NO 34, MARCH 2021

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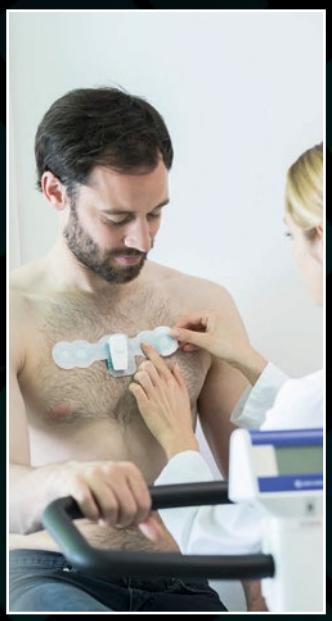

OPE journal Issue 34

Smart Living & Mobility

Editorial deadline:
9 February 2021

OPE journal Issue 35

IoT, Sensors & Healthcare

Editorial deadline:
13 April 2021

OPE journal Issue 36

Flexible Displays & Lighting

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Martin Hirschmann
Editor-In-Chief OPE journal
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Dear Readers,

Once again, I spent the first few working days of the New Year by browsing through the latest gadgets and consumer electronics innovations at CES – a fully digital event due to the pandemic. One thing I noted fairly quickly is that we are close to the age of robotics at home. For instance, Samsung dedicated large parts of its media presentation to this exciting field. The second big trend that I think dominated CES 2021, was the advent of the Internet of Everything, instead of 'just' the IoT.

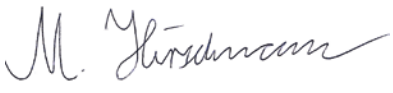
I have said it before in this editorial section: I am not a fan of all IoT solutions. Please spare me with smart doorbells – why would I pay for a technology that makes my home vulnerable to hackers, as has been the case numerous times?[1] I also really do not need a smart fridge with internet connection – I still want to buy my own things in the supermarket!

The experts at Henkel, one of the editorial contributors to this issue, say: "While today's pursuit of the Internet of Things is filling our homes with ever more connected devices, a new vision is emerging where all this technology increasingly disappears." And this is where things get interesting for me. I want to profit from an IoT that analyses my consumption of electricity, water, heating, etc. and offers me ways of improving these cost factors. I would also like to enjoy AI technologies within the IoT that go beyond what is oftentimes the case today: For instance, when I order sushi online, I am still baffled at the fact that in the next few weeks, I will see dozens of ad banners for sushi restaurants. Smart AI would know that it is far more likely for me to order Italian food next time. Even when I bought a new TV set recently, I was flooded with ads from TV manufacturers afterwards. Quite obviously, this is not smart.

I would be happy to discuss these and other topics with you soon. One platform for exchange will be LOPEC online – even though we will not be able to be physically present there. Besides our focus on "Smart Living and Mobility", this issue also includes a preview on this event.

As always: Stay safe and enjoy reading this issue!

Yours



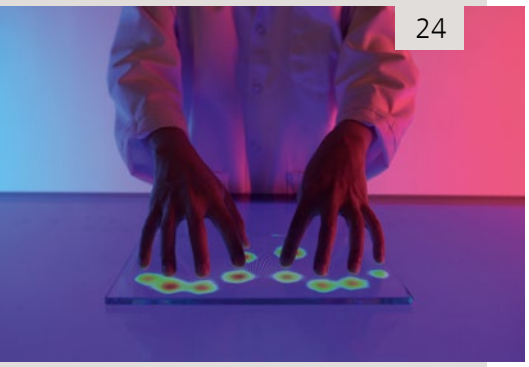
[1] https://www.bbc.com/news/technology-55044568

2021

TechBlick: "Printed, Flexible, Hybrid, & InMold Electronics" www.techblick.com	10 March 2021	Virtual event Organiser: TechBlick
LOPEC DRIVING THE FUTURE OF PRINTED ELECTRONICS	23-25 March 2021	Virtual event Organisers: Messe München, OE-A, www.lopec.com
TechBlick: "Graphene, Nano Carbon & 2D Materials: Applications and Commercialization" www.techblick.com	14 April 2021	Virtual event Organiser: TechBlick
virtual.drupa 2021 www.drupa.com	20-30 April 2021	Virtual event Organiser: Messe Düsseldorf GmbH
Touch Taiwan 2021 www.touchtaiwan.com/en	21-23 April 2021	Location: Nangang Exhibition Center, Taipei, Taiwan; Organisers: TEEIA, Chan Chao Int'l, TDUA
InPrint Munich 2021 www.inprintmunich.com	Postponed to 22-24 June 2021	Location: Messe Munich, Germany Organiser: Mack Brooks Exhibitions
ICE Europe www.ice-x.com/europe	Postponed to 22-24 June 2021	Location: Messe Munich, Germany Organiser: Mack Brooks Exhibitions
Nanotexnology www.nanotexnology.com	3-10 July 2021	Location: Porto Palace Conference Centre, Thessaloniki, Greece Organisers: LTFN et al.
ICFPE 2021 https://www.eng.niigata-u.ac.jp/~icfpe/	28 September – 1 October 2021	Location: Toki Messe, Niigata, Japan; Organiser: ICFPE
productronica 2021 www.productronica.com	16-19 November 2021	Location: Messe Munich, Germany; Organiser: Messe München

2022

CES 2022 www.ces.tech	5-8 January 2022	Location: Las Vegas, Nevada; virtual space Organisers: CTA



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oe-a NEWS

Epishine unveils thin and flexible organic solar cell

NEWS

Epishine's "light cell" can change how we power small electronics – a thin and flexible organic solar cell that can be integrated in sensors, consumer electronics and other low power devices to reduce or eliminate the need of batteries. "We are very proud to have taken the results from more than 25 years of research into this product. What makes it even better is that we have also developed a production process that is scalable into large volumes. This makes us one of the global leading actors in printed organic solar cells," says Anna Björklou, new CEO of Epishine (Linköping, Sweden).

Epishine's light cells are non-toxic, based on organic electronics and encapsulated in recyclable plastics. The unique scalability is due to the fact that the entire manufacturing process is based on different printing techniques, roll-to-roll. The thin and flexible cells can easily be integrated into typical plastic-based electronics housings.

The global digital transformation requires more and more dataflow between the physical and digital worlds. This will rapidly lead to countless of small sensors and displays that today are powered by batteries. This is not sustainable, neither from an environmental perspective nor from a maintenance perspective. Epishine's cutting-edge light cell is optimised for ambient light indoors. All electronic devices that today are powered by small batteries that last for a year or more can potentially be powered by harvesting ordinary indoor light with this innovation.

The new Swedish light cell that Epishine is starting to sell is manufactured in an industrial process with capacity for the world market (image source: Epishine)

Changes in the management board of 3D-Micromag AG

NEWS

3D-Micromac AG (Chemnitz, Germany), a leading specialist in laser micromachining and roll-to-roll laser processing systems, has announced that as part of its successful strategic realignment, a consortium of US investors has acquired a majority stake in the company. The founder and previous majority shareholder Tino Petsch has also sold part of his share package and will withdraw from the operative business. His former fellow board member, Uwe Wagner, will continue to manage the business of 3D-Micromac AG with overall responsibility.

Tino Petsch founded 3D-Micromac AG in 2002, built it up over the years and represented it as a board member. Together with Uwe Wagner, Tino Petsch has consistently advanced the company in recent years, putting 3D-Micromac AG on a solid economic footing despite the current difficult times. The investors now acquired also contribute to this. Tino Petsch will remain with 3D-Micromac AG as a consultant and will continue to be associated with the company as a shareholder.

Uwe Wagner has been appointed to the management board of 3D-Micromac since 2017 and was previously responsible for the technological and commercial management. He commenced his professional career at the Laser Zentrum Hannover (LZH). In the following years, he was responsible for product management, international sales and the development of new business areas at LPKF Laser & Electronics AG, Jenoptik Automatisierungstechnik GmbH and Jenoptik Laser GmbH, among others, and worked in business development at Jenoptik's Lasers & Material Processing division. Uwe Wagner has been working for 3D-Micromac AG since 2012. After starting in business development, Uwe Wagner was appointed chief sales officer (CSO) in 2013. In early 2017, Uwe Wagner took over the technological management of the Chemnitz-based mechanical engineering company as chief technology officer (CTO). In the same year, he was appointed to the management board.

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Executive Management Board:
Peter Esser, Sönke Reimers (Speakers of Management Board), Thomas Berner, Markus Gotta

Supervisory Board: Andreas Lorch, Catrin Lorch, Peter Ruß, Angela Wisken

Publishing Director: Dirk Lehmann,
☎ +49 69 7595-1291, ✉ dirk.lehmann@dfv.de

Editor in Chief: Martin Hirschmann, ☎ +49 69 7595-1546, ✉ martin.hirschmann@dfv.de

Director Finances and Media Services:
Thomas Berner, ☎ +49 69 7595-1147

Production: Hans Dreier (Ltg.), ☎ +49 69 7595-2463

Logistics: Ilja Sauer (Ltg.), ☎ +49 69 7595-2201

Graphics: Nadine Bauernfeind

Advertising Director technical publications:
Heidrun Dangl, ☎ +49 69 7595-2563, ✉ heidrun.dangl@dfv.de

Advertising Sales Director: Nina Pirchmoser,
☎ +49 69 7595-1227, ✉ nina.pirchmoser@dfv.de

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ITRI and DuPont jointly inaugurate semiconductor materials laboratory

NEWS

The Taiwanese Industrial Technology Research Institute (ITRI) and DuPont Electronics & Imaging (DuPont) recently celebrated the opening of a new semiconductor materials laboratory in Hsinchu, Taiwan. DuPont established the laboratory to stay close to the semiconductor industry in Taiwan. DuPont will conduct, in collaboration with ITRI, semiconductor material research, development and enhancement, and accelerate pilot testing and commercial viability to support DuPont's customers as they pursue the next generation of semiconductors in Taiwan.

Dr Chih-I Wu, VP and general director of ITRI's Electronic and Optoelectronic System Research Laboratories, stressed that ITRI has long invested in semiconductor research and development and has a solid foundation in the fields of electronics and optoelectronics, advanced packaging processes, chemistry and materials. With the support from AI on Chip Program of Department of Industrial Technology (DoIT), Ministry of Economic Affairs (MOEA), ITRI will expand investment in advanced equipment and technology, heterogeneous integrated packaging experiment platforms and diversified design, manufacturing processes and prototype production services. "Bringing together ITRI's semiconductor-related technical strength and DuPont's expertise in materials, this laboratory in ITRI's vicinity will enable closer exchanges between the two organisations to bring more innovative solutions and meet the immediate needs of Taiwan's semiconductor and IC substrate industries," he said.

"DuPont has been conducting business in Taiwan for more than 50 years and has grown alongside Taiwan's industrial development, especially in the electronics industry. Our investment in semiconductor technology and manufacturing centres in Taiwan serves as our hub in Asia Pacific to promote advanced semiconductor technologies globally," said Dennis Chen, DuPont Taiwan president. "Over the years, we have made efforts in strengthening technological breakthroughs, terminal applications and supporting the strategic technology roadmap in Taiwan. The inauguration of this laboratory marks another important milestone as we continue to enhance innovation and R&D capabilities in Taiwan."

