanding electronic automotive systems due to added functionality, the complex wiring harnesses are to be further increased. Here, SFFCs allow new integration possibilities such as attaching them directly to the car frame surface, as well as malfunction inspection methods via thermal imaging. SFFC’s flat and thin form factor makes it possible to connect them to commonly used automotive connectors that have a flat mating terminal. Other general demands are mechanical and chemical characteristics withstanding in harsh environmental operating conditions which can be engineered via the top and bottom coating of the cable.

Information
New Cable Corporation Ltd offers printed electronics solutions. Besides their standard products which are shielded flat flexible cables (SFFC), see the photograph in Fig. 3, and connectors, the company provides customised solutions for original equipment manufacturers (OEM) in the automotive and consumer electronics market. The solutions range from design to manufacturing of flexible and rigid printed circuit boards (PCBs) including embedded surface-mount technology (SMT) and the utilisation of various materials. Their products exhibit savings in weight, space and materials and the shielding on both sides of the flat cable reduces disturbances caused by electromagnetic fields. The cable surface allows customisation regarding the material, colour, printable text such as logo, serial number, QR code, technical information and instructions.

Image sources: New Cable Corporation Ltd
The heat is on!

A consortium of 16 companies under the direction of KEX Knowledge Exchange AG has developed a prototype of new heating for electric cars.

Companies are regularly faced with the challenge of understanding and evaluating the influence of new technologies and trends on their business and of initiating corresponding innovation processes. In order to successfully implement innovations, expertise in different and new fields of technology is necessary. Existing networks are mostly not sufficient for this – there is a dearth of novel ideas. The methodology of KEX Knowledge Exchange AG (Aachen, Germany) breaks this down: In consortium projects new companies from different industries come together to jointly tap the potential of technological hypes.

In the consortium project Printed Electronics, the BMW Group, Lohmann GmbH & Co. KG and Papierfabrik Louisenthal GmbH under the direction of KEX Knowledge Exchange AG have recently developed a prototype of a new heating concept for electric cars. “An automotive OEM, a manufacturer of banknote and security papers and an expert in adhesive applications are working together to develop a possible solution for one of the central challenges of the electric car: This network aspect is what makes our consortium projects so special,” says project manager Frederik Klöckner.

Applications for printed electronics

At the beginning of the consortium project, KEX presented possible fields of application for printed electronics. The consortium decided to examine printed heating elements in more detail and to develop a prototype for panel heating in electric cars. KEX analysed and evaluated various concepts for the prototype, which were discussed in the consortium. The decision was made to install a heating foil as close to the surface as possible in order to achieve the most energy-efficient result possible. It can also be produced cost-effectively in a roll-to-roll process and is therefore scalable to mass production.

For the development of the prototype, the BMW Group provided the original components of the glove compartment of the BMW 7 Series in which the heating elements were installed. Louisenthal had newly developed a flexible and transparent PET film in which a fine-meshed metallic net is embedded. The use as heating foil was tested for the first time in this project. Lohmann implemented the bonding of the layers as well as the electrical contacting of the film: Conductive adhesive solutions ensure the contact is sufficiently thin not to be visible on the component’s surface. KEX provided key support to the development of the prototype methodically and ensured access and rapid exchange with the network at the RWTH Aachen Campus.

“The trusting cooperation in the consortium and the methodology of the agile approach were decisive for realising a functional prototype in the shortest possible time,” says Mario R. Keller, strategic technology marketing at Papierfabrik Louisenthal GmbH, explaining the benefits of the project.

Development within three months

During the final meeting of the project, the prototype was presented to the consortium: With the help of a thermal imaging camera, the temperature and homogeneity of the thermal radiation were detected. The heating system can realise surface temperatures of over 60°C. The functional prototype was developed within three months. “Key success factors were the close collaboration of the four companies involved in the implementation together with 16 consortium companies such as Tesat-Spacecom, Rehau and SRG Global, from the concept stage to the very joining of the components,” says Klöckner. “The prototype is by no means the end product; it is intended to give impetus and show that the rapid implementation of alternative concepts in heterogeneous consortia is possible if innovations are approached correctly.”
Beautiful and durable

TactoTek, Geely Design and CEVT initiate automotive interiors project in printed, in-mould electronics

Geely Design (Gothenburg, Sweden), CEVT, and TactoTek (Oulu, Finland) have jointly initiated projects to develop smart surfaces for multiple automotive brands owned by CEVT’s parent company, Zhejiang Geely Holding Group. The current interiors project is the first of several anticipated by the framework agreement between the companies.

CEVT is developing technology for several brands in the Geely Group family, who had a combined annual volume of 2.15 million vehicles in 2018. The platform developed by CEVT, the Compact Modular Architecture (CMA), is currently shared by Lynk & Co vehicles, the Volvo XC 40 and will also be in coming Geely models. For interior design, CEVT works closely with their sister organisation, Geely Design, a global organisation with design centres in Sweden, the UK, Spain, the USA and China.

“CEVT focuses a great deal in new innovative technologies and TactoTek’s IMSE technology complements our future ambitions with light, thin, conformal electronics that are both beautiful and durable, and use up to 75% less plastic than traditional electronics assemblies,” says Didier Schreiber, SVP of Innovation at CEVT.

New degrees of freedom

“In addition, IMSE technology gives Geely Design new degrees of freedom to realise our design vision with innovative product design and intuitive functions”, says Andreas Nilsson, SVP of Geely Design Sweden. TactoTek develops and commercialises IMSE technology. Much of the company’s work in developing design rules and proving the IMSE technology platform has been in partnership with automotive OEMs and their suppliers to meet demanding automotive use cases. For the automotive market, TactoTek licenses its technology and know-how so OEMs and brands can purchase IMSE parts manufactured by their established suppliers.

“The cost-efficient and scalable approach of CEVT’s and Geely’s platform-based strategy matches well with IMSE technology. Within a specific brand, they can easily use the same tooling for an IMSE part across multiple vehicles and customise cosmetics and electronic functions with additive printing processes for different models or trim levels. This operating model supports design and engineering optimisation because that investment is reusable many times over,” noted Jussi Harvela, TactoTek CEO.

Image sources: TactoTek
In August 2018, it was announced that ATH Altonaer-Technologie-Holding GmbH from Hamburg – owner of KROENERT – would acquire all shares in Coatema Coating Machinery in Dormagen. On this occasion, OPE journal spoke exclusively with Dr Tarik Vardag, managing director of ATH, KROENERT and Coatema, and Dr Andreas Giessmann, managing director of Coatema, about the new forward-looking alliance, important core markets and expanded opportunities for mutual customers.

OPE journal: Dr Vardag, Dr Giessmann, for a long time the name KROENERT stood for particularly fast and large coating systems. In recent years, Coatema has made a name for itself primarily with pilot plants. How will the two companies strategically position themselves in the market in the future?

Dr Tarik Vardag: About ten years ago, KROENERT entered the narrow web segment with LabCo and, if I may say so, also enjoyed this market segment very much. But you are right, of course, KROENERT stands first and foremost for large and wide plants on which our customers primarily manufacture commodity products. But obviously the other market areas are also of great interest to us and so we have seen numerous attractive opportunities here in particular to make a big difference together with Coatema.

Dr Andreas Giessmann: I can only underline that! We see KROENERT and Coatema as two companies that can penetrate the market much better together.

OPE journal: Then you will certainly be able to take advantage of numerous attractive synergies arising from the merger of your two companies in the future?

Dr T. Vardag: Yes, definitely. An interesting development has taken place here: While five years ago we saw ourselves first and foremost as competitors, our first discussions showed that this is no longer the case. Quite simply, this is because our respective fields of activity and focal points have developed differently. This is how we at KROENERT see our task in working together with our customers to develop ways of optimising the processes of existing products. Coatema, on the other hand, has particular strengths in all questions of basic process development. As you can see, the overlaps here are relatively small.

OPE journal: On the other hand, both companies have certainly appeared as competitors in the field of printed electronics …

Dr T. Vardag: Yes, although KROENERT was particularly successful at printed electronics when it came to production and manufacturing optimisation, while Coatema scored particularly well in the areas of new and process development.

Dr A. Giessmann: The printed electronics area of expertise is a good example of our expertise: Coatema picks up customers when they come up with a product idea, and at this early stage some of them still don’t know anything about process engineering or need advice on chemical issues. Here Coatema offers prototype lines. If these ideas go into production scale and mass production, this is exactly the interface to KROENERT.

OPE journal: Then you certainly didn’t have any antitrust concerns to resolve?

Dr T. Vardag: No, absolutely not. The acquisition of Coatema was not about buying market shares, but about strategically complementing and strengthening each other.

OPE journal: How did your customers - your mutual and also your respective customers – react to the news?

Dr T. Vardag: Interestingly, very similar. Both KROENERT customers and Coatema customers have noticed: that really makes sense!

Dr A. Giessmann: In fact, nobody asked “Why are you going to merge now?”, but this alliance was immediately understood as a comprehensible and meaningful step. We can now serve our customers from the product idea to mass production – an invaluable advantage!

OPE journal: According to your strategy, will the two brands KROENERT and Coatema be retained?

Dr A. Giessmann: Absolutely, it is part of our strategy to retain these established and renowned names that stand for certain brand cores.
**Dr T. Vardag:** The same naturally applies to the production sites, because we are aware that the brands are shaped by their employees. It is therefore in our own interest to preserve this structure.

**Dr A. Giessmann:** Accordingly, our employees have reacted to the changes in a positive way, as they too see the opportunity to do much more together than just in their own world.

**OPE journal:** How will your sales network be organised in the future? Do you appear together or do you still have different contact persons?

**Dr T. Vardag:** We appear separately, but we have a very close and intensive exchange of information about our activities so that we can “pass the baton”. The respective sales and representative teams remain in place, as they also serve different markets and offer products.

**OPE journal:** Research and development: Will there be joint activities here?

**Dr T. Vardag:** We are coordinating our research and development work, but we do not necessarily conduct joint research and also maintain our two pilot plants. Our two companies together have 15 pilot plants, 12 of which are located at Coatema in Dormagen. This equipment is second to none. While here in Hamburg three large pilot plants are on production scale, Coatema has numerous smaller and very flexible pilot plants. Therefore, it makes sense to leave these two competence centres and also to open them for the customers of the respective partner company.

**OPE journal:** Which markets will be your particular focus in the future?

**Dr T. Vardag:** Not only the new markets are of interest to KROENERT, but of course also the classic markets such as siliconisation and barrier coating. We will pay special attention to these topics! But there will also be new markets, in the development of which we want to enter as early as possible. We see Coatema’s focus in the areas of renewables and printed electronics, among others.

**Dr A. Giessmann:** Yes, that’s right, this also applies to the market for flexible touch panels, which is slowly growing out of its infancy and where there is an increasing demand for large systems. The transition to mass production is in progress and we will see the results in five or six years at the latest. Here in particular, we can benefit outstandingly from our synergies.

**Dr T. Vardag:** Since the step to production maturity is being taken more and more frequently in the future markets mentioned — and this is also a significant achievement of Coatema’s development work — they are of course of extraordinary interest to both companies. Another important market for us is composites, where we will be represented with different approaches and offers. We see a great deal of potential in the entire area of membranes, and also in the fields of pharmaceutical and medical technology.

**Dr A. Giessmann:** As you know, we have a promising cooperation with OPTIMA and the joint brand COMEDCO in the areas of transdermal plasters and oral dispersible films, which we are actively promoting. In addition to thin-film technology, we are also interested in the nano-structuring of surfaces. Under the brand name TEMICOAT, we are working with TEMICON on this exciting topic.

**Dr T. Vardag:** As you can see, we can get a lot out of this merger of KROENERT and Coatema under the ATH umbrella. One plus one is sometimes more than two.
Printing the IoT

With its headquarters in Silicon Valley, California, PARC has been responsible for some of the most important technological breakthroughs of our time. The Xerox subsidiary boasts 175 physical, computer and social science researchers from 22 countries and holds more than 2000 patents. Janos Veres was invited to deliver a keynote at innoLAЕ 2019 in Cambridge recently.

In an exclusive interview with OPE journal, Janos Veres, PARC’s programme manager for printed and novel electronics, talks about the future of electronics and the opportunities of IoT technologies.

OPE journal: You define the Internet of Things as ‘the collision of information and matter’…

J. Veres: For us, the IoT is a mixture of things. The physical aspect is only one part here, to be precise. For instance, we are also working on network infrastructures, big data, and artificial intelligence. In fact, AI is a very important growth area for PARC at the moment. What I really tried to emphasise in my presentation is that IoT entails a multitude of different issues. Frequently, people concentrate on the efficiencies that they get out of the IoT. For instance, when you are running a factory, you have all the sensors throughout the factory that tell you whether everything is working as it should. Yes, this is part of the IoT! However, there is a different side to it as well: We can configure and reconfigure solutions to thousands of unique problems such as reliability, speed, convenience, experiences by creating custom physical “things” and connecting them with custom data solutions fulfilled by a host of players providing analytics, networking, databases and insights. This configurability opens the path for new business models.

OPE journal: Mr Veres, you started your presentation highlighting the importance of ‘open innovation’. Could you explain the meaning of this term for your company?

Janos Veres: ‘Open innovation’ is the idea of not only relying on your internal resources. Sometimes, you have to acknowledge that you do not have all the solutions in your own company or team. Even some of the biggest companies with almost endless resources cannot afford to exclusively rely on internal development. In any research and development environment, you are sometimes confronted with unexpected results of your work, and some companies do not know what to do with that. Therefore, ‘open innovation’ is a must! However, at the same time, it is very hard to practice because of the inherent ‘anti-logic, chips, batteries, sensors, MEMS and photonics. This is all about spreading electronics and putting them where they belong. The third one is electronics manufacturing as well as design becoming more accessible, on-demand, and local. This is part of a greater democratisation trend in technology. This also requires collaborative tools and can really change the landscape of electronics manufacturing. Ultimately, we could even end up with something like “download your part!” For instance, when you buy a book on Amazon in the near future, that book might not be printed before you click on ‘buy’. What has become a reality for books might also happen to electronics. Furthermore, the fragmentation of products will also likely increase with the need for customisation and personalisation.

OPE journal: In your keynote, you were talking about the future of electronics and the role of printed electronics in particular. Can you summarise your main points for our readers?

J. Veres: I see three trajectories – one of them being the new form factors, which you can already see, for instance, in wearables, smart labels or automotive. This development towards flexible, stretchable, pliable or even soft devices is going to expand a lot more. The second trajectory is what I call ‘integration beyond Moore’. This entails the seamless integration of micro and macro devices: logic, chips, batteries, sensors, MEMS and
OPE journal: Let us focus on what printing can bring to the IoT – this is actually quite a lot, isn’t it?

J. Veres: Yes, indeed. People are beginning to see that the future of manufacturing is 3D – especially when it comes to spare parts and on-demand manufacturing. This development will also come to electronics! This resolves a lot of the issues that I mentioned surrounding the IoT, such as the fragmentation of use cases. The three trajectories I just pointed out all have to do with printing in some form – at least potentially.

OPE journal: Can you elaborate on the meaning of hybrid electronics in the near future?

J. Veres: Hybrid solutions make sense because they can enable unique circuitry. Not only can we turn rigid boards flexible, we can also create stretchable solutions or layer structures with electronics embedded within. We can provide one-at-a-time, on-demand manufacturing with quick iterations. Hybrid electronics combines the computational power of silicon with large area processes provided by printing and new material technologies for flexible or even soft circuits. Fully printed circuits are somewhat ambitious, although some companies are successfully testing flexible chips based on thin film technologies. Printing is not to compete with nanometre lithography but it is an opportunity for novel integration techniques and new form factors.

OPE journal: One of the main applications of printed electronics is smart packaging. What are your thoughts on this area?

J. Veres: We often think of smart packaging in terms of supply chain efficiency, but I would like to emphasise the customer experience. Products that not only look better but are interactive are a game changer for physical retail competing against online. Packaging that makes it easy to understand the product or provide information about their benefits or their use is preferred by consumers. Furthermore, in retail, brands have very little insight into what is happening to their products in the stores. Interactive packaging can connect them with the consumers, providing valuable insight and analytics to customers’ preferences.

Image sources: PARC

Flexible circuitry in shoe insoles
A mouthguard with flexible electronic sensors

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Connect everything!

At the recent innoLAE conference in Cambridge, UK, OPE journal sat down with Dr Richard Price, CTO at PragmatIC, for an exclusive interview on his company’s vision of creating ‘trillions of smart objects’

Richard Price

Being a representative of a Cambridge-based company, innoLAE was a true ‘home game’ for Richard Price from PragmatIC. The integration of electronics in everyday objects has been the main goal of PragmatIC since its foundation in 2010. During his presentation at the event, Price pointed towards item-level identification as a main benefit of this concept. “Digital traceability enables big data,” he underlined. This entails the entire lifecycle of a product: from start-of-life to the supply chain, the store, at home, and after its disposal (end-of-life).

Nonetheless, the challenge to implement item-level identification is enormous: Fast-moving consumer goods (FMCG) have huge volumes – for instance, there are more than 20 trillion beverage servings per year, excluding water, worldwide. Moreover, FMCG prices are very low, with typically under US$5 per item. “High volume requires low cost,” emphasised Price. PragmatIC’s suggested solution is the FlexIC technology, which not only reduces total inlay costs by up to 80%, but also enables extreme thinness, flexibility and durability.

OPE journal: Mr Price, you just gave a fascinating presentation about PragmatIC’s goal of making trillions of objects ‘smart’, as well as item-level identification . . .

Richard Price: Item-level identification is essentially providing a cost-effective way of putting an electronic code onto any product that you want to, e.g. by means of a label or sticker. What we developed is a low-cost way of doing exactly that with our electronic semiconductor chips. This also facilitates the assembly processes. In terms of applications, I think that almost anything goes: from packaging to household objects. As you saw in the talk, we are also expecting high potentials in sensing technology.

OPE journal: Where do you see the main demand for this technology?

R. Price: When we look at retail and the supply chain, it is a natural extension of what is already happening. In clothing, item-level identification is already firmly established. In stores like Decathlon, for instance, RFID-enabled products are the norm. In my talk, I also pointed at the correlation between the cost of the tags and the number of objects. Therefore, the demand from retail is certainly strong, but we also see similarly high demands in other areas, e.g. healthcare. In the latter case, there are lots of requirements to track different samples through a supply chain.

OPE journal: Is it fair to say that your solution is the only one to offer such a low cost level, which makes large-scale implementation feasible for the first time?

R. Price: We certainly believe that! We found a good balance between performance and costs on the one hand, and the manufacturing approach on the other hand. This is why we are now able to scale up to these large volumes of trillions of objects.

OPE journal: In your talk, you mentioned the astonishing number of more than 600 billion soft drink servings per year on a global scale. This requires enormous manufacturing capacities – are they already available today?

R. Price: Not all of it is already available today. From the manufacturing perspective, there are two elements to consider here: One is the capacity for making the integrated circuits. We estimate that a trillion smart objects will require 100 FlexLogIC manufacturing lines – this is actually a fairly low number. However, you also need the assembly capacity. We expect that this could grow on a similar scale as well. We are working on that together with assembly partners and tag manufacturers.

OPE journal: So it will be a decentralised solution for different parts of the world?

R. Price: Exactly.

OPE journal: What will be your next steps to take?

R. Price: This year, we are aiming at getting our technology into the market in higher volumes. Moreover, we want to increase the maturity of our products. In the coming years, we will be expanding our manufacturing – also through deploying our systems in other locations. While we are ready for the first set of applications, we are also working on future technologies and improvements to enable more efficient manufacturing. The integration of sensors is a further goal.