The unveiling ceremony marked the official opening of the materials laboratory (photo: DuPont)

VON ARDENNE welcomes new member of the executive management

NEWS

Klaus Löffler is now part of the executive management of the VON ARDENNE Group. He will join Pia von Ardenne-Lichtenberg at the executive management of the Dresden-based technology company and assume the newly created role of chief sales officer (CSO). Previously, Löffler was head of sales and managing director of Trumpf Lasertechnik GmbH. He has a lot of experience in international industries such as laser technology, medical engineering, consumer electronics and the automotive industry. At VON ARDENNE, he will focus on growth markets and the expansion of sales channels.

The emphasis will continue to be on the megatrends e-mobility, renewable energy, saving resources and digitalisation. In these fields, VON ARDENNE has decades of technology expertise gained from manufacturing efficient and high-quality vacuum coating systems and covers the whole spectrum of requirements in applications ranging from R&D to pilot to mass production.

Klaus Löffler, new CSO at VON ARDENNE (photo: VON ARDENNE)

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Enhanced comfort and safety in future cockpit design

Lotte Willems, business development manager, TNO at Holst Centre, highlights the latest in car interiors: transparent displays, safe and programmable interfaces and sensing chairs

Vehicles of the future are being transformed today to meet the societal challenge of reversing climate change. Meeting zero-emission goals, increasing shared mobility and improving safety are some of the focal points. The latter is not limited to reducing accidents, but also focuses on stopping the spread of viruses, something which the recent pandemic has made us acutely aware of. Manufacturers of cars and commercial vehicles and their supply chain are exploring, developing and implementing new technologies to meet the upcoming European regulations on safety. TNO at Holst Centre supports the automotive supply chain by bringing their expertise in flexible electronics to the table. Innovations in flexible electronic materials and processes enable new features in car interiors: transparent displays, safe and programmable interfaces and sensing chairs. In this article you will learn more about the technologies behind these new features and how they can enhance comfort and safety in the cockpits of the future.

Blind spots become visible

To achieve 'zero road deaths and serious injuries' by 2050, new European regulations dictate that detection of vulnerable road users like pedestrians and cyclists by commercial vehicles should be improved. One of the main topics is reducing or even eliminating a truck's blind spot, where the field of view is limited. Cameras are available, but information they generate is typically displayed outside the driver's direct line of sight, increasing distraction. There is a need to bring all available information into one line of sight. A future solution is the use of transparent signage or displays in the window of a truck that only signal dangerous situations. A warning or camera image can be displayed if a car, a cyclist or a pedestrian is present in the truck's blind spot, but in other situations the window is transparent. This innovation is enabled by the developments of very small pixels, the so called mini-and micro-LEDs in combination with transparent conductors and large-area, low-cost processing technologies. TNO at Holst Centre has demonstrated full roll-to-roll manufacturing of up to 30-metre-long flexible LED foils, and now focuses on improving transparency and resolution together with its network of material and component suppliers. In addition, we team up with assembly equipment partners and end-users to bring this technology to the market.

Flexible LED foil from TNO's fully automated roll-2-roll assembly line

Sensing seats

Another safety aspect of the upcoming European safety regulations is that they require detection of driver fatigue and alertness in all motorised vehicles. There are several methods available today, but each has its own drawbacks. Cameras infringe on privacy, steering wheel hands-on-detection can be tricked, and lane monitoring does not work in all weather conditions. On top of that it would be beneficial to be able to detect a driver's emotional state, as anger and stress also increase the chance of having an accident. With sensor mats invisibly integrated in car seats, it becomes possible to unobtrusively monitor people's physical and emotional state. These sensor mats contain a dense grid of pressure and piezo sensors, allowing direct sensing of physiological parameters. The principle used to detect movement, heart rate and respiration rate with piezo sensors is called Ballistography and it measures the vibration produced by pulsating blood or breathing. TNO at Holst Centre has demonstrated the ability to measure a driver's heart rate and respiration rate under driving conditions with a system that passed most automotive tests. TNO at Holst centre has optimised the process to directly 'print' piezo and pressure sensors on highly conformable substrates, enabling low-cost, large-area sensors that can be unobtrusively

integrated into the car seat. This technology is now on the verge of being scaled up to production level and can seriously contribute to a safer driver's experience.

Safe, personalised dashboard for shared mobility

In the near future, vehicles will be shared by multiple users to increase vehicle utilisation and reduce the carbon footprint. These users, often from different generations and backgrounds, have different needs and preferences. Creating one dashboard or interface that meets the needs of all these different people is nearly impossible when physical buttons are used. The result would be an overcrowded console with a multitude of buttons, which would greatly inhibit its usability. That is why there is increasing interest in programmable interfaces, which also contributes to shared mobility. Furthermore, after an update or change of ownership interfaces can be re-programmed, so every person driving the car will have his or her own personalised dashboard.

Programmable interfaces are available as conventional glass-based displays such as touch screens, but these typically take up a lot of space and do not allow for a seamless integration in the dashboard, impacting the look and feel of a car's interior. Innovations in technology known as plastronics or in-mould electronics pave the way for the invisible integration of flexible touch screens in dashboards. TNO at Holst Centre has demonstrated such a three-dimensional and programmable interactive surface. This demonstrator was made by optimising the thermoforming process to avoid cosmetic defects and damaging the flexible touch OLEDs.

A sensor mat that can be integrated in a car seat

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TNO at Holst Centre

TNO at Holst Centre develops, innovates and connects. As an independent research and innovation centre, it is at the forefront of flexible electronics innovation that makes a difference for the future of mobility. The centre is a research & development partner for the automotive industry, offering system and process development, prototyping, productization support and technology transfer. It connects the Dutch Brainport region with a global ecosystem of industry partners and academia, enabling them to take advantage of each other's profound expertise.

The recent pandemic has spiked interest in the hygiene of consoles for deployment in shared vehicles. One solution is looking into touch-free interaction, but even though this is on the increase, gestures and voice-activation do not completely overtake touch, which is why the car of the future is expected to have multi-modal controls.

In the field of interactive surfaces there is a trend to measure the force of touch via piezo or image sensors and providing haptic feedback to the user via piezo actuators. It is important that these touch features are safe and that the risk of spreading viruses is reduced. Potential solutions to create safe interactive surfaces consist of applying special antimicrobial coatings, tracking the use and cleaning of the console and even actively applying cleaning methods. Together with partner-company Nanogate, TNO at Holst Centre is exploring the compatibility of these new coating materials with plastronics and in-mould electronics technology.

Hybrid printed electronics in Europe

The core technology that enables transparent displays, safe and programmable interfaces and sensing chairs is 'hybrid printed electronics'. This is the ability to make electronic products by means of an additive manufacturing process where conductive patterns are printed on foils, combined with semiconductor components. Combining printed circuits and devices with traditional electronic components like LEDs and chips enables large-area, flexible and freeform applications that can be manufactured in high volumes using roll-to-roll printing and assembly processes. In Europe the full supply chain of hybrid printed electronics is available: from research institutes to manufacturing capacity.

Image sources: TNO at Holst Centre

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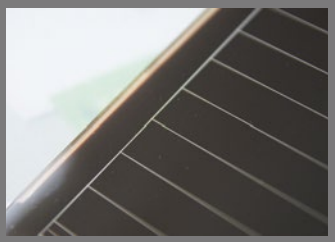
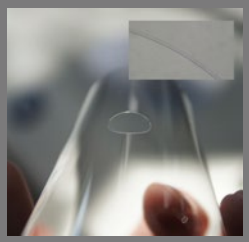
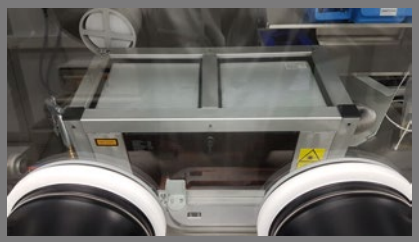
R+D laser systems for PV, battery and printed electronic


patterning, edge deletion and contacting


thin glas cutting


battery: cutting, drying, cleaning, recycling


Glovebox system (picture: KIT)

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Wireless interface for wearable IoT devices based on inkjet-printing technology

To create a flexible IoT device as thin as possible, DoMicro (Eindhoven, The Netherlands) has developed specific inkjet printing technology and micro assembly techniques to integrate thinned bare dies on foils. Combining these technologies has resulted in a demonstrator for wireless IoT devices

Demand for integration of electronics and wireless applications such as Internet of Things (IoT), wearables, healthcare and sensors is increasing. Applications such as big data requires numerous sensors being integrated in tools, products, systems and even wearables for personal health monitoring and well-being. Sensor devices in those applications and products require seamless and invisible integration.

Die bonding and contacting

Several die contacting and bonding configurations have been studied by DoMicro. Figure 1 is showing a Fan In Ball Grid Array (BGA) configuration by inkjet printing on bare die. An inkjet-printed dielectric is covering the die keeping open areas at the contact pads. Next on top silver ink is connecting the bond pads to a BGA pattern on top of the dielectric coating. Alignment and registration of structures are performed through the automatic vision system of the used PixDRO LP50 laboratory printer equipment.

Figure 2 shows the flip chip bonding of a bare die to an inkjet-printed silver pattern. For interconnection high accuracy alignment die bonding equipment is used.

Figure 3 is showing the face up thinned bare die of a microprocessor being interconnected on the bond pads. As it is impossible to print conductive tracks via a steep vertical surface, a dedicated ramp structure is provided to guide and support the inkjet-printed silver conductors. This innovative approach of contacting is avoiding any regular and height consuming wire bond loops with glob top or as applied in advanced packaging, a redefinition layer or substrate (RDL) interface. This 'die first' approach is creating minimal height for assembly and mounting dies in systems. Special attention is given to the optical alignment and compatibility of material surface interaction. With this innovative technology a flexible hybrid electronic (FHE) demonstrator was built.

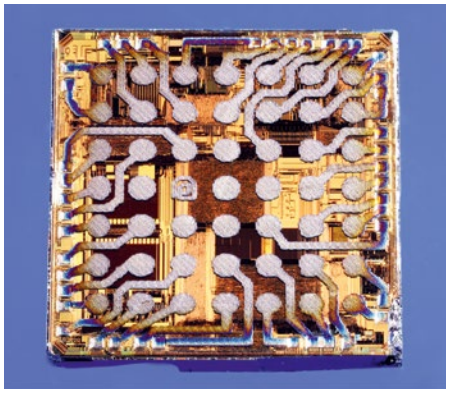


Fig. 1: Fan In Ball Grid Array printed on die

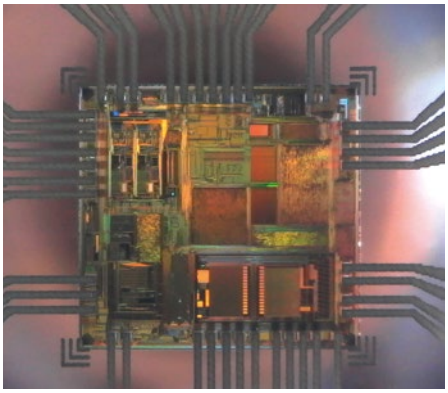


Fig. 2: Flip Chip bonding on printed tracks (through substrate view)

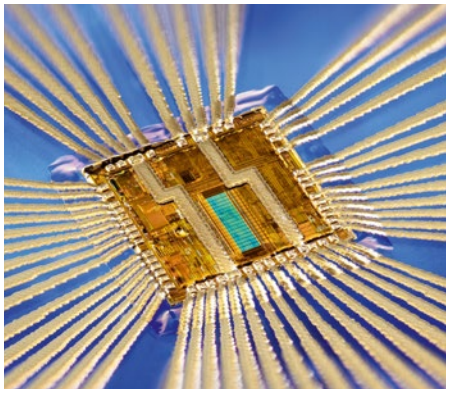


Fig. 3: Fan Out Die first face up

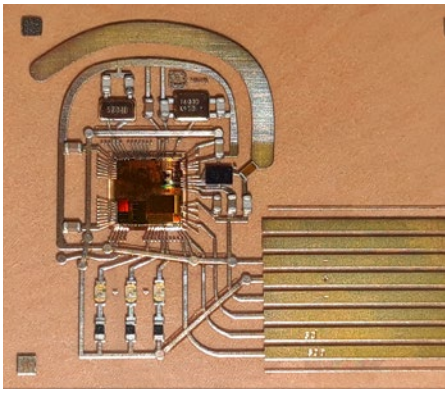


Fig. 4: Printed BLE beacon

Bluetooth beacon

The first step was to create the Bluetooth functionality. The Nordic 51822 Bluetooth low energy (BLE) chip was available in thinned bare die version and used. Based on an existing beacon design, a printed version has been built and demonstrated (figure 4).

Wireless flexible hybrid electronics interface

Typically, for having wireless functionality for IoT devices, some sensing function, computing processing and radio functionality should be combined and integrated to operate and communicate remotely from nodes to the network. DoMicro has built a demonstrator showing these functions by integration of a micro controller and Bluetooth radio Integrated Circuit (IC) onto a polyester foil. For the sake of demonstration, powering the demonstrator has been addressed with a regular cell battery. It is

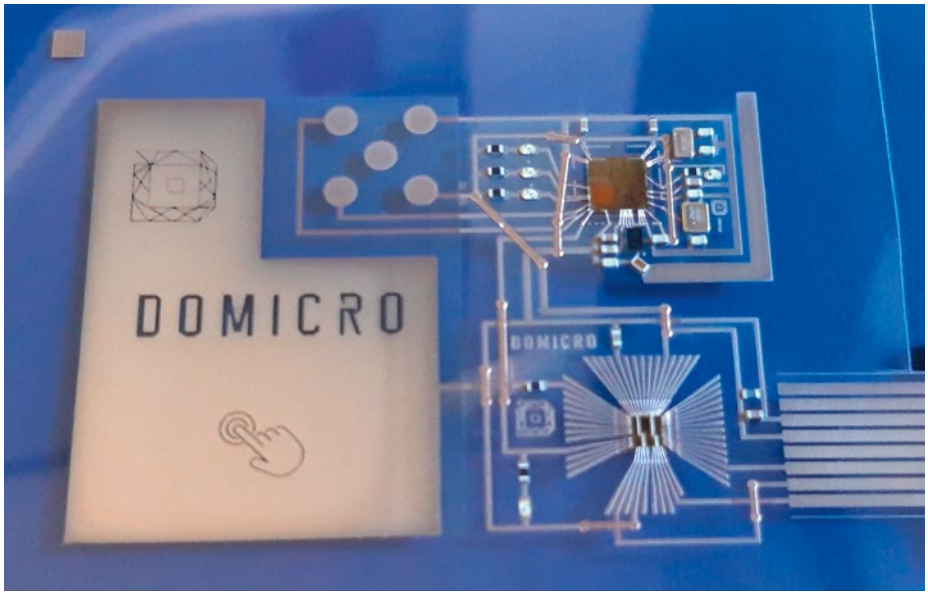


Fig. 5: Printed and bonded realisation in FHE

understandable that integration of a flat flexible battery solution would top off this wearable flat flexible device. Typical advantage over standard wire bond interconnection is the ability to print functional circuitry on all kinds of thin and bendable substrates. This form-factor enables smooth integration of functionality in all kinds of surfaces, labels, fabrics, etc. Next to that, the ability to integrate a bare die chip face up instead of flip chip, can expose the sensor interface in an extremely low height package solution.

On the polymer foil, a thinned Nordic 51822 BLE IC and a thinned Cypres CY8C20 touch controller are bonded and contacted in a functional circuit and antenna by inkjet printing technology. Powered with the external cell battery this demonstrator is able to show two-way Bluetooth communication with a cell phone app. The highly accurate inkjet-printed traces are aligned and connected to the fine pitch (60 micron track/gap) bond pad of the IC's. Passives used are approximately 0.5mm thick (height) as this is commonly available in SMD components. Figure 5 is showing the layout of touch area and electronic circuitry for both MC and BLE including the antenna structure.

After powering and testing by the Nordic Blinky app functionality is shown while interaction is initiated from the demonstrator device back and forth. The touch area is changing the states message in the app. Touch function is activated by a manual touch area on the sample, the state of the button is shown on the wireless interface. The LED can be switched on/off remotely and activated by a switch on the app.

DoMicro has demonstrated the possibilities of using FHE for thin bendable Bluetooth electronics that can be laminated in a thin flexible and/or wearable product or application. Target groups for the demonstrator can be all kinds of application developers in several industry sectors like automotive, transport and logistic companies, medical device companies, but also science, aerospace and other applications that might have a need for new ways of integrating electronic functionality in products and structures.

DoMicro BV is a technology company providing innovative manufacturing technology, application solutions and micro assembly technology for flexible hybrid electronics (FHE) and micro devices. DoMicro excels in developing cutting edge inkjet printing processes and technology for micro assembly and 3D packaging. At the forefront of innovation DoMicro offers state-of-the-art R&D services and exploration of new capabilities and applications for customers with manufacturability in mind. Its approach is lean, agile and dedicated.

The company delivers R&D services, small series production, system architecture and project management. Typically for customers exploring new technologies for circuitry on flexible substrates like transparent conductive films, OPV electrodes, OLED, Lab-on-chip, wearables, in-mould electronics, IC and MEMS integrations.

Image sources: DoMicro

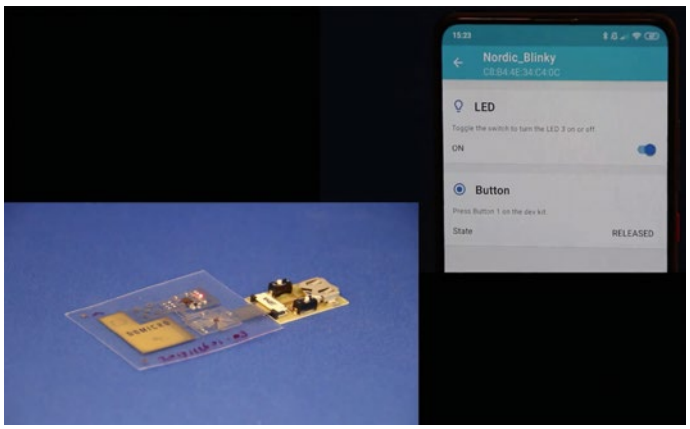


Fig. 6: LED on, button released

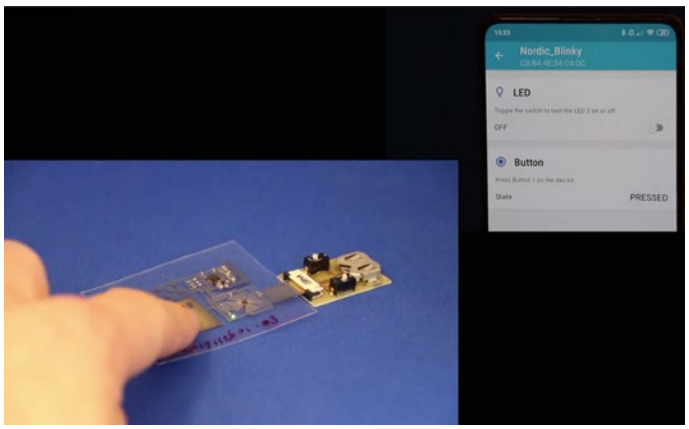


Fig. 7: LED off, button pressed

New value beneath the surface

The experts at Henkel and Bare Conductive explain how smart homes of the future are enabled by printed electronics technologies

Step into the smart home of the future and you might not see a difference. While today's pursuit of the Internet of Things is filling our homes with ever more connected devices, a new vision is emerging where all this technology increasingly disappears. For Henkel, a global leader in specialised and cross-functional ink formulations for printed electronics, the next decade will see the rise of smart surfaces that integrate new capabilities into the built environment. Whether it is homes that warn of leaking pipes, walls that heat our rooms, or floors that tell us when an elderly relative has suffered a fall, many of the core technologies are already here. Today, the challenge facing pioneers is less about innovation and more about building networks and creating markets. Stijn Gillissen, Global Head Printed Electronics at Henkel and Matt Johnson, CEO of Bare Conductive, describe the promise of smart printed electronics surfaces and the challenges of ecosystem building. While Henkel (Düsseldorf, Germany) is a globally leading manufacturer of printed electronics materials such as inks and coatings, Bare Conductive (London, UK) provides the technology to produce smart surfaces for a variety of applications.

Fig. 1: With smart printed electronics surfaces, wall elements can take on additional functionalities such as self-regulating heating, optimising the use of space

Any object can become smart

"In ten or fifteen years any object that we have in our home today has the potential to become smart," explains Stijn Gillissen. As global head of Printed Electronics at Henkel, anticipating this evolution is an important project for Gillissen and his team. With a portfolio of silver, carbon, dielectric and clear conductive inks, Henkel has been enabling leading-edge printed electronics solutions for more than four decades. Its printed electronics materials are used in a wide range of application fields, from smart surfaces in automotive, furniture and building materials to solutions for medical and consumer products. Over this time, the company has formulated inks to address changing market requirements, such as printed electronics applications becoming finer in dimension and more complex in functionality.

"It is hard to predict which products will evolve to become smart," says Gillissen. "However, it's clear that printed electronics offer the possibility to introduce smart functionalities where we need them and make many everyday objects and surfaces smart in an affordable way. We can't yet predict winners, but we know that our industry will be a key enabler in this respect."

According to Gillissen, Henkel is convinced that no one industry or company will define the emerging smart surfaces market. Rather, collaboration across the industry will be key. Alongside major established players, pioneering start-ups such as Henkel customer and partner Bare Conductive will be instrumental in bringing the first products to market.

"Today, we have homes that are not smart, but with smart objects all around. We don't really put smart functions into the home itself. To make the home truly smart, you have to take a truly holistic approach," explains Matt Johnson, CEO of Bare Conductive. "In five years, I think that smart homes will go through what cars are going through today – moving from the incredible complexity of internal combustion to the comparative simplicity and reliability of an electric car. Today's homes have technology and wires and pipes everywhere, but printed electronics will help reduce this complexity. Both the companies and consumers that we collaborate with tell us that people don't want to live in homes dominated by technology – this is a different vision to previous ways of installing technology at home. Smart surfaces provide the opportunity to add technology into the home without redefining the look of it."