Image sources: PragmatIC
Difficult to miniaturise
Considering just oxygen sensors, there are many current-based sensors on the market able to cover large temperature ranges, but they are difficult to miniaturise and restricted to certain measurement points. Optical sensors, such as phosphorescence sensors, overcome these hurdles. They are popular alternatives due to their ease of handling and capability of being integrated into existing systems. The reliability, low susceptibility to interference, and simple maintenance of most devices quickly persuades users. Fraunhofer FEP has many years of expertise in the development and manufacture of highly integrated OLED-on-silicon optoelectrical devices. This has become standard for realising high-resolution microdisplays in augmented- and virtual-reality glasses, and is now increasingly under development for optical sensor solutions.

Optical fingerprint sensors have already been created by merging the display and image sensor into a so-called a bi-directional OLED microdisplay. In addition to the display function, the display pixels serve as smart illumination of the finger on the surface, whose features are then detected by the embedded photodiodes.

Modulated blue OLED light
Now the researchers have taken another step and developed a miniaturised phosphorescence sensor. In this sensor, a chemical marker is excited by modulated blue OLED light. The phosphorescent response of the marker is then detected directly inside the sensor chip. The marker determines the substance to be measured; a typical application is measurement of an oxygen concentration.

Why not use commercial sensors? The challenge lies in the design of an extremely small sensor that combines all the functionalities and could be manufactured cost-effectively in future due to its small size. For this purpose, the OLED control and the sensor front-end were integrated into the silicon chip, then different configurations of the excitation and detection areas were investigated. In the first stage, a miniaturised phosphorescence sensor was developed. It is barely the size of a thumbnail and combines the marker and sensor in a single component. It consists of a blue OLED integrated together with a commercially available marker on the silicon chip.

“Currently, the sensor is designed to detect changes in oxygen level. We have achieved functional verification of the component with this first setup, and can use the miniaturised sensor chip for oxygen measurements in gaseous environments. In addition, we see the sensor chip as a platform for future developments, such as the measurement of further parameters and deployment in other environmental conditions,” explains Dr Karsten Fehse, project manager in the Organic Microelectronic Devices group.

Oxygen-sensitive marker
The current sensor emits blue light in an area of approx. 4.7 x 2.2 mm for exciting the oxygen-sensitive marker. The decay time of the light emitted by the marker after excitation is a parameter of the oxygen concentration of the environment. The significantly lower phosphorescence signal is recorded via integrated silicon photodiodes, amplified locally in the chip and subsequently evaluated in relation to the excitation signal with regard to the phase shift. In the future, the chip will be significantly reduced in size, the goal being <2 x 2 mm total chip size.

Thanks to the advantages of the innovative phosphorescence sensor – the small size, the combination of marker and sensor on a single chip, as well as the fast and precise evaluation of the data – the researchers see further areas of application in which the sensor design could be used.

The monitoring and evaluation of cell cultures in very small disposable culture vessels and in bioreactors is an interesting application example for the technology. “Single-use bioreactors” usually only offer a very small installation space and a limited number of ports to which measurement systems can be connected. In the future, the sensor system will be further developed in the direction of multi-parameter measurements. Monitoring liquids after the filling process in the pharmaceutical sector, in blister packs, and for quality control of oxygen-sensitive drugs is also conceivable. Fraunhofer FEP is very interested in project partnerships for these advanced developments.

Detecting Phosphorescence
Fraunhofer FEP presents a new prototype that can be used for oxygen ratio monitoring and other applications.
The organisers of innoLAE from the EPSRC Centre for Innovative Manufacturing in Large-Area Electronics could have barely found a more suitable location for their annual innoLAE conference than the impressive Wellcome Genome Campus near Cambridge. After all, the research that was conducted on this site increased our understanding of the human genome on a massive scale – more than a good example for the experts from our industry who participated at the event.

Before the opening of the actual conference, the organisers hosted the innoLAE Industry Day on 21 January, in order to bring together research and investors, as well as institutes and companies. Raghu Das, CEO at IDTechEx opened the presentations on that day and underlined: “Printed electronics has already experienced commercial success in many different categories. Now, we are close to the commercialisation of printed displays.”

Leading companies

The Industry Day featured representatives from several companies that are leading in their respective sectors. Dr Natasha Conway from the white goods manufacturer Beko emphasised that printed electronics may enable her company to seamlessly integrate electronics into surfaces. Christoph Zipko from the globally active plastic and foam converter Greiner emphasised: “For our product range, printed electronics is a key technology.” He then offered examples such as smart aircraft seats, predictive maintenance, smart packaging, shelf life monitoring, bioscience and smart mattresses.

Dr Peter Jarritt from the British National Institute for Health Research added insights from a healthcare perspective: “Healthcare needs new treatments, because the old ones are too expensive. We are looking for cost-effective technology-based solutions and the development of new medical devices.” He pointed out that especially low-cost diagnostic and monitoring devices for mobile and static implementation could be enormously successful. The Industry Day also included numerous short 90 second pitches from well-known companies as well as new businesses as a showcase of their offering for the printed electronics market.

Organic transistors

On 22 January, the innoLAE conference opened with a keynote by Prof Karl Leo from TU Dresden, who talked about “Novel high performance organic transistor structures.” He underlined that applications of organic transistors require much improved performance and that the contact resistance is often more important than mobility. Ashutosh Tomar from Jaguar Land Rover was next with his talk on “Applications of flexible and hybrid electronics in the car.” In terms of design, he expects printed electronics to be able to deliver new impressive controls, functional surfaces, thin light controls, flexible displays and interactive illumination.

A new application of printed electronics was presented by Simon Johnson and Tim Moor from CPI: “Large area pressure sensor system for critical injury diagnosis.” The two experts showcased a large-area pressure sensor that covers the whole of a human head with an array of sensors. These sensors will be integrated into a helmet and therefore must be lightweight and ultra-thin. The design currently uses a printed graphene-based piezoresistive sensor. The initial market focus of the product is expected to be in sports and leisure helmets, but also in the military.

Circular economy

The second keynote of the first day was delivered by Marco Meloni from the Ellen MacArthur Foundation: “The circular economy

Janos Veres during his keynote
opportunity.” He noted: “73% of clothing ends up in landfill or is being incinerated. Today’s economy is very wasteful. For instance, 30% of foods produced is wasted, and a typical European car is parked 92% of the time. The linear economy is not only creating environmental and social issues, but also loses lots of values.”

Electronic textiles workshop
The second part of the day was divided into workshops. The session “Science, technology & commercialisation of electronic textiles” was opened by Theodore Hughes-Riley from Nottingham Trent University: “Microchips in yarns – a revolutionary new approach to manufacturing intelligent garments.” He opened with the question “why do we use electronic textiles?” For instance, when sensing human physiological parameters, measurement should be made as close to the body as possible. Hughes-Riley then introduced the audience to the three generations of conductive elements in textiles that have been observed so far. In the first generation, we saw conductive fibres in textiles, as well as electrical circuits or electronics added to garments. The second generation is all about the integration of conductive fibres, while the electronics are still visible. Issues that still have to be solved in this generation are reliability, costs and the limited scope of applications. The upcoming third generation can be characterised under the term ‘functional yarns’. These E-yarns contain small-scale semiconductor chips such as LEDs or sensors. “Any small chip can be integrated into the yarns with only one restriction: the larger the chip, the larger the resulting yarn thickness,” explained Hughes-Riley. In terms of fabrication, small semiconductor or MEMS devices are soldered to thin copper wires. Application examples include LED electronic yarns, temperature sensing socks to prevent freezing in cold conditions, temperature sensing gloves or cycling suits, or even smart wound dressings (wounds experience a small temperature change when an infection occurs; these dressings are capable of warning the patient without the need to remove the dressing).

The next speaker was Kay Ullrich from TiTV Greiz in Germany: “Working with smart textiles – about materials, processes, products and their testing.” He showcased the ELITEX conductive thread – a highly flexible, conductive, washable textile-processible polyamide fibre with a silver coating. It is suitable for sensors, conductive textiles, circuits and illumination in general. As concrete products, he mentioned jackets with solar panels, adaptive power supplies for the arm for increased power while working, and environmental sensing.

Two-dimensional materials
While Francesc Manosa Moncunill from Eurecat presented the 1D Neon Project, which aims at combining conductive and semi-conductive fibres in order to manufacture fibre devices, Felice Torrisi from the University of Cambridge talked about “Washable and wearable electronic textiles enabled by two-dimensional materials.” He emphasised that wearables needed new electronic materials that are environmentally stable and stretchable. Other factors include low power, conformability, breathability, easy integration with clothes and washability. Graphene, which consists of single layers of carbon atoms, is a perfect match for these requirements: It is highly transparent, conductive, stretchable and conformable, as well as environmentally stable and bio-compatible. The first day of innoLAE ended with a treat for all guests: A gala dinner
innoLAE also included a scientific poster session

at Cambridge’s world-renowned Queens’ College was the perfect occasion for more networking and a fruitful exchange of ideas. After a festive evening in what could have easily been the setting of a Harry Potter movie, everybody was looking forward to the second day.

**From the IoT to manufacturing**

Day two at innoLAE opened with Janos Veres’ presentation on “Printing the IoT.” Read more about this topic in our exclusive interview on page 16. In his presentation, Simon Johnson from CPI was confident: “Large-area and printed electronics comes of age.” He said: “Additive processes for creating electronic sensors, circuits and assemblies on flexible substrates are available in the industry and the processes for the manufacture are well-established.” The next speaker was Richard Price from PragmatIC – we also had the opportunity to interview him in detail (page 18).

Another highlight presentation was given by Antti Keranen from TactoTek, who outlined his company’s injection-moulded structural electronics solutions. “We want to turn plastics into smart surfaces by integrating flexible printed circuitry and electronic components like LEDs into 3D injection-moulded structures by using standard, high-speed manufacturing methods and equipment,” he explained. The advantages are numerous: The solutions are lightweight and space efficient, and at the same time durable even in unconventional locations. Product updates can happen quickly, with a large degree of design freedom and simple assembly.