Material technologies ready to drive change beneath the surface

However, while certain things will stay the same, consumers are keen to embrace change to take on continuous challenges in homes. By applying inks from Henkel, Bare Conductive is currently developing products that could seamlessly add sensing capabilities into domestic environments to solve everyday challenges. Henkel's portfolio of printed electronics inks and coatings encompasses different materials, be they carbon-based, silver or silver-chloride inks or dielectric inks. The material of choice depends on the functionalities sought for or specific properties needed. With its broad range of inks and coatings, Henkel is able to provide partners such as Bare Conductive with the materials required for producing printed electronics, including positive temperature coefficient (PTC) inks for self-regulating heating elements, force sensitive inks for pressure detecting surfaces and inks to detect moisture, to name a few.

"Pipes will still break, dishwashers will leak, people will still experience a fall in the shower. Water leaks are expensive – especially in unattended properties – and homes can be cold and uncomfortable when incorrectly heated," explains Johnson. "If you think about smart flooring, smart surface technology will allow installation with any type of flooring. The floor looks the same but now it generates data which can translate into information such as the activity level. This sort of system gives added confidence without changing the experience of the home."

Johnson describes how the cost-effective nature of printed electronics can add real value for applications such as leak detection: "A water leak isn't a problem if you notice the first drops. But what are the chances of catching that first drop? It's like looking for where lightning will strike – trying to find a low probability/high-cost event." Printed electronics offers the potential to address such risks through low-cost sensors of sufficiently high resolution that can cover large areas. Crucially, these are flexible and thin enough to fit into awkward spaces such as underneath dishwashers, water tanks or even within walls or flooring.

Stijn Gillissen thinks applications like smart flooring exemplify how and where printed electronics can add value: "It lends itself perfectly to be used on this type of larger surface. It can either be manufactured directly onto one of the substrates or laminated in between and therefore won't be visible when in use. So even if the house will stay seemingly the same, the functionality will change." While smart surfaces can make it possible to add new capabilities to a home in a non-intrusive fashion, they can also help to make existing capabilities such as heating more discrete. For example, substituting bulky radiators with printed heaters that are applied under the flooring or integrated into the gypsum boards that are used to build walls could help make interiors more flexible while delivering more efficient heating.

Fig 2: Printed electronics for force sensing flooring surfaces allow for a broad range of new applications – from optimised heating to security functions

Finding a route to market

A clear challenge is how such solutions will be introduced. Consumers will implement some technologies themselves where they are easy to retrofit into properties – such as a leakage detection sensor underneath a dishwasher. While Bare Conductive is developing solutions of this sort, Johnson concedes that a consumer is less likely to rip up their floor to retrofit sensor capabilities. For these larger scale applications – and with products like heating elements – the more probable route to market would be as part of a professionally installed solution and via suppliers to the construction industry.

"We will see a consumer market demand, but the high volumes will likely be demanded by companies selling materials and components into the construction industry and to professional installers," explains Gillissen. "These players have the channel to market and the power to change that market. Moreover, they are looking for ways to bring new products and innovations to their customers. Smart functionalities offer the possibility to diversify and to increase the value of products in a space that is often very high volume and low margin. This is a unique opportunity."

Printed electronics is well suited to such high volume low-cost applications such as construction materials. Gillissen points to Henkel's experience in the medical sector, where moisture detecting diapers for adult care have been made possible through sensors that can be printed at a rate of around 500m per minute. "I don't believe that the main hurdle is in the production of these sensors, but in developing the market itself. Convincing more conservative markets that they can do this is actually more of a challenge than showing them that the product exists."

Unlike the fast-paced electronics industry that has embraced a "permanent beta" mindset, manufacturers supplying the construction industry may encounter more risk-averse mindsets. In this sector, the long-term performance of a product is exceptionally important, for example. Henkel has been addressing such hesitations in the market early on, when introducing printed electronic heating boards for example. This is achieved of course by demonstrating the effectiveness and durability of the solutions. However, showing that the strong

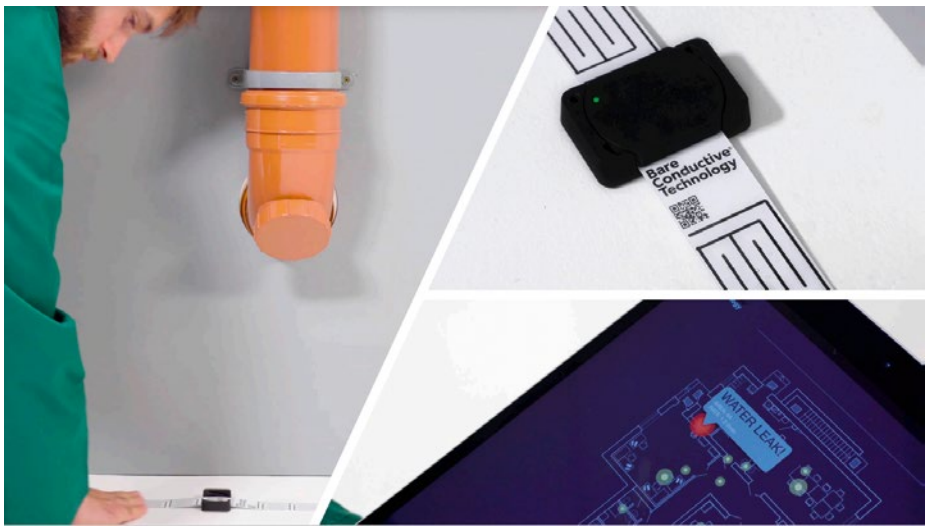


Fig 3: Thin and flexible printed electronics allow for applications in both tight areas as well as non-flat surfaces, such as leaking detection for piping

ecosystem of partners is able to support with every aspect of the new technology is just as important.

Building an ecosystem for innovation

For Matt Johnson, commercialising innovations at scale via existing trade channels therefore demands new approaches: "Even with a fantastic prototype, the go to market remains the main challenge. Part of the reason is that for these products to have value, they have to have a technology stack. It's not enough to demonstrate that we can manufacture the sensor, or that the consumer would find the functionality to be useful, or even that there is a way to install it. To deliver value, we have to create the product, choose appropriate functional materials from Henkel, add electronics and then build a technology stack in the cloud."

Beyond the product itself, Johnson observes that traditional players have yet to engage with the challenges of handling and realising value from data: "Where does the information go, who is in control of that information and how do we protect the privacy of the consumer? How do we create value from that information? Certainly, no one wants to pay per month for their smart surface application! This is not the future we are trying to create but it is where you would arrive if you just applied the model used in other sectors. This is an important discussion that we want to foster when moving forward as an industry. It helps us to create an understanding for the potential obstacles that may arise with the implementation of the technology. We have to bring an understanding of these issues to our customers."

"Compared to a smart electronic device like a smartphone, which is developed within a relatively closed ecosystem, the home has an incredibly diverse array of industries that contribute to its creation," adds Johnson. "It's not reasonable to assume that one company could create a truly successful smart home product – they have to leverage construction experience, expertise in materials science, in electronics. It must be an ecosystem approach."

To help customers and partners meet such a breadth of challenges, Henkel has built an ecosystem of partners able to cover all aspects related to the integration of printed electronics into their surface products – and is inviting other industry members to join its network. The hurdles that can be addressed together include the production process itself: Which additional production steps need to be integrated at which point? What can be implemented in-house? Where would a partner jump in, and how can this all be achieved while keeping the production processes lean?

"Where customers see a need for integrating smart functionalities within their products, we can support in bringing the necessary partners together along the supply chain. By using partnerships and the technologies from companies like Bare Conductive and by drawing on some of our design, manufacturing and software partners, we can quickly help create a minimum viable product (MVP). By assisting customers to reach this MVP phase, we can put something in their hands that fits their needs and demonstrates the added value and viability to their management or customers. The importance of making this cycle as short and clear as possible was the main driver for us to create this partnership network. Our experience doing this has shown that this approach really works and adds value," explains Gillissen.

The best of both worlds

"We are in an age where the large traditional companies are now aware that they must innovate," observes Johnson. "They have some infrastructure for innovation, but it doesn't always get very far if that department lacks advocacy or authority. This is where working with a partner like Henkel can make the difference. Henkel has a very well described process for working with small companies, evaluating the technology and understanding where it can be deployed within their ecosystem. They can not only support us with technical expertise, but also demonstrate to the parties we are engaging with that we have the capabilities to win the advocacy of a major player."

Gillissen believes that such collaborative processes will allow established players like Henkel proactively introduce new ideas to its existing and potential partners and customers. For example, the creation of heating boards was born out of a long-standing relationship with gypsum board manufacturers to supply adhesives. "Where we have existing commercial channels, we can leverage those in driving innovation by introducing our network. Many of the new technologies are emerging from smaller companies or start-ups. At Henkel, we also have the opportunity to provide support to these pioneering players. Where start-ups have a unique technology, we can support the assessment and advancement. This is bringing in the best of both worlds, combining the dependability and reach of a company like ours with the drive of pioneering start-ups."

Image sources: Henkel/Bare Conductive

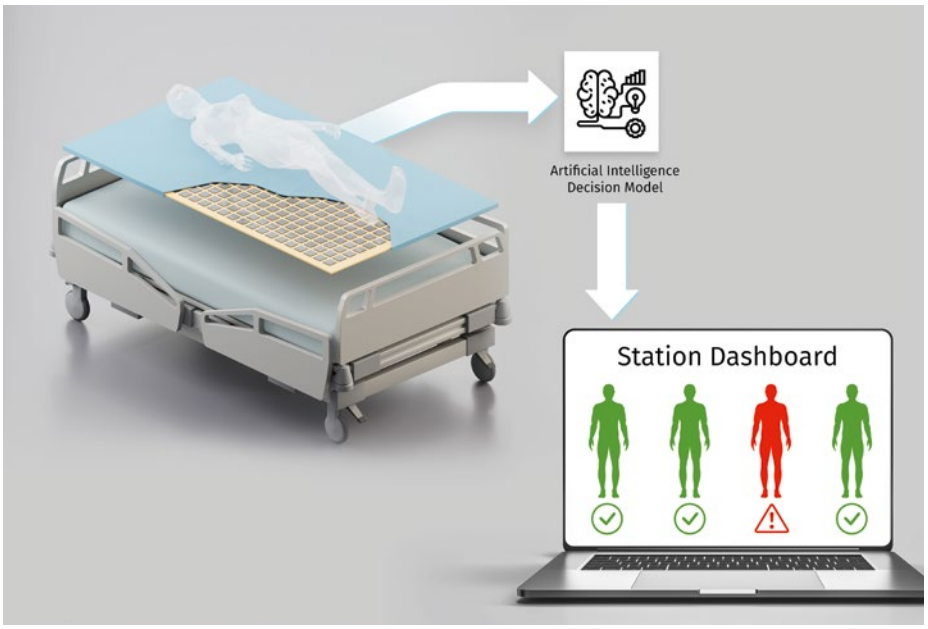
Dramatic risk reduction

InnovationLab and Bitquadrat demonstrate smart mattress cover for real-time patient monitoring in hospitals and senior living facilities

InnovationLab (Heidelberg, Germany), an expert in printed electronics "from lab to fab," presents a smart mattress cover that may reduce by up to 88% the risk of developing decubitus ulcers, the potentially life-threatening pressure ulcers that affect up to 2.5M hospital patients in the U.S. annually. Combining InnovationLab's flexible printed sensors with Bitquadrat's specialised health-monitoring software, the new cost-effective platform conducts personalised, real-time risk-assessment of pressure ulcers – providing the most efficient way to inform nurses and other caregivers when patients require repositioning on their mattress.

"A significant number of patients worldwide will develop pressure ulcers, and global mortality directly attributable to pressure ulcers is rising by double digits, making this a very serious healthcare issue," said Dr Christoph Kaiser, head of Tech-2-Market department, InnovationLab. "As a designer and manufacturer of roll-to-roll printed and organic sensors, we identified a market need where our technology can help – and then we decided to pursue it. With our ability to mass-produce high-accuracy large-area printed pressure sensors and Bitquadrat's market-specific expertise in intelligent healthcare software, we can now deliver a cost-effective integrated hardware/software platform that vastly improves real-time monitoring of patients susceptible to developing pressure ulcers. Suppliers to hospitals and senior living facilities – as well as mattress companies and system integrators – can use our solution to build a new generation of smart mattress that will improve the experience of patients by empowering caregivers to provide better care through better technology."

The smart mattress-cover demonstrator features an array of several hundred flexible printed pressure sensors from InnovationLab integrated with health-monitoring software from Bitquadrat, which leverages machine learning (ML)/artificial intelligence (AI) and real-time data processing. The smart mattress cover assesses the risk of pressure ulcers by monitoring the size and duration of pressure at each point of contact. This is a major advantage over smart mattresses that use motion sensors, which only detect when a patient moves and changes position but cannot detect the size or duration of pressure on the mattress.



The smart mattress cover from InnovationLab and Bitquadrat

Advantages of the Smart Mattress Demonstrator

- Reduces the incidence of pressure ulcers – promoting better care in an acute-care setting to improve the patient's experience
- Allows caregivers to monitor patients remotely in real-time instead of requiring them to examine a patient's entire body for pressure ulcers every thirty minutes to two hours – improving efficiency and saving personnel costs
- By using local AI models and on-board computation no sensitive data leaves the device. Only critical alerts are relayed, providing patient monitoring around the clock while preserving privacy.
- Reduced incidence of pressure ulcers leads to decreased risk of costly lawsuits against healthcare professionals.
- Environmentally friendly disposable product thanks to organic electronics

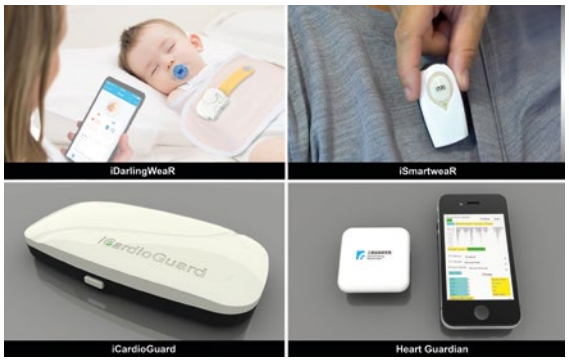
"As a software firm deeply committed to a radical paradigm shift in the healthcare industry, Bitquadrat's focus is to keep people healthier for longer, reducing the time they are ill to improve their quality of life," said Andreas R. C. Diehl, managing director, Bitquadrat GmbH. "The smart mattress demonstrator exemplifies our philosophy. Combining pressure sensors with real-time health-monitoring software that leverages AI/ML for data processing, we're now able to open up previously unimagined possibilities for the prevention of decubitus and other serious illnesses. And while the well-being of patients outweighs all other objectives, there's also an economic benefit to preventing pressure ulcers because for every ulcer avoided, insurance companies can save tens of thousands of dollars. We're delighted to collaborate with InnovationLab on this important project."

Image source: InnovationLab

Health comes first

ITRI exhibited innovations in e-health wearables at CES 2021

The Industrial Technology Research Institute (ITRI), Taiwan's largest and one of the world's leading high-tech applied research institutions, demonstrated e-health wearable technologies at its CES 2021 event site.



ITRI's product innovations at CES 2021

iCardioGuard is an e-health wearable combining multi-sensing microwave and electrocardiogram physiological sensors with psycho-cardiac status analysis software for continuous cardiovascular monitoring and emotion, pressure and fatigue analysis. It measures heart rate, blood pressure, and the circulatory system for various age groups, evaluating mood, stress, fatigue levels, and vascular parameters. Its applications include home care, eldercare, exercise and fitness evaluation. The device can be placed on the chest or integrated with a heartbeat belt, electrode patches or smart clothing. It functions anytime and anywhere, which allows the users to collect the vital readings over long periods. This innovation helps reduce incident cardiovascular disease, the leading cause of death globally according to the World Health Organization, taking over 18 million lives annually, representing 31% of deaths worldwide, and costing US$200 billion annually on related medical expenses.

The Heart Guardian is a non-invasive e-health wearable device that monitors cardiac output per minute, heart rate, pulmonary artery blood flow velocity, and blood output volume. With a miniature, high-sensitivity patch-type transducer, the first low-power Doppler ultrasound signal processing chipset, and a mobile computing device, the Heart Guardian offers continuous real-time monitoring of patients with heart disease. The device can be worn throughout the day including during exercise to assess blood circulation and cardiovascular conditions.

iSmartweaR measures physiological conditions including heart rate and respiratory rate using washable conductive fabrics and non-contact nanosecond pulse near-field sensing (NPNS) technology. The system detects signals from up to 20cm, different from existing smart textile technologies requiring contact with the wearer's skin. It has been verified for hospital night care with high accuracy. Medical workers can access the real-time information delivered by Bluetooth to a mobile app.

iDarlingWeaR is a wearable innovation for infant healthcare featuring ITRI's harmless low-power radar sensing technology. It helps protect infants from dangers such as sudden infant death syndrome and accidental suffocation. Caregivers and parents need only attach the device to the baby's blanket for continuous heartbeat, activity and respiratory monitoring. iDarlingWeaR also detects whether the baby is asleep or awake and sends alerts if it detects abnormality. Unlike other infant monitoring technologies, iDarlingWeaR does not require contact with the infant's skin. It is easy to operate and carry, and deviation in average heart rate per minute is less than 5%.

Image source: ITRI

Fraunhofer IFAM

Wiener Straße 12
28359 Bremen

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Electroluminescent textiles for home interior decoration

Illumination and well-being are important aspects of "Smart Living" today. Within the IraSME Network a consortium of four German and two Belgian partners therefore developed a low energy consuming light source integrated into home interior decoration

In the ZIM research project funded by AiF Germany and Agentchap Innoveren & Ondernemen Vlaanderen, a smart textile wallpaper with an integrated electroluminescent capacitor was realised by an economic roll-to-roll-process. In addition, a miniaturised inverter was developed to control the devices. From October 2018 until March 2021, the German companies Coatema Coating Machinery, Adphos Innovative Technologies and IMST cooperated with the research institutes FTB and FAST at Niederrhein University as well as with the Belgian partners Fibertex and Hasselt University.

During recent years different research groups have worked with luminescent textiles with various technologies and solutions. The two research teams within this project approached the illumination effect on textile substrates with the physical phenomenon of electroluminescence (EL): A capacitor contains two electrodes, a di-electric layer and a luminophore layer, mostly based on zinc sulfide pigments doped with impurity atoms like gold, silver, manganese, copper or gallium. When the EL-capacitor is electrically charged, the phosphor between the plates ejects photons. Usually the capacitor is operated with alternating current at a voltage between 70 and 150V and a frequency of about 400 to 2400Hz.

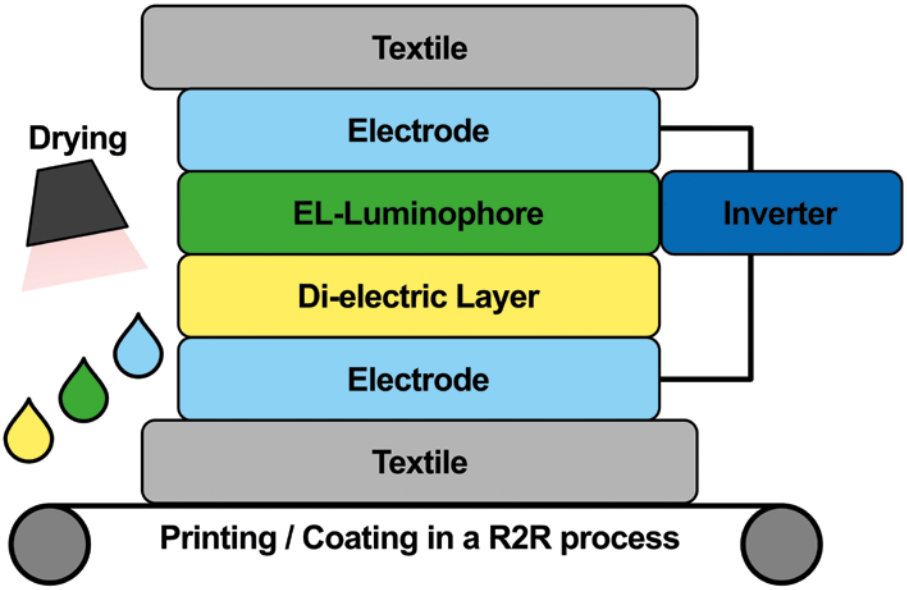

Fig. 1: Roll-to-roll process of EL-stack on textile (drawing: FTB/Coatema)

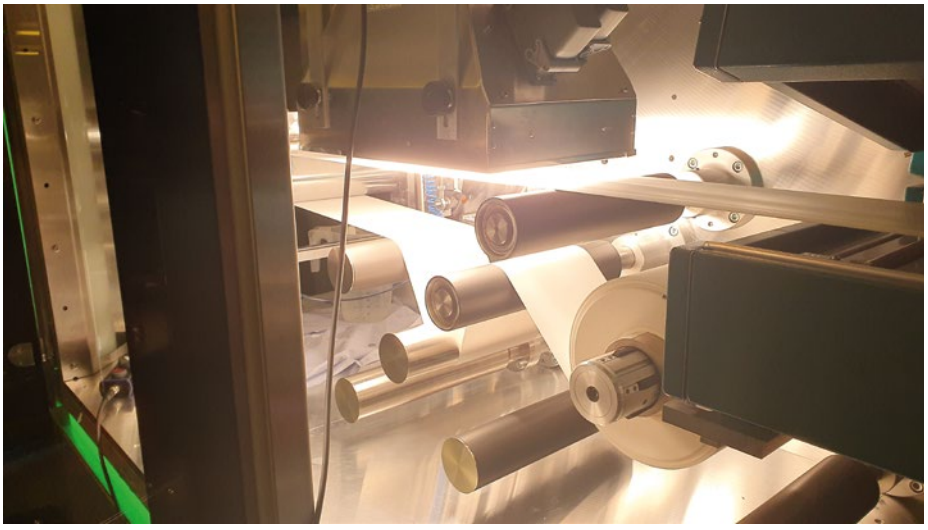

Fig. 2: Roll-to-roll process with NIR drying (photo: Coatema)