**Sustainability workshop**

innoLAE 2019 was likely the first major conference in our industry, in which sustainability and the circular economy were treated as central elements. The workshop on this topic was opened by Chris Rider from CIMLAE, who emphasised that the debate is absolutely necessary, even for this emerging industry that does not yet generate massive amounts of waste. Clement Gaubert from Veolia provided “Waste management and compliance considerations for LAEs” and put an emphasis on WEEE, the directive on waste of electrical and electronic equipment, which is the fastest-growing waste stream in the world. Especially interesting for printed electronics companies: While some wearables such as watches, LED tapes, PV panels, and RFID anti-theft devices fulfil the definition of equipment that requires electrical current to perform its primary function, this is not the case for all products in our industry. Out of scope are certain types of smart clothing that can still work properly without their electrical functions, but also furniture with USB charging ports or connected household devices. The same counts for RFID as a security feature forming part of the product’s packaging.

Sophie Verstraelen from the OE-A presented her association’s initiative on sustainability. In the OE-A working group on this topic, the OE-A members came up with a ‘generic printed electronics device’ containing the materials that are typical and commonplace in printed electronics. The aim is to develop a quantitative model for the impact of PE on the waste streams.

Gillian Ewers from PragmatIC emphasised that NFC technology on packaging could be used to offer precise, localised recycling information.

*Image sources: EPSRC*
All eyes on Munich

In this issue of OPE journal, we provide you with an extensive preview on LOPEC 2019, which will take place from 19-21 March at Neue Messe München. Not only did we interview exhibition director Barbara Ismaier, we also examined the exciting field of aviation – and we supply you with information about select LOPEC exhibitors.

Take off with printed electronics

As Barbara Ismaier indicated in her interview with our magazine, the aviation industry will play a major role at LOPEC 2019. In order to provide you with more details on this sector and its interest in printed electronics, we present you an interview with Dennis Hahn from the aircraft manufacturer Airbus and Max Seissler from the consulting and technology company Altran. Based in Hamburg, Germany, they are cooperating on printed electronics for the aircraft cabin. In this interview, originally conducted by the LOPEC press team, they illustrate the challenges and visions.

Since when has the aviation industry been interested in printed electronics?

Dennis Hahn: As early as 20 years ago, university researchers recognised that printed electronics is of interest for the construction of aircraft and presented their results to Airbus. At that time, however, the materials did not yet meet the extremely high safety requirements of aviation. But a lot has happened since then. Together with two Fraunhofer Institutes and Altran, we have developed demonstrators, and together with Altran we are currently providing proof that printed electronics are ready for applications in aviation.

What are the specific requirements that the materials have to meet?

D. Hahn: We examine flammability, for example. To do this, the films on which we print the electronics are held over an open flame for 15 seconds. They are then removed and must extinguish themselves within 14 seconds if they caught fire – a tough test for plastics. Even our fire experts cannot predict how a combination of film, ink and coating is going to behave. That is why we had to test various materials.

Max Seissler: We have tried from the outset to minimise risks and use materials that are already aviation-certified. But when we use these materials for other applications and in new combinations, additional tests are required. And flammability is just one issue. The components must be resistant to moisture and condensation, aggressive cleaning agents, insecticides, extreme temperatures, vibration and more.

At the Innovation Showcase, Airbus and Altran present the "sidewall demonstrator", showing printed functionalities a future cabin layout could provide (photo: Airbus)

OPE journal: Mobility will be one of the central topics of LOPEC 2019. What can visitors interested in this vast field expect from the show? What are the developments in printed electronics that are most promising for automotive and mobility?

B. Ismaier: That’s correct. Mobility is one of our central topics again in 2019. This segment continues to drive forward developments and innovations. Low weight, no wires and customised production are just some of the benefits that printed electronics can offer the automotive and aviation industry.

I very much look forward to the joint presentation by aircraft manufacturer Airbus and consulting and technology firm Altran; they will show that printed electronics is ready for applications in aviation because it can now meet the extremely
high safety standards of that industry. From individual fittings for aircrafts to immense fuel savings: The technology is turning visions into reality. This presentation is not to be missed. And let’s look at the automotive sector too, where applications are evolving at a rapid pace thanks to printed electronics. The trade show and conference will give us insight into new and optimised applications, especially 3D structural electronics. At the Technical Conference, for instance, company representatives and scientists will use the 3D Structural Electronics session to report on their experiences and outcomes on the production of printed electronics in 3D. The subject will also be the focus of the panel discussion: Experts from MAN Truck & Bus and NeoTech AMT GmbH, among others, will be on site for the discussion titled “3D Structural Electronics and the Future of Automotive Design.”

OPE journal: The medical and healthcare sectors will also be in the focus of LOPEC 2019. Ultra-thin sensors, diagnostic tools and further biomedical applications are certainly fascinating aspects of our technology. Can you elaborate on LOPEC’s offering for visitors interested in this area?

B. Ismaier: That’s right, our second focal topic, Wellbeing, will highlight sporting goods, smart textiles and wearables as well as medical applications for printed electronics. Exhibitor booths will demonstrate the many versatile applications of printed electronics in the medical sector. These include Brewer Science and InnovationLab, just to name a few. Also taking place in connection with the LOPEC Technical Conference is the Biomedical Applications session. The presentation by Jaye Tyler, CEO of the US company Nissha Si-Cal Technologies, is sure to be one of the highlights of the session. Tyler will discuss the development and production process of printed electronics, including a more detailed look at various printing technologies and case studies from the medical sector.

OPE journal: Can you name further highlights of LOPEC’s conference programme, which has established itself as a vital information exchange, learning and networking hub for the printed electronics community?

B. Ismaier: With around 200 conference presentations this year, it is difficult for me to point out just a few. I think that this abundance of topics means there will be something for everyone: whether in the Plenary Session, the Scientific, Business or Technical Conferences or in the Short Courses. I previously addressed two highlights from the Plenary Session and Technical Conference with Airbus and Nissha Si-Cal. Another exciting presentation in the Plenary Session will be Sébastien Chaumié, electronics leader at IBM, on the subject, “Printed Electronics and AI – Foundation for an Enhanced Connected Life Experience.”

OPE journal: Finally, what are your expectations for the future of printed electronics as a technology? After all, LOPEC created a ‘community spirit,’ uniting different aspects of the industry and emphasizing collaboration as a success factor. Can this sense of community continue to thrive, now that many players are focusing on one or two specific target markets, instead of showcasing possible applications for a number of different sectors?

B. Ismaier: Organic and printed electronics has grown into a world market. OLED displays certainly make up the largest share of the market at the moment. According to projections, however, strong growth is expected in applications such as NFC/RFID, sensors, wearable electronics and in the automotive and medical fields. I am certain that it is only a matter of time before other segments discover the technology and begin to influence the development of printed electronics. I also believe that our exhibitors will be open to these new segments and continue to grow in the sense of community spirit. What makes LOPEC special is the interaction that takes place across the entire value chain. In my view, networking at the trade fair, learning from one another and exchanging ideas and experiences are what move the industry forward. Something that is being researched in one area may lead to a benefit in another area. Take 3D functional electronics, for instance: bent and curved displays were essentially developed in the automotive sector. But today they are also being used in the consumer electronics and white goods segments.

OPE journal: Regular visitors at LOPEC have noticed that the traditional exhibition hall has been occupied to the last square-metre in 2018, and this year promises a similar success. How do you intend to further develop the event?

B. Ismaier: Yes, the exhibition is getting bigger every year. Hall B0 is fully booked this year as well. In terms of expanding space, we are fortunate that we have the ability to continue growing at the ICM (International Congress Center Munich). For instance, this year we have included the foyer of Hall B0 as exhibition space.

When it comes to our strategic development, we want to continue the cross-industry approach that we began two years ago. At Messe München, we have a comprehensive industry network of technology, consumer goods and investment goods trade fairs. Our goal is to raise awareness for printed electronics and the capabilities of the technology. I am confident that cross-industry events, ideas and visions will bring about these transfers of know-how that will contribute significantly to the development of the various industries.
You are cooperating on innovations for the aircraft cabin. What are the advantages of printed electronics in this field?

M. Seissler: At the beginning of the project two years ago, we initially had an optimised production in mind. Airlines want the furnishings of their aircraft to be customised. Corporate branding should be reflected in the cabin. For aircraft manufacturers, however, it is expensive if one customer wants a display here and the next one wants something else there, because for conventional electronics cables have to be planned and laid. This is still often done manually and takes weeks. If we print the conductor paths on film, we can eliminate cables. Our goal is a digitised, automated production: a modular printing line, right next to the production line, that allows the implementation of individual requirements within a few hours to days, even if the customer makes a decision at the last minute.

D. Hahn: With printed electronics, we can realise new system architectural concepts. We assemble the customised electronic components and integrate them into the cabin module without having to modify the aircraft’s hardware. This enables us to offer our customers even more options for customised furnishings. And at the same time, the printed electronics help us to reduce weight.

M. Seissler: Moreover, we need less space if we install flat film instead of cables for the transmission of power or data – and there are thousands of them hidden behind the paneling in the aircraft. If we save this space, the cabin will be larger, and the passengers will have a much more pleasant flight experience.

What stage has your printed electronics project reached?

D. Hahn: We are now working on the first near-series prototypes, on a display module for the emergency exit and for the toilets in the cabin. We screen print a silver ink onto a polymer carrier, which we then glue onto a honeycomb structure.

Do you only print with silver or do you also use organic inks?

M. Seissler: We use silver inks for the info panel. For other prototypes, for instance in sensor technology, we are also working with organic inks. There is an extremely large number of possible applications for sensors in aviation. Sensors integrated into the outer skin, for example, can measure loads and provide information on when the aircraft requires the next overhaul or repair cycle. Temperature and humidity sensors, on the other hand, can be used for climate monitoring. Printed electronics in aircraft construction is an extremely broad field, from organic light-emitting diodes for cabin lighting to RFID antennas in...
Together with two Fraunhofer Institutes, Airbus and Altran have developed demonstrators. Together, the companies are providing proof that printed electronics are ready for applications in aviation (photo: Airbus).

Manufacturing, that enable the tracking of when certain components are ready for installation at which specific production site.

What comes after the printed info panel? Do you have any long-term visions?

D. Hahn: Airbus not only builds passenger aircraft, but also develops ideas for the urban transport of the future. Take the future concept “Pop-Up”: This is about air taxis for cities, flight attachments for autonomous automobiles, and the combination of car and drone. This is what tomorrow’s mobility looks like – and printed electronics should make it all possible.

M. Seissler: As the flying cars are electrically powered, weight reduction comes even more into play. Every kilogramme plays a decisive role here.

At the LOPEC Conference you will give a plenary lecture. What topics are you going to cover?

D. Hahn: We want to talk about the requirements of the aviation industry in general, but also about our current developments and about where we are headed. It should become clear that, in the future, printed electronics will enable the realisation of bold ideas.

M. Seissler: Moreover, there are still some outstanding issues, for instance with regard to connectors. Numerous functions and applications can already be printed on film. However, the films must ultimately be connected to a power or data network. We are still looking for compelling solutions that meet the strict requirements of aviation.

D. Hahn: It is generally the case that we deal with cutting-edge technologies in aircraft construction. Many companies are in a kind of awe of these high requirements. This is probably one of the reasons why there is currently still a gap between what we need in aviation and what is on offer.

M. Seissler: We have been attending LOPEC for several years. This time we will be actively represented for the first time with a lecture. We would like to seize this opportunity and call on all potential partners to support us.
Select exhibitors at LOPEC 2019

CERADROP (Booth 206) a MGI Group company, offers materials deposition digital platforms for the printed electronics industry and smart 3D printing from advanced R&D up to 24/7 high performance manufacturing. Thanks to their modular-based scalable concept, the CeraPrinter Series models present new opportunities for feasibility studies and launches of new products into the printed electronics market. Combining various materials deposition technologies as well as the latest generation of post-treatment modules, this equipment line enables reaching a wide range of application fields such as: flexible electronics, IoT, sensors, smart packaging, OLED, electroceramics, energy harvesting, life science and automotive. The booth is located in the AFELIM Pavilion (French Printed Electronics Association).

Coatema Coating Machinery (Booth 304) will present three different sizes of equipment for printing, coating and laminating in the printed electronics sector. As part of Coatema’s success story of Lab2Fab in new emerging technologies, there will be an A4 Test Solution slot die coater at the Coatema booth. The other Test Solution R2R system is the most compact Coatema R2R unit, with a working width of 100mm and different options for application systems. Both systems are the optimal entry units in printed electronics, not using a lot of materials and inks and still providing the opportunity to make products on small scale. The third unit shown at the Lopex Demoline area is a version of the new Smartcoater, with a screen printing system in operation and an integrated UV Nanoimprint process.

CSEM (Booth 505) is a private RTO, ensuring competitiveness through deep-technology development and transfer to industry. CSEM solutions include microsystems, surface engineering and smart integration. CSEM provides flexible, professional services with an industry-friendly IP approach and shares its global industrial networks. CSEM clean room facilities include state-of-the-art equipment for OLAE process developments. Its hybrid electronics are deployed in domains such as optical sensors for aerospace, “artificial skin” for human-machine interaction with robotic arms and localisation. CSEM’s printed electronics offering includes process optimisation for PePV and OLED light management.

DuPont Photovoltaic and Advanced Materials (Booth 408) is a leading innovator and high-volume supplier of electronic inks and pastes for a wide variety of printed electronic applications in the display, photovoltaic, automotive, biomedical, telecommunication and consumer electronics markets. DuPont PVAM will be exhibiting its extensive portfolio of electronic inks including the new 2nd generation of In-Mould Electronic (IME) materials enabling 3D structural electronics. Also featured is the DuPont Intexar range of stretchable, washable inks and substrates for wearable applications.

DuPont Teijin Films UK (Booth 405) is a leading manufacturer of high-performance PET polymer film. Its wide range of stabilised films are strong and flexible with excellent resistance to heat, abrasion, chemicals and moisture. These films are the substrates of choice for precise registration and dimensional control. Polyester films are particularly suited to demanding applications including touch screens, flexible OLEDs, e-paper, high-barrier flexible substrates, flexible microelectronics and TFT’s. New co-extruded PET films have smooth clean surfaces that are ideal for deposition of conductive and barrier coatings. Melinex TCH index matched films provide superior optical properties and our range of UV barrier films offer the protection required for demanding external applications.

Elantas Europe (Booth 405) is a leading manufacturer of insulating and protective materials. The company develops and produces wire enamels, impregnating resins and varnishes, casting and potting resins, electronic coatings, adhesives, flexible electrical insulation materials, special coatings, products for printed electronics as well as a wide range of tooling and composite materials. Functional inks and personal support for printed electronics are offered by the product line printed electronics. Its portfolio includes conductive, insulating and functional screen printing inks for applications such as membrane switches, touch surfaces, in-mould electronics, hybrid electronics, sensors, RFID antennas and electroluminescent lighting.

Folex Coating (Booth 515) is a specialist for functional coatings and the thermal stabilisation of polymer films under clean room conditions, Folex has more than 60 years of experience in the manufacturing of products for the printing and electronics industry. From its vast portfolio, several products are particularly interesting for printed electronics applications: typically substrates to be printed on, with minimal residual shrinkage, and optimal surface properties, as well as overlay films. Also transparent conducting coatings for which the conductivity can be adjusted according to the needs of the various potential application requirements.

FUJIFILM Dimatix (Booth 402) is a renowned provider of piezoelectric inkjet printheads and systems and has more than 35 years of experience in advancing the performance of drop-on-demand dispensing
devices with its state-of-the-art MEMS technology. The Dimatix Materials Printer, DMP-2850, is a versatile system for the accelerated development of inkjet solutions in electronics, displays, chemical, life sciences, photovoltaics, 3D mechanical, optical, and other emerging technologies and industries, and it provides improved performance and functionality for IoT applications. By employing single-use cartridges, the DMP-2850 minimises waste of expensive fluid materials, thereby eliminating the cost and complexity associated with traditional product development and prototyping.

**IST Metz (Booth 409)** develops, manufactures and distributes UV curing systems for many industrial applications such as electronics, displays, medical, automotive, cosmetics, metal, flooring, energy storage and converting. The company group was founded in 1977 and consists of 14 companies. Thanks to the worldwide network of sales and services, fast and reliable support on-site is guaranteed. The IST Metz group offers its customers the world’s largest product portfolio of high-performance UV lamp and UV LED systems for the curing of inks, varnishes as well as adhesives and silicones.

**Kimoto Ltd (Booth 604)** boasts know-how in coated films for industrial applications found in the electronic, lighting, automotive and printing industries. The company follows the dynamic developments in these fields to offer up-to-date products to the market. Kimoto uses clean room coating lines for highest optical quality.

**KROENERT (Booth 305)** is offering versatile and flexible R2R coating, printing and laminating machines to produce large area printed electronics regardless whether the machine is used in R&D institutes, laboratories, start-ups or at industrial customers. Applications for large area and compact printed electronic systems such as NFC, OPV, RFID and display applications are increasing. In order to make the final products more affordable, but highly accurate too, Roll to Roll (R2R) production on flexible transparent polymer substrates is the way forward. Numerous printing and coating technologies are suitable depending on the design, the product application and the chemical process technology.

**M. Braun Inertgas-Systeme (Booth 202)** offers versatile, clean environment solutions to markets around the globe. From the standard glovebox to complex, customised systems – its solutions are tailored to suit all types of budget requirements. M.BRAUN is a pioneer in OLED equipment with more than 20 years of experience in providing standardised and customised solutions for the OLED market.

**Meyer Burger Technology (Booth 303)** offers industrial inkjet printing equipment to apply functional materials for printed electronics, OLED, PCB, semiconductors, chemical machining, photovoltaics, structural electronics, moulded interconnect devices and OPV for high quality laboratory prototyping and small volume industrial production. DMD100 allows manufacturers to create new products in shorter time to market and laboratories to validate in real time, device structure and new functional materials without formulation phase.

**Neotech AMT (Booth 215)** is a leading company developing manufacturing technologies for 3D printed electronics. Since 2009 the company has pioneered developments in this emerging market and offers production level solutions. The patented 45X system is currently used in the high volume manufacture of cell phones. The low cost PJ15X system is designed for R&D, rapid prototyping and product development for mobile communications, automotive and industrial customers. Applications include 3D circuits, antenna, sensors and heater patterns as well as “fully additive” 3D printed electronics.
NovaCentrix (Booth 403) offers industry leading photonic curing tools, conductive inks, material and expertise enabling development and production of next generation printed electronic devices – some already on the market. PulseForge tools utilise photonic curing which is a cutting edge technology that dries, sinters, and anneals functional inks in milliseconds on low-temperature, flexible substrates such as paper and plastic. PulseForge tools can save time and money, and enable new types of products in applications like solar, RFID, display, packaging, and circuit. The company’s Metalon conductive inks capitalise on advanced materials and formulation to provide conductivity options for additive manufacturing of printed electronics with stretchable, solderable, resistive, and magnetic qualities.

nsm Norbert Schläfli AG (Booth 507) specialises in developing and manufacturing high-precision printing, coating, laminating and curing systems mainly in the area of printed electronics and security printing. From the table top lab sheet-fed printing machine to a complex multi-functional printing system, nsm is developing – based on over 33 years of expertise in printing/coating technology – innovative and customised solutions for laboratories and companies worldwide. The product range also includes innovative, ultra-precise sheet-to-product and R2R printing and coating systems.

nTact (Booth 205) is a pioneer of slot die coating for microelectronics applications and a leader in emerging markets such as OLED and various printed and organic electronics applications. nTact developed products which are fully compatible for processing in inert gas environments and through its partnership with M. Braun offers these as fully integrated systems capable of depositing highly uniform, submicron layers of organic films. Based on the acute demand for a system which is low cost yet capable of high performance processing needed R&D applications, nTact launched two new products which allow researchers to develop a process on an affordable R&D platform, while providing a direct, scalable path to large area substrates and high yields in a volume manufacturing environment.