Development of new processes and devices

EL-textiles for interior illumination should allow freedom of design regarding shape and size and still remain very thin, highly flexible, rollable and bendable. In order to commercialise such products, the production process was improved towards sustainable, environmentally friendly and still cost-effective ways. For this reason, a roll-to-roll technology for continuous production of EL-textiles was developed. In order to facilitate handling during production as well as finally achieving a sustainable product, all inks where changed to water-based blends without any harmful organic solvents, and all layers were dried within a few seconds with highly economical NIR emitters. In addition, a suitable device for power supply and control of current and frequency in miniaturised form was developed. This inverter can charge even large textile EL-capacitors including compensation of loss

Fig. 3: EL-prototype in off-mode (photo Fibertex)

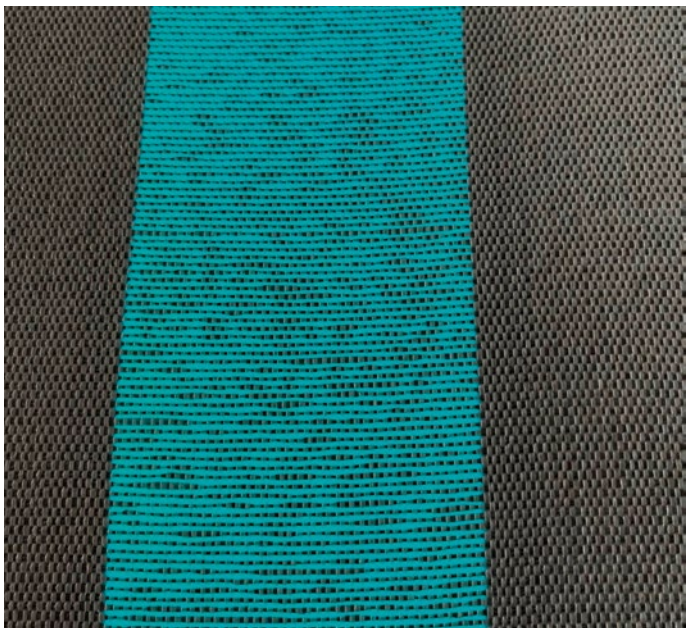

Fig. 4: Activated EL-prototype (photo Fibertex)

of light intensity and ensures safe and durable performance as well as long lifetime of the EL-textile.

Technical details

The initial sheet process for EL-textiles was previously developed by Hasselt University and Niederrhein University. However, for future commercial use the process was transferred to the roll-to-roll-process by Coatema and Adphos. Two different pilot-scale machines were used for the development of such a process, one equipped with a hot air dryer section, one with an NIR drying system. The substances for building the EL-stacks were newly developed with water-based products for optimum electrical conductivity in the two electrode layers and optimum light intensity as well as light colour in the dielectric and luminophore layers. The application of the various layers in the EL-stack was realised via coating and printing directly onto wallpaper from the Belgian partner Fibertex.

With the introduction of a block with 12 NIR-emitters with max. intensity of 500W for intermediate drying the overall processing speed during coating and printing was adapted to 3m/min as well as 5m/min depending on the type of layer and the respective thickness.

Conclusion

Smart EL-textiles can be produced in a cost effective and sustainable process. A 50-metre-long prototype was produced at Coatema, using coating and printing in combination with highly efficient NIR-drying, and finished as textile wallpaper at Fibertex. The new power supply inverter from IMST can activate the EL-capacitor with an infinitely variable current (0 – 200V) and frequency (300 – 2500Hz) via remote control. The EL-wallpaper can be installed for smart living offering sufficient light for a pleasant atmosphere or for eye-catching effects. The smart textile wallpaper emits cold light in numerous colours while using very small amounts of energy. The design for the illuminating patterns is not limited in any way, can be pointed or planar, clearly visible in high resolution or rather diffused through the textile construction.

Authors: Evelyn Lempa, Anne Schwarz-Pfeiffer, Research Institute for Textile and Clothing, Niederrhein University of Applied Sciences, Mönchengladbach, Germany

Harmen Rooms, Julian Koc-Richter, Coatema Coating Machinery GmbH, Dormagen, Germany

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Making smart living smarter

Alastair Hanlon, chief commercial officer at PragmatIC Semiconductor (Cambridge, UK) discusses low-cost RFID, flexible electronics and sensors as technological foundations for truly smart living

The Internet of Things (IoT), smart objects, and smart living are all terms that have been around for some time. Smart devices and appliances are now common in many homes. What was once seen as something a little strange – such as calling out for lights to be turned on and off in our houses – is now often the norm.

Over the last decade, innovation in semiconductors, flexible electronics and sensor technology has led to amazing advances, but it is exciting to note that this is in fact only the beginning of the story. There is potential for so much more. Why not the Internet of Everything? Connectivity and intelligent electronics in everyday low-cost items? This is where lives could really start to change – with positive results for people and society. It is not just about having 'quirky' devices in the home. Let's take a look at the benefits of truly smart living…

The IoT is on its way to become "The Internet of Everything"

Smart healthcare

Digital healthcare is on the rise. There are now novel remote patient monitoring solutions being trialled. For example, flexible patches that measure cardiac activity and wound dressings that include sensors that provide alerts when the dressings need to be changed. RFID (Radio Frequency IDentification) and NFC (Near Field Communication) technology are not new, but now with more low-cost options smart solutions are likely to become more widely available. For example, NFC-enabled blister packs used to ensure patients are adhering to their medication regime and reassure remote families that their elderly relatives are safe and well.

Really smart home appliances

Many people have started investing in smart home appliances in recent years, but with technology advances, smart keeps getting smarter. How about an affordable smart coffee machine that could sense when new refills are needed and automatically sends a request for supplies? There are an increasing range of smart fridges, but how about a really smart (and reasonably priced) fridge that automatically senses when you need milk and reorders more? Or alerts you when it senses via a 'smart' label on the milk bottle that it is close to past its best? Or suggests recipes for food items left in the fridge? This is much more than convenience – this would reduce food waste too.

Smart learning and play

Millions of parents have juggled work with home schooling and childcare during the COVID-19 pandemic. Online resources and technology have been an incredible help, but still many children have struggled. Imagine a new generation of smart interactive education resources and fun toys that could bridge the gap between the physical and digital worlds. Embedding item-level identities into objects and games could create opportunities to make activities more dynamic. Making learning and play exciting and challenging. PragmatIC was part of the PING (Printed Intelligent NFC Game Cards and Packaging) Consortium, the first group to develop technology for interactive card and games.

Smart resource use

Smart living extends to smart resource use, re-use and disposal. Advances in RFID, flexible electronics and sensor technology could play a significant role in the challenge to increase recycling rates. A low-cost inlay (tag) could be added to the packaging at manufacture allowing the consumer, with a simple tap of their NFC enabled smartphone, to access information about the packaging and how to recycle it. With NFC each item can be uniquely identified, and the data given to the consumer can be personalised to reflect the recycling information in their local area.

We could go further and incentivise consumers to recycle. For example, a smart recycling bin that gives the consumer credits for how much is collected – an extension of the reverse vending machines (RVMs) that are in use at Tesco and by Coca Cola. Promoting positive behaviour rather than the negative 'pay as you throw' schemes, which propose to charge for the amount of unsegregated waste.

A new era

Advances in technology mean that for the first time it is now possible to integrate intelligence and interactivity into high volume everyday items. As the costs involved in implementing new connectivity solutions reduce, the variety of use cases it can be applied to rapidly increases. It is the end of the era of The Internet of Things and the beginning of a new era – The Internet of Everything. This will lead to truly smart living.

Image source: PragmatIC

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Making smart living more secure

Isorg (Limoges, France) showcases its full display finger print solution

Home office, lots of online transactions, virtual medical conferences etc. – a pandemic makes our homes the centre of work, shopping, and healthcare. Home is not just a place of retreat anymore. A study conducted by Global Market Insights suggests that by 2026, global mobile payment transactions will exceed 300bn in volume and USD17 trillion in value. Another study from Juniper Research found that losses by e-commerce merchants to online payment fraud will exceed USD25bn in 2024.

Embracing disruptive organic photodiodes (OPD) as core technologies, the France based pioneer in organic photodiodes, Isorg, produces unprecedented large area image sensors with an ultra-slim feature by means of a printing technique at less than 100°C instead of traditional deposition at 300°C in vacuum. The OPD process does not require a special mask for pixel patterning, making the large sensor very cost effective for seamless integration. The considerably large area sensor underneath the full display permits multiple finger authentication at the same time, making it a true breakthrough in increasing the security level.

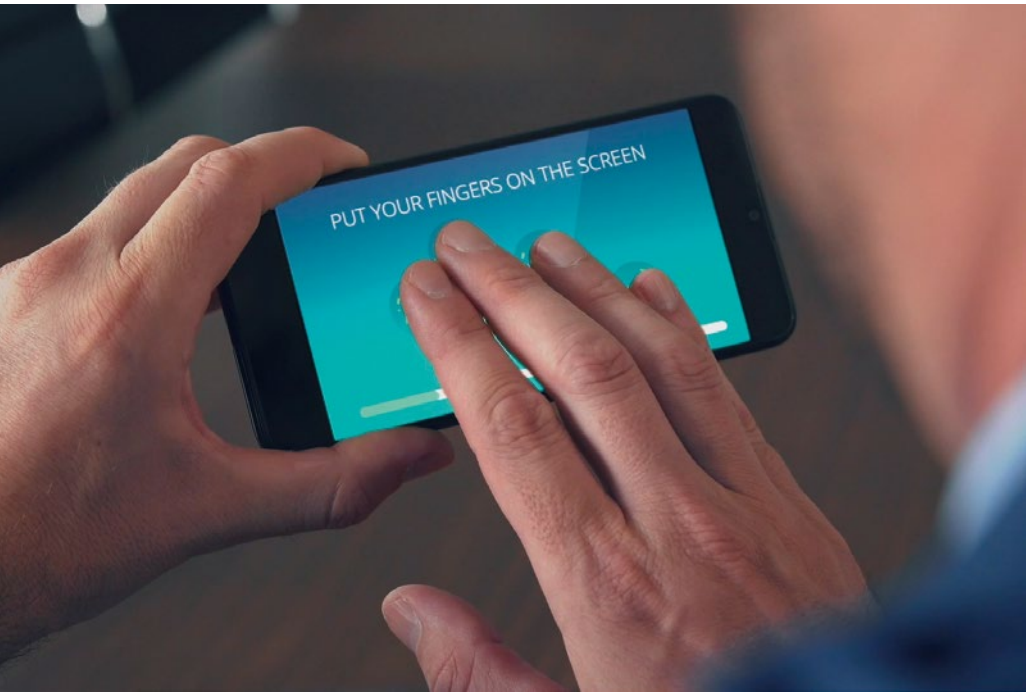


Fig 1: Multi-finger authentication on a smartphone

More fingers, more security

These facts are underlining the need to verify who we are in a safer way before each sensitive transaction. Verifying your identity with multi-finger authentication to manage daily personal and professional tasks rather than one finger authentication or traditional passwords makes our smart living more secure. Isorg technology is providing a solution to this need, as will be explained in the following paragraphs.