OE-A (Organic and Printed Electronics Association) (Booth 216) is the leading international industry association for organic and printed electronics. The OE-A represents the entire value chain of this emerging industry. Its members are world-class global companies and institutions, ranging from R&D institutes, mechanical engineering companies and material suppliers, to producers and end-users. Well over 200 members from Europe, Asia, North America, South America, Africa and Oceania are working together to promote the establishment of a competitive production infrastructure for organic and printed electronics.

OE-P journal (Booth 111) is the leading international trade magazine for the organic and printed electronics industry. We offer you the latest news, insights, articles and trends from our sector and keep you up-to-date with our online news, social media activities (Twitter and LinkedIn), and, of course, our quarterly print magazine. Visit us at our booth and talk to us about editorial and advertorial opportunities!
Piezotech (Booth 206), an Arkema Group company, designs and produces electroactive fluorinated polymers and inks for organic electronics, plastronic and smart fibers. Piezotech FC: a range of ferroelectric polymers and inks, with piezoelectric, pyroelectric properties for applications in sensors (touch, pressure, ultrasound, IR), actuators (printed speakers, haptics, microfluidic) and energy harvesting. Piezotech RT: a range of relaxor polymers with electrostrictive properties for applications in actuators (haptics, microfluidics etc.), electrocalorics and high-k dielectrics.

PolyIC (Booth 400) develops and markets PolyTC metal-mesh sensors based on the platform technology printed electronics. All PolyTC sensors are produced individually and according to customer specifications. These products enable a large variety of applications: Touchscreens, touch controls, and transparent conductive films.

Polytec/Xenon (Booth 416) provides instruments and components for photonics sintering, UV curing and measurement applications: Xenon Sinteron sources, UV-LED, Four-Point-Probes (simple manual to sophisticated fully automated systems), optical thickness measurement, CV mapping systems, fibreoptic sensing as well as machine. Xenon has over 50 years of experience providing high energy pulsed light lamps and systems. The company has solved low-temperature curing problems based on the extraordinary range of power and system flexibility of pulsed light. Xenon has introduced the Sinteron systems for the work in sintering silver and copper nanoparticle inks on low-temperature flexible substrates, such as PET and paper, at room temperature.

Pröll KG (Booth 500) offers non-conductive, but formable and backmouldable IMD/FIM screen printing inks for printed electronics applications. Besides the proven two-comp. inks such as NORIPHAN XMR and XWR, there is a new carbon-free black colour shade available for the one-comp. ink NORIPHAN HTR N, based on non-conductive Spinel pigments. The opaque black shades of these inks can be used for decorating films as well as for back printing of conductive pastes within functional capacitive touch IMD/FIM parts due to their high electric resistances. Those inks can also be used as washout barrier during the injection moulding process while showing outstanding adhesion in compound and long-term durability in the final IMD/FIM part.

Quad Industries (Booth 213) is a solution provider for printed flexible electronics and uses its expertise in high-precision, automated screen printing techniques to integrate functionality directly on lightweight, flexible and stretchable materials such as PET film, TPU, paper and textiles. This allows the integration of a wide range of electronics – touch controls, sensors, connectivity, heating – in any object, whatever its shape, size or material. Through in-house automatic SMD assembly, the company creates hybrid flexible electronics that find their way in sports & healthcare wearables, automotive interiors, smart objects and many more.

RK PrintCoat Instruments (Booth 617) specialises in the design and manufacture of equipment used to produce repeatable samples of most surface coatings. These may then be used for quality control and presentation purposes, research and development and computer colour matching data, elements vital to a company’s success in the modern world. The major industrial users of RK equipment include printing ink and paint manufacturers, pigment, resin and dyestuff suppliers and manufacturers of textiles, adhesives, papers, films, foils and medical and pharmaceutical products.

SAUERESSIG Matthews International (Booth 108) is a leading brand deployment company that supports its customers along the complex prepress process, from design to print by providing innovative solutions. The design-to-print management is applied in many sectors in the packaging world such as flexible packaging, tobacco or the pharmaceutical industry. Saueressig regularly realises creative designs and accompanies renowned brand-name producers with international product launches especially when it comes to fast moving consumer goods.
tacterion’s (Booth 606) market ready sensor solution plyon is one of a kind: flexible, sensitive and robust. Equipped with capacitive and resistive sensing, it aims at making flexible, soft and curved surfaces smart. Providing proximity, touch and force detection, it can easily be customised to address a variety of use cases, from industrial applications to consumer electronics. With its emphasis on partnerships, tacterion can provide support in every step of the product development process, including design and software services. It is part of tacterion’s vision to offer comprehensive solutions for seamless integration of tactile sensors. By enabling new ways of human-machine interaction, tacterion supports its partners in creating revolutionary products that make life easier and safer.

TSE Troller (Booth 506) offers optimised slot dies for electronic products. When designing new products in the field of flexible electronics, with the examples of organic photovoltaic (OPV) and organic LEDs (OLED), the appropriate components of the coating liquids are often only available in very limited quantity and correspondingly expensive. Thus, the filling volume of the entire system is very important to allow for economic development. Also, the application of a uniform, only a few micrometres thin wet layer, with a simple manual procedure is not possible. In order to ensure the scale-up from the laboratory in a subsequent “roll-to-roll” process the same application process should be used from the beginning, as it is most promising for a later production. This requires bridging the gap between the lab-scale of the development laboratory on one hand and industrialised, well proven coating processes on the other hand. For this purpose TSE has developed a modular coating system which allows coating onto individual “sheets” with an optimised slot die in lab-scale.

Ushio Europe (Booth 203) is specialised in industrial light sources. While the curing of inks, paints and adhesives used to be a process that could take a great deal of time, today, hardening and drying are fast and energy-saving procedures. In the printing and coating industry, these procedures can be done using the UV lamps and modules USHIO offers.

VARTA Microbattery (Booth 405) is an international innovation leader in the microbattery sector which offers high-end and technology leading power supplies in the areas of wearables, hearables, medical, as well as IT/communications, industrial/robotics, consumer and home & garden.

VDL Enabling Technologies Group (Booth 610) is a tier-1 contract manufacturing partner operating worldwide. The main customers of VDL ETG are leading original equipment manufacturers (OEMs) and users of advanced production lines in many high-tech markets: semiconductors, thin-film photovoltaics, analytical instruments, medical systems, aerospace, defence. VDL ETG manufacturers complex parts, subsystems and fully-integrated equipment in six volume factories located in The Netherlands, Switzerland, China and Singapore, and has strong design and engineering capabilities to support its customers throughout the entire lifetime of their products.

VTT Technical Research Centre of Finland (Booth 501) is a visionary research, development and innovation partner. The centre drives sustainable growth, tackles the biggest global challenges of our time, and turns them into growth opportunities. The researchers aim to go beyond the obvious to help the society and companies to grow through technological innovations. VTT offers a leading roll-to-roll pilot manufacturing infrastructure for printed and hybrid flexible electronics process upscaling. Its expertise covers a wide range of printed intelligence technologies, from material formulation and process development to production of individual components and systems.
Printed, flexible and organic electronics is a market worth US$31.6bn in 2018, according to IDTechEx Research. The majority of that is for OLED displays, with glass-based versions now entering their golden age and foldable OLEDs and printed OLEDs currently entering a phase of commercial growth. Then there is the near $2bn market for conductive ink used in many diverse applications and the $3.6bn market for sensors, mainly comprising of biosensors so far.

However, for many components and capabilities, one could categorise the printed electronics sector as “an old embryonic technology”. From the high levels of excitement and investment 10-15 years ago, to the sombre reality some 5 years ago as organisations focussed on real commercial benefits by addressing the challenges of making the technology suitable for purpose while also identifying new market opportunities.

The time has come
The industry is now at a very different point in its maturity curve. On the one hand, suppliers have increasingly successfully identified key business opportunities, where the technology provides benefit, while on the other hand more and more end users are flocking to the technology, where they seek competitive advantage through benefits such as reducing processing steps, adding new form factors and features and achieving things not readily possible before.

Huge opportunities are arising across a huge number of applications – some of them being multi-billion dollar opportunities. Take for example electronic skin patches, which have grown to be a market worth over $5bn in 2019 for monitoring glucose or heart rate. Increasingly, these require more and more flexible electronics. Indeed, e-textiles will become a market with over $2bn alone by 2028. On the other

Out of academia, into industry

On 10 and 11 April 2019, the “IDTechEx Show!” in Berlin will bring together decision-makers, innovators and investors in some of the most promising emerging technologies in the world. Just like in previous years, printed electronics will play a major role at the event.
hand you have those in PCB manufacturing who are switching to inkjet printing to reduce the number of process steps and therefore save time and money. One automotive electronics supplier will move to inkjet printing etch resist for all its PCBs this year. Then there is another using printing to repair defects on large area display panels – the alternative being to discard the new panel.

Smart packaging has come centre stage, with the user needs and technology capability now aligning for the first time thanks to new high volume production capability of flexible ICs and widespread reader infrastructure in addition to intent from global consumer brands. Other sectors that are particularly strong are healthcare, such as the OLED eye mask disrupting a multi-billion dollar industry for injections into the eye used to treat diabetic retinopathy, or the automotive sector where vehicle interiors are the new battleground in differentiation, with user interfaces and lighting enabled by printed electronics, to materials addressing the heat management issues in the increasing range of power electronics used in electric vehicles. In consumer electronics the adoption of 5G is creating massive new opportunities for spray-on or printable electromagnetic shielding materials. In short, printed electronics capabilities have spread into many different use cases, with the list growing and companies aligning themselves with the opportunities. Such applications are covered in depth in the IDTechEx report Flexible, Printed & Organic Electronics 2019-2029.

Printed electronics business opportunities
Held on 10-11 April 2019 in Berlin, Germany, the unique focus of the IDTechEx Printed Electronics Europe event is to speed up the adoption of printed electronics by bringing together end users with suppliers across the value chain and highlighting the successful case studies and end user needs. With 2500 attendees and 200 exhibitors expected, it is considered to be one of Europe’s largest shows highlighting the business opportunities in printed electronics. Buyers are no longer predominately the academic world – it is industry that is now driving the growth of printed electronics, which is the focus of this event.

To provide insight on applications, speakers include ABInBev, Beko, Boston Scientific, Continental, Google, Microsoft, Panasonic, Qualcomm Life, Samsung, Schreiner MediPharm, Siemens Healthineers, Sony, StoraEnso, United Technologies, US Army, Visionox and many more.

Image sources: IDTechEx report Flexible, Printed and Organic Electronics 2019-2029; Martin Hirschmann
Printed electronics is a key enabling technology. If we travel back in time a bit, printed electronics was seen as the key technology to enable electronics everywhere. This has become reality in some applications. However, this is not at all an obvious observation. In some cases, it may be reality but purposely hidden, integrated or embedded. Let us take a look at what printed electronics has achieved so far and what printed electronics everywhere means today.

The advantages and main characteristics of products using printed electronics are:

- Thin
- Flexible
- Lightweight

Especially in applications where functions need to be integrated, the usage of printed electronics brings value. Starting with the integration of conductive lines to connect components or printing of antennas, to embedded sensors or heating elements. Integration does not stop with printed electronics, conventional electronics such as LEDs and microcontrollers are integrated as well. Hybrid electronics solves both performance and structural requirements.

Key enabler
Printed electronics is the key enabler to integrate or hide functionality. This leads to advantages thanks to lower weight, lower complexity, better design options and, finally, lower cost. Electronics can be an integrated part of the housing, such as the integrated sensors in a car’s dashboard or the human interface of a coffee machine. It can also be the invisible integrated sensor matrix or heating element in the seat of a car.

The obvious killer applications for printed electronics are still missing. Today, printed electronics is hidden and integrated, so it is not easily recognised – but close to being everywhere. Consequently, we need to spread the news: Printed electronics – embedded and integrated – is a key enabler for a lot of new products and functions and also new product designs. Thin, flexible and embedded – the values for successful printed electronics projects today.

A good place to spread the news is the annual LOPEC (19–21 March), with an increasing number of applications demonstrated at the exhibition, as well as challenges and potentials being discussed at the different conference parts (business models and applications at the Business Conference, Challenges of upscaling and application challenges at the Technical conference).

Image sources: MSWtech

Printed electronics spreads out into new regions as well: At OPE MENA in January 2019 in Dubai, applications and products of printed electronics were discussed that could fit well into the region’s requirements.
Celebrating failures

VTT’s first Gala of Failures wanted to demonstrate that research sometimes needs setbacks to succeed in the long term.

“Not my fault, I followed the instructions!”
Have you ever felt the blush rising on your cheeks or had the uncomfortable feeling after realising that you have made a mistake? There is no reason to worry, we surely all have! However, our reaction to this is even more important. At the VTT Technical Research Centre of Finland’s Gala of Failures, which took place in January 2019 for the first time, VTT’s staff shared their stories of failing and learning from it – openly and in front of an audience.

In VTT’s Hackathon event in 2017, the researchers explored the idea of challenging different aspects of an issue – and instead of shame and blame starting to celebrate failures, because in the end they may be the remarkable moments that teach us a lot. “We wanted to encourage people to talk more openly about their failures, share their experiences and even be proud of what they have learned thanks to failing,” said young professional vice-chairman Nicolaas van Strien, who supported the idea of such an event.

Personal stories
At the Gala, VTT researchers told their personal stories about failing. Among them was VTT’s CEO Antti Vasara. He reminded the audience that VTT wanted to endorse the culture of failing – and learning from it.

“We cannot always choose not to fail, but we can choose to learn from it. If you never take risks, you will miss some great opportunities. A failure is not the end of the world, so let’s speak up about them and learn the lessons the failures teach us. Learn fast,” he emphasised.

Dressing up as an ant, laughing at Linux
During the evening, stories were heard from VTT researchers’ failures in personal life such as poisoning one’s family members by cooking toxic mushrooms or going to a masquerade evening party mistakenly dressed up as an ant, as well as related to one’s earlier studies or career. Being too self-confident to admit that one has made some totally wrong calculations as part of an important research, or taking Linus Torvalds’ ideas about open source as something ridiculous.

“I very much appreciate that people from different stages of their career shared their learning processes. Actually, the best innovations in the world are often born as a result of trial and error,” added VTT’s senior VP in human resources, Kirsi Nuotto, who also shared her own story during the evening.

At the end of the gala, the Fail of the Year was awarded to VTT’s research scientist Mykola Ivanchenko, who even presented a theory about failing with its most typical “it wasn’t me, I wasn’t even there” reactions. The VTT leadership especially thanked the people behind the idea for the gala, Nicolaas van Strien, Magnus Strandberg, Erkka Rinne and Marton Szogradi for organising this memorable event. So, maybe it is time to ask: “What has been the biggest or funniest failure during your career?”

Image sources: VTT
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Get in touch with us and become a part of the media hub for organic and printed electronics:
Please contact Nina Pirchmoser, sales@ope-journal.com or call: 0049 69 7595 1227, to book your personal entry in OPE journal.
Dear Reader,

Printed electronics is an innovation driver, also in the mobility sector. This thin, light-weight and flexible technology is increasingly being applied in areas ranging from automotive and vehicle technology to avionics.

A key trend in the automotive industry is the tendency for motor vehicles to become “smarter” and to have more and more information interfaces with the driver or passenger, all while being lightweight and taking up very little installation space. As more operating functions, including eventually driving itself, are carried out by on-board computers, the driver/passenger will have even more interaction with information and entertainment systems in the car.

3D structural electronics promises a new approach to integrating electronics into vehicle designs – doing away with the complexity of multi-part assemblies, removing buttons and switches; and instead creating seamless, fully integrated designs. The trend is for these interfaces to be integrated into the car interior, which has led to flexible and conformable touch sensors and displays, enabled by printed electronics to be used in modern cars. OLED technology is already implemented commercially in cars, both for interior displays and for taillights. A key selling point for OLED in this case is the freedom of design, which is not feasible with any other light source. OPV is also being used as an energy harvester to power ventilation when a car is parked in the sun and electrochromic windows can be used to automatically dim blinding lights.

Many of these examples can also be applied in aviation and public transportation modes. Sensors, lighting and other elements made with state-of-the-art printing technologies are now being used in planes. There are for example printed sensors integrated in turbine blades which detect bird strikes. In case a plane is hit by a bird, serious damage or even engine failures can occur. With this sensor technology it is possible to easier as well as quicker recognize and locate the damage, enhancing safety and reducing cost. Furthermore, some airplanes are already equipped with electrochromic windows which can automatically or manually adapt its shade from transparent to black. Due to this technology shutters are no longer required, which enhances user experience and reduces thickness and weight.

LOPEC 2019 will of course cover these industry sectors in more depth at both the Conference as well as the Exhibition. We are looking forward seeing you on March 19-21 in Munich, Germany!
OE-A’s Activities at LOPEC 2019

Also this year, OE-A will organize several exciting printed electronics related activities at LOPEC 2019.

OE-A Exhibition
Visit the over 60m² sized OE-A exhibition booth (B0 216) to meet us personally and find out everything you want to know about printed electronics. The booth will feature various products integrating the organic and printed electronics technology. All aspects of printed electronics, from research, materials and production techniques to end-products will be showcased. Exploring the products and demonstrators from the OE-A Competition should prove especially interesting.

OE-A Competition 2019
The annual OE-A Competition encourages young engineers and scientists, as well as companies and designers, to develop a vision for future applications incorporating organic and printed electronics as well as to present exciting new products.

The jury, consisting of experts from the organic and printed electronics industry, will announce the winners of the various categories during the LOPEC 2019 Dinner & Award Show on Wednesday, March 20. But you, the visitor at LOPEC, can have a say too! Visit the OE-A booth on that special day, discover all submitted demonstrators, and vote for your favorite. The winner will receive the Public Choice Award, and you, as voter, have a chance to win a very special prize.

Demo Line
LOPEC will also provide all this year’s visitors, from manufacturers to users of printed electronic components, with a perfect opportunity to obtain information on the production process involved in organic and printed electronics by seeing the machinery in operation. On March 20–21, the Demo Line will demonstrate the entire value chain of producing an electronic dice based on a flexible chip, printed battery and LEDs – a perfect example of a hybrid system, in which classical electronics are combined with printed electronics.

This technology showcases the versatility of printed electronics especially when it comes to flexibility and ease of production through roll to roll processes.

The LOPEC Demo Line is a unique initiative of OE-A members, coordinated by Hochschule der Medien in cooperation with adphos Digital Printing, American Semiconductor, Coatema Coating Machinery, DuPont Teijin Films, Elantas Europe, Elmaric, Novacentrix, Varta Microbatteries and Witte. Several OE-A member companies, representing the entire value chain, come together and pool their resources to further develop emerging technologies as well as create innovative products – and this in the challenging environment of an exhibition hall.

If you want to experience the entire value chain of an electronic dice, then visit the Demo Line (B0 405) at LOPEC 2019 and pick up your demonstrator! Try your luck this year: Win a prize by rolling the sequence 1, 2, 3 and 4! When all 7 lights flash, come to the Demo Line booth to pick up your prize. \^

For more information about OE-A’s activities at LOPEC 2019, visit www.lopec.com or www.oe-a.org
For the third time in a row, OE-A represented the printed electronics industry at CES – one of the world’s largest trade shows for consumer technology. Held annually in Las Vegas, NV, USA, it attracts 180K+ attendees, gathering over 223,000 net square meters of exhibit space and presenting more than 300 conference sessions.