Two-finger authentication and four-finger authentication is 50 times and 700 million times more secure than that of one finger. Hence, the more fingers, the more secure. The up to full display scalable technology also brings ease of use with just a touch of fingers anywhere on the display to unlock and authorise transactions.

Challenges in current FoD solutions

Traditional fingerprint sensors in smartphones are based on capacitive silicon and have moved to CMOS image sensor solutions (CIS) behind the display 2 to 3 years ago, which usually provide a small sensing area around 8mm x 8mm or less. There appears to be an inconvenience with the location of the sensing area as it is usually small and fixed somewhere on the screen. Another technology based on ultrasonic sensors was also introduced by leading manufacturers in recent years. However, due to the nature of the material, this solution still cannot provide large area to full display sensors at affordable prices. Both CIS and ultrasonic sensors are not as cost-effective as OPD sensors for large areas. Last but not least, the concern of the lower security with one-finger authentication architecture remains.

FoD module stack structure

Isorg's complete solution module behind the display consists of three main parts, including the OPD based sensor, optical filter and readout IC (ROIC). The optical filter is plastic-based and laminated onto the sensor to permit it to fulfil the image quality required by fingerprint detection application. A total thickness of less than 300µm for glass sensor modules is achievable.

The ROIC is integrated with gate control and SPI interface so as to communicate control signals and transfer data with the main processor of the smartphone.

Beyond security

Isorg as the pioneer in OPD technologies delivers its solution with innovative designs for ultra slim sensor modules. They integrate printed photodiodes on different substrates to enable large-area image sensors for the smartphone market.

Thanks to the tens of very thin OPD layers in the nano-metre range together with Isorg's thin film optical filter, a total thickness of

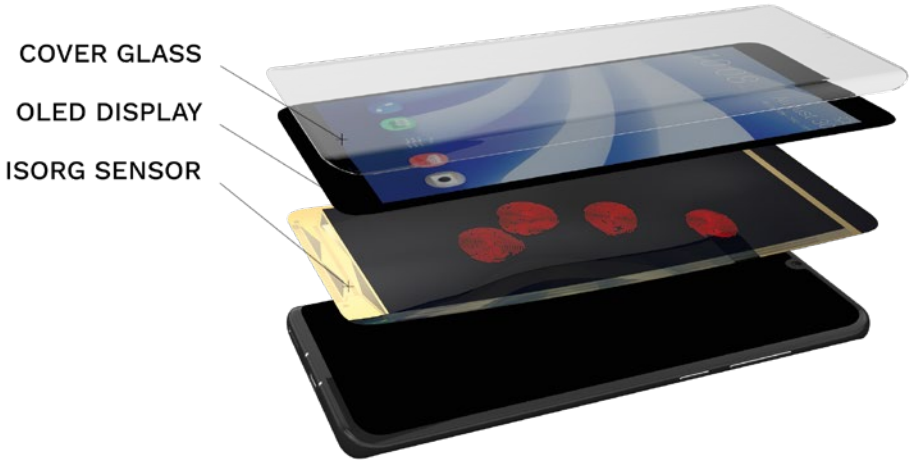


Fig 2: The Isorg sensor underneath the OLED display in a smartphone

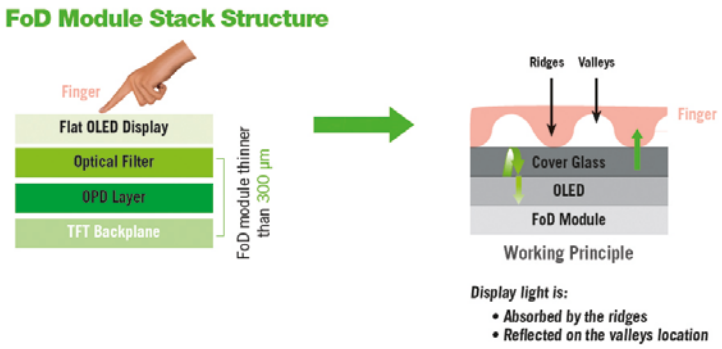


Fig 3: FoD module stack structure

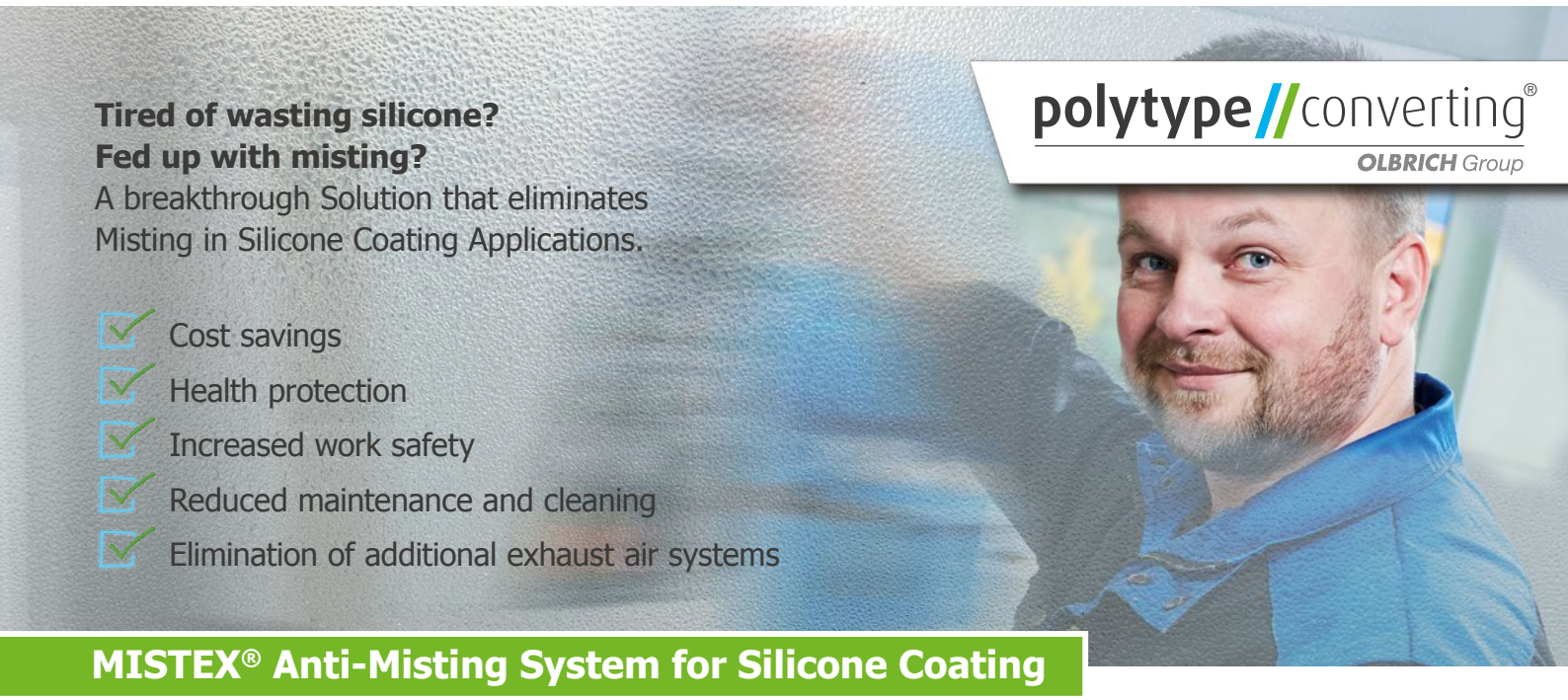
the fingerprint sensor module less than 300µm is achieved. Its fingerprint on display module ranks as one of the slimmest and is compatible with the widest range of OLED displays. The sensors integrate seamlessly into smartphones including curved OLED full displays for high-end phone; therefore the integration for smartphones is made effortless to OEMs.

The slim module also maximises the friendliness in phone architecture to enable more space available for optimum battery capacity. The spiralling trend of 5G also unveils the need for such space within phone architectures as 5G is considerably power intensive.

The full display solution offers benefits to phone manufacturers by being able to incorporate fingerprint scanners without losing screen real estate, as it allows fingers to be put anywhere across the smartphone display. The solution can read multiple fingerprints with a lot more biometric data per user ID, building a strong case for improving smartphone security for mobile banking and payments, personal health monitoring and remote home control applications, etc.

In conclusion, this impeccable invention troubleshoots the pain point of the high costs of large area fingerprint sensors that smartphone manufacturers have long had and safeguards end-users in a better way.

Image sources: Isorg



Sensing breakthrough enables large size, optically superior, lower-cost PEDOT sensors

SigmaSense (Austin, Texas) and Heraeus (Hanau, Germany) together create a quantum leap forward in PEDOT sensor size, while providing more performance and functionality

Fig 1: Heraeus PEDOT-based 65-inch high resistance sensor demonstrates a lower cost, optically superior touch sensor manufactured by TWS. SigmaSense's SigmaDrive technology enables using the high resistance touch sensor while providing breakthrough performance

Projected capacitance (PCap) touch sensors have the great user experience that customers now expect on all devices. Even large displays are now interactive and desire to use the reliable, feature rich PCap touch sensing. Manufacturers seek solutions that are optically superior and, ideally, lower in cost. Conductive polymers possess superior optical properties when the conductive material is thinly applied and are cheaper to manufacture than the current mainstream alternatives, such as indium tin oxide (ITO) and metal mesh or silver nanowire-based solutions. However, conductive polymers have not gained acceptance due to their higher resistance and the inability of the industry's existing voltage mode ADC-based touch controllers to drive the resultant high resistance channels. This has precluded the use of conductive polymers in mainstream laptops, tablets and large interactive displays – until now.

SigmaSense controllers enable the use of Heraeus' Clevios conductive polymer technology across the full range of sensor sizes while improving all performance metrics. The flexibility, optical clarity and cost-effectiveness of polymer conductor materials are now a viable and attractive option for PCap touch sensors of all sizes.

SigmaSense's disruptive SigmaDrive technology enables 100 to 1000 times better touch performance. And concurrency provides high fidelity capacitive imaging information of the entire sensor surface, including objects in proximity to the sensor surface. This novel technology overcomes the barrier of very high sensor channel resistance. It is now feasible to use conductive polymer films for the full range of touch sensors, from watch sizes up to very large touch sensors measuring 86 inches diagonally. For the first time, SigmaDrive touch controllers make PEDOT conductive polymer sensors a viable choice for large display sizes. In addition, SigmaVision capacitive imaging introduces touchless interaction provided by SigmaDrive's high hover features. SigmaDrive controllers with new touchless hover interactions will unlock an entirely new generation of user experiences. Such experiences are now demanded by the market, especially during the COVID19 pandemic where touching items in a public space is discouraged.

PEDOT conductive polymers – a boost for large touch sensors

Conductive polymers are deposited with high yield throughput by the most cost-effective roll-to-roll wet-coating processes. This is a huge advantage compared to previously popular PCap touch sensors in the industry that require costly metal deposition and precise etching. Roll-to-roll processing has already been done successfully for more than two decades in the production of antistatic films. The high resistance of these films had limited their use to specific applications using smaller size displays where sheet resistances were not an issue. Only small-sized capacitive touch sensors had been possible until now. While lower sheet resistances of 150 Ohm/sq. or less are possible, a thick layer of conductive polymer would then be required to be deposited on the substrate. This can result in higher cost and an undesired bluish tint that significantly reduced optical light transmission. Therefore, for capacitive touch sensors in smartphones and tablets, typically indium tin oxide (ITO) films are used instead of conductive polymers. Larger PCap touch sensors used for interactive displays, monitors and televisions require even more costly conductive materials such as silver nanowires (AgNW) or metal mesh because they can meet the low resistance drive requirements of the industry's existing voltage-mode ADC touch controllers.

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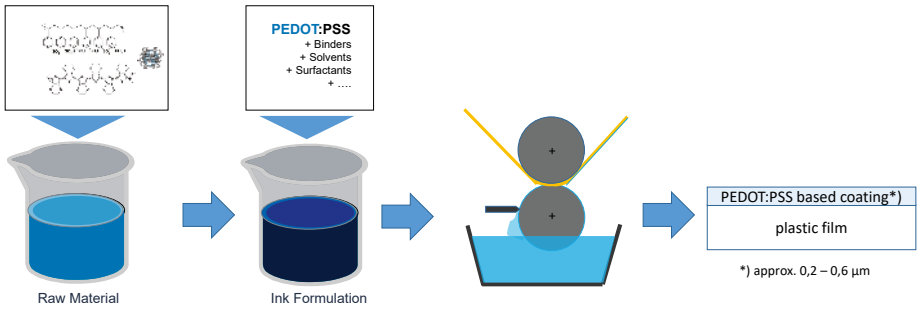


Fig 2: PEDOT:PSS conductive raw materials for ink formulations that can be coated by a roll-to-roll process on plastic films

SigmaSense's disruptive SigmaDrive technology can uniquely support touch sensors with high resistive materials and can deliver the high performance that is a game changer for large screen capacitive touch sensors. Now, thin layer PEDOT coatings can produce lower cost and optically clear touch screens at sizes well over 65 inches. This is an industry first that will enable broad adoption of PEDOT:PSS touch screens for large digital signage, interactive white boards and even tabletop interactive displays. These new applications were simply not possible previously.

PEDOT:PSS is produced as a water-based polymer dispersion that consists of tiny swollen gel particles, and it is used as a raw material to prepare ink formulations that can then be coated or printed on substrates. After drying, a transparent conductive layer is formed with a typical thickness of only a few hundred nanometres. What is often forgotten when talking about PEDOT:PSS is that it is a raw material for coating and printing inks and is typically not ready-to-use. That means, it first must be formulated with suitable additives to provide good substrate wetting, film adhesion and cohesion, environmental as well as mechanical stability and durability.

One aspect that makes Clevios PEDOT:PSS formulations special is that Heraeus has succeeded in stabilising PEDOT:PSS formulations. Being an organic polymeric material, PEDOT:PSS, as well as most other organic materials, can undergo oxidation and degradation processes that are accelerated by higher temperatures, oxygen, and UV light. This is sometimes mentioned as a fundamental drawback of PEDOT:PSS and other organic conductors. However, Clevios formulations have been successfully adopted even in very demanding automotive printed capacitive touch sensors. Superior reliability is one of the main drivers for adoption of Clevios. An important characteristic for adding touch to folding displays is flexibility of the touch sensor substrate as well as the stability of the conductive material on the substrate. This is where PEDOT:PSS excels compared to the commonly used indium tin oxide (ITO) material.

SigmaSense has pioneered a new approach using current mode Sigma-Delta modulation ADCs enabling PEDOT conductive polymer films to be used in large size interactive displays.

SigmaDrive current mode Sigma-Delta architecture breakthrough

SigmaSense, the global leader in touch sensing, delivers silicon and software solutions to the leading display and electronic manufacturers in the world. The company's touch solutions significantly reduce manufacturing costs while improving sensitivity 100 to 1000X for products ranging from mobile phones to large digital signage. This level of performance is also enabling new touch experiences for a wealth of product categories from tabletops to foldable notebooks to retail touchless touchscreens.

SigmaSense is delivering SigmaDrive technology that introduces a new touch controller solution that eliminates many of the engineering and manufacturing challenges that are associated with PCap touch. By providing enormous improvements in minimisation of noise and by making all touch sensor channels entirely software programmable, design and testing cycles can be greatly reduced with automated and rapid tuning. While competitive systems often must be driven with higher voltages (as high as 30 or 35 volts in large screens) in order to gain enough signal across the sensor, SigmaSense's silicon can typically operate at under one volt in the same environment. This helps with reliability, emissions, heat dissipation, and other product design challenges caused due to the use of higher voltages.

Proprietary core invention

Traditional "threshold" voltage-based sensing technologies – applied to virtually every interface between the analogue and digital world – rely on a high voltage drive signal that must be detected above the noise, and then must perform a scan to detect the threshold signal on a different set of device pins and compare it with the driven input. SigmaSense has developed an enormous sensing breakthrough by instead sending out ultra-low voltage signals with many different frequencies and instantaneously, without scanning, monitor every change in every frequency due to impedance changes. This digital approach provides instantaneous input, delivering more data, with higher fidelity and faster response. Customer experience is better while the device manufacturers get a simpler, more reliable, and lower cost product design.

SigmaSense uses Sigma-Delta techniques with advanced digital filtering to overcome the problems of traditional PCap touch sensors. The unique design offers simultaneous capacitive imaging and 300Hz touch reporting providing mutual touch, self-capacitance touch and pen reporting. There are no scanning delays typical of voltage mode techniques that sample only a portion of touch sensor at a time. True continuous and simultaneous sampling of all electrodes at the same time through a digital architecture provides excellent noise rejection, significantly improves speed, signal-to-noise ratio, and touch sensitivity. Sigma-Delta converters are used for high resolution current mode ADC and DAC applications. They also perform noise shaping, filtering, decimation, and are inexpensive to produce. One of the unique characteristics of Sigma-Delta converters is that the frequency transfer functions for the input signal and quantization noise are different, thereby enabling very high-resolution signal creation with a significantly improved signal-to-noise ratio (SNR). The result is signals with high accuracy and fidelity.

A defining feature of the SigmaDrive touch controller architecture is the sense driver (Sigma-Delta Modulators or SDM) on every

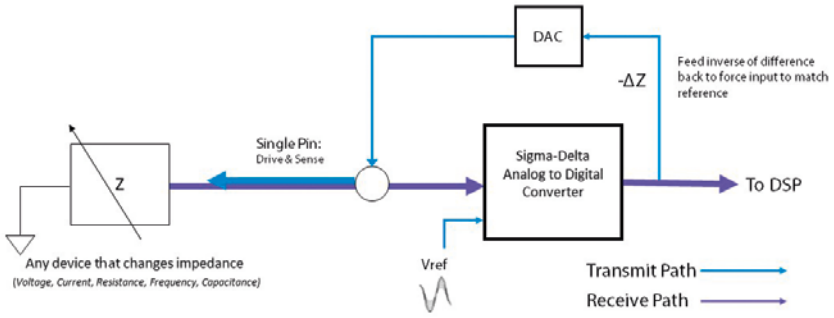


Fig 3: The SigmaSense SigmaDrive driver architecture that delivers 100 to 1000 times greater signal-to-noise ratio compared to existing solutions

row and column of the touch sensor. These operate independently under software control. This architecture allows for multiple frequencies and simultaneous drive and sensing on each row and column of the sensor. Since there is no time wasted on scanning, the SigmaSense controller is extremely fast, generating touch reports at a 300Hz rate. The touch and non-touch state of every row and column is continuously capacitive imaged and produces the high-fidelity data necessary for additional processing with AI techniques. Further, different frequencies can be used for multiple pen recognition which are also detected in the same cycle. Having a Sigma-Delta modulator on each channel allows for the individual channel frequencies to be adapted in real-time to avoid environmental noise. Since processing is done in the digital frequency domain, the drive frequency can easily be relocated in a different band frequency that is known to be free of the noise interference. This, along with powerful digital filtering that rejects out-of-band noise completes the noise tolerance capability of SigmaDrive architecture. The high SNR signal from the Sigma-Delta modulator, means that the SigmaSense approach has unparalleled noise immunity. The modulator rejects out-of-band noise that is just 100Hz away from the fundamental drive frequency thereby improving touch sensitivity and system reliability.

The SigmaSense controller shown operates in a significantly different way from all other traditional touch controllers. There is no time-consuming switching of the drive signal on the electrodes. The signal on the electrode is a continuous low-voltage pure-tone sinusoid. Low voltage and pure-tone sine waves minimise electromagnetic interference (EMI) that could be generated. This allows the SigmaDrive technology to be used in a variety of applications such as military and rugged environments that could not previously be served by PCap controllers. The challenges of managing high voltage square waves with the inherent harmonics are eliminated completely in the SigmaSense approach. Thirty-two inch sensors have been demonstrated to perform touch sensing with only 20 millivolts of drive voltage, an industry first that has not been equalled.

Disruptive SigmaDrive technology

The disruptive SigmaDrive technology unleashes Clevios conductive polymers' strengths and this great combination provides industry leading performance. The largest initial benefits are expected in large-sized touch sensors for interactive flat panel displays and whiteboards where costs can now be significantly reduced. Addressing the needs of future flexible display trends, zero bezel displays, 3D-moulded, stretchable and wearable displays, is still another key value brought to the market with the combination of SigmaSense and Heraeus' technology package. Leading the list of demonstrated successful collaboration is the world's first 65-inch PEDOT touch sensor unveiled in 2020.

Image sources: SigmaSense/Heraeus

Authors: Dr Armin Sautter, global head of technical services for display, Heraeus Epurio and Gary Baum, VP for emerging technologies, SigmaSense

A door made of OLEDs

LG and ASSA ABLOY are jointly developing a transparent OLED automatic door

LG Electronics (Seoul, South Korea) has signed a memorandum of understanding with ASSA ABLOY Entrance Systems (Stockholm, Sweden), a global leader of automated pedestrian, industrial and residential doors and service, for the development of transparent OLED automatic doors. The innovative, first-of-its-kind customer experience solution has been designed with specialised commercial applications in mind.

The new product combines LG's Transparent OLED signage (model 55EW5G) and SuperSign software-based integrated content management solution with the automated glass sliding doors of the Swedish manufacturer ASSA ABLOY Entrance Systems to deliver a transparent product. In addition to providing convenient and touchless access to buildings and structures, the Transparent OLED Automatic Door will present new opportunities for greeting customers, communicating with employees and delivering advertising and marketing content unobtrusively to consumers.

Accurate and bright colours

Thanks to LG's WRGB technology, the self-lighting OLED pixels reproduce accurate colours with exceptional brightness and high contrast. LG's transparent OLED technology is also expandable and can be easily customised for a variety of doors and entranceways. Additionally, its transparency means objects behind the display can be easily seen, enabling the solution to harmonise with its surroundings while providing useful information at the same time. With a robust design featuring tempered glass, the product offers excellent durability and improved safety when combined with ASSA ABLOY Entrance Systems' automatic sliding doors.

The Transparent OLED Automatic Door from LG and ASSA ABLOY

"LG, the leader in next-generation digital signage, and ASSA ABLOY Entrance