The future of consumer electronics includes printed and flexible technologies

Numerous industry sectors, from automotive, consumer electronics and household appliances to packaging and healthcare, have products based on organic and printed electronics. Consumer electronics is currently the largest industry in which this technology is being applied. This technology can be found in e-readers, smartphones and tablets, and it is used to turn clothing and accessories into intelligent wearables, as well as making the operation of automobiles and many devices more intuitive and thus easier through the use of touch sensors. The adoption of flexible and printed electronics is being driven by numerous benefits – ranging from low-cost and robust to lightweight, flexible and thin.

On January 9-12, 2019 OE-A introduced the new technology of organic and printed electronics at this international event. This novel technology has a major influence on the consumer technology industry, especially in the areas of the Internet of Things (IoT), wearables and automotive. Special focus was given to the integration of this innovative technology into consumer electronics. This growing market helps to bring more end-users to the printed electronics network, which will prompt closer collaboration between the product industry and the technology developers. This cooperation will eventually lead to the optimization of existing products as well as to the development of new ones.

OE-A successfully brought the future of printed electronics to CES 2019

OE-A joint pavilion and conference track drew a crowd in Las Vegas

OE-A successfully brought the future of printed electronics to CES 2019. OE-A's conference track “Printed Electronics: Flexible, Lightweight, Smart” consisted out of the sessions “Driving the Future of Mobility”, “Digitizing healthcare for increased wellbeing” and “Connecting Objects, Homes and Cities”. Speakers included, Coatema Coating Machinery, PolyIC, Holst Centre/TNO, IEE, Cambridge Display Technology, American Semiconductor, VTT Technical Research Centre of Finland, InnovationLab, COPT Center, NovaCentrix, Fraunhofer FEP and Ynvisible. Topics ranged from IoT, wearables, and human machine interfaces (HMI) to flexible, OLED displays, interactive touch sensors, and hybrid systems.

As one of our members said: “CES enabled us to meet with leading electronics companies and broaden exposure outside our standard customer base. We were able to build relationships with other OE-A companies and existing collaborators showcasing our products and partnerships, and promoting our brand in the US.”
OE-A presented its initiative on sustainability at innoLAE 2019

Circular economy proofs to be an important yet challenging topic in the printed electronics industry

The 5th annual Innovations in Large-Area Electronics Conference (innoLAE 2019) was held at the Wellcome Genome Campus Conference Centre, Cambridge, UK on 22-23 January 2019. The conference programme highlighted the most innovative and exciting aspects of large-area electronics (LAE), a new way of making electronics that includes printable, flexible, plastic, organic and bio electronics. Besides that OE-A and LOPEC exhibited, OE-A presented its initiative on sustainability.

Large-Area Electronics and the Circular Economy

For the first time innoLAE organized a session dedicated to exploring the issues of LAE and the circular economy. Society, governments and businesses are increasingly aware of the need to shift the design, manufacture and end-of-life treatment of products towards a more sustainable, circular model. This provides a timely opportunity for the LAE community to discuss the challenges and opportunities of the circular economy for our industry.

On the first day of the conference Marco Meloni, research analyst at the Ellen MacArthur foundation, set the scene by delivering a keynote presentation introducing the circular economy. He pointed out that this can be realized by designing out waste and pollution, keeping products and materials in use, as well as by regenerating natural systems.

The Circular Economy workshop took place on the second day and provided attendees the opportunity to explore the topic further with examples and discussion specific to LAE. The workshop included a presentation by Sophie Isabel Verstraelen, Project Manager at OE-A, who presented what the printed electronics industry is currently doing to address sustainability and introduced the aims and activities of the OE-A Sustainability Working Group. Other speakers included Dr Danick Briand, Senior Scientist, Ecole Polytechnique Fédérale de Lausanne (EPFL); Gillian Ewers, VP Marketing, PragmatIC; Clement Gaubert, WEEE Scheme Manager, Veolia; and Marco Meloni, Research Analyst, Ellen MacArthur Foundation. The dialogue during the panel discussion that followed confirmed that this topic is very important for the various stakeholders. The aim therefore is to continue working together on creating a more sustainable industry.

Sophie Isabel Verstraelen, Project Manager, OE-A, presented the aims and activities of the OE-A Sustainability Working Group as well as discussed the topic with various stakeholders at the panel discussion during the Circular Economy workshop at innoLAE 2019

OE-A presented its initiative on sustainability at innoLAE 2019
First Conference on Organic and Printed Electronics in Dubai

Organized by MasarPrint, Dubai Media Inc. and OE-A in Dubai, UA on January 29-30, 2019

Dubai invests heavily in future technologies and has kickstarted several initiatives to enable partnerships between entrepreneurs, private sector organizations and government entities, to co-create solutions in a broad range of technological approaches and societal impacts. It is therefore no surprise that the technology of organic and printed electronics is of great interest and importance as well. This was also confirmed by the visit of Sheikh Mohammed bin Rashid Al Maktoum, the Vice President and Prime Minister of the United Arab Emirates (UAE), and Ruler of the Emirate of Dubai.

On January 29-30, 2019 MasarPrint in cooperation with Dubai Media Inc. and OE-A organized a conference on Organic and Printed Electronics at the Grand Hyatt in Dubai, UA. Supported by the Dubai Energy and Water Authority, this conference included the topics Functional Printing, Organic Photovoltaics, Smart Home / Connected Objects, Upscaling Production, and RFID / NFC / IoT.

The conference was filled with presentations from various OE-A members, such as PragmatIC, MSWTech, Heliatek, Armor, Merck, FlexEnable, db-matik and VTT. They talked about Flexible and Printed IoT Devices, Organic Photovoltaics & Energy Storage, Materials for Printed Electronics, Flexible Displays and Lighting Solutions, Process and Production of Printed Electronics, Sensors and Smart Objects, and Applications of Printed Electronics.

Furthermore, there were various tabletop stands where the printed electronics technology was showcased through various products which could be tried out. In addition, there was a company visit to the facilities of MasarPrint, one of the largest print shops in the region.
OE-A at ISPO 2019: Flexible and Printed Electronics for Electrifying Sportswear

**Printed Electronics represented at world’s biggest sporting goods trade fair**

On February 3-6, ISPO – the world’s leading sporting goods fair – took place at Messe München in Munich, Germany.

### OE-A Seminar “Flexible and Printed Electronics for Electrifying Sportswear”

Flexible sensors to measure your performance, integrated lighting for additional safety or self-heating jackets to increase your well-being. Organic and printed electronics stand for a revolutionary new type of electronics, which are thin, lightweight, flexible, robust and produced at low cost, from organic, polymeric or inorganic materials. The high degree of freedom of design requires a holistic approach in product design to enable this wide range of novel applications.

On Monday, February 4 OE-A organized a seminar at the ISPO Academy. This one-hour seminar presented current use-cases on integrating printed and flexible electronics into sporting goods to increase functionality of garments as well as efficiency and well-being of the wearer. OE-A members CenTi, DuPont Advanced Materials as well as MAS Innovation and Real Track Systems presented their use-cases of integrating printed electronics technologies into sporting goods to enable new features for the whole industry. When the speakers were being asked to look into the future, they expect that the next major thing is energy harvesting in textiles. This enables the powering of the electronic devices while wearing the apparel.

With this seminar, OE-A further strengthened the connection to the end-user and showcased the necessity of joint product development to successfully integrate next-generation electronics into sporting goods.

### Cross-industry: Join the guided tour to meet the end user

To combine technology and sport, we continued our successful cross-industry initiative. Following the seminar, OE-A and LOPEC offered a guided tour to selected end users of the international sporting industry, such as Reusch, Schöffel and Mammut. We organized a matchmaking between a group of executives from Organic & Printed Electronics, R&D professionals and product managers from international exhibitors. What became apparent was that the sporting goods industry is highly aware of the added value integrating electronics in their products. However, since this technological know-how is often outside their traditional domain, they are looking for development partners to tackle these challenges. This is where OE-A comes into play: By connecting its members with the sports industry, knowledge and technologies can be exchanged and new partnerships can be made. The result will be new smart products, enabled by printed electronics.
**OE-A Calendar of Events**


Creating the right partnerships is essential both among companies as well as between companies and research institutes. By hosting quarterly Working Group Meetings, the OE-A provides its members with an effective networking and communication platform, fostering collaboration and promoting information exchange among all the players along the value chain.

### OE-A Meetings Europe

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
<th>Location</th>
<th>Host</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Assembly / OE-A Meeting Europe (incl. board elections)</td>
<td>March 18, 2019 (day before LOPEC)</td>
<td>Munich (DE)</td>
<td>Hosted by IBM Watson</td>
<td></td>
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### OE-A Meetings Asia

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>OE-A Meeting</td>
<td>October 22, 2019 (day before ICFPE)</td>
<td>Hsinchu/Taipei (TW)</td>
<td>Hosted by ITRI</td>
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### OE-A Meetings USA

The OE-A is cooperating together with North American industry associations and conferences in order to increase end-user involvement in the printed electronics industry. Upcoming OE-A Working Group meetings in the USA to be announced.

### Trade fairs and conferences where you can meet the OE-A

**Members benefit from reduced fees for several conferences**

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
<th>Location</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOPEC</td>
<td>March 19-21, 2019</td>
<td>Messe München, Germany</td>
<td>Messe München and OE-A jointly host the leading international trade fair and conference. The event offers a high-quality platform to all manufacturers, industrial customers and research institutions engaged in the field of organic and printed electronics. <a href="http://www.lopec.com">www.lopec.com</a></td>
</tr>
<tr>
<td>ICDT Display Conference and Tradeshows (SID China)</td>
<td>March 26-29, 2019</td>
<td>Suzhou (CN)</td>
<td>OE-A is partner and organizes a Flexible Printed Electronics session</td>
</tr>
<tr>
<td>ICFPE 2019</td>
<td>October 23-25, 2019</td>
<td>Taipei (TW)</td>
<td>OE-A is partner of ICFPE and organizer of a conference session</td>
</tr>
<tr>
<td>productronica 2019</td>
<td>November 12-15, 2019</td>
<td>Munich (DE)</td>
<td>OE-A will have an exhibition booth and will host free seminars on organic, flexible and printed electronics</td>
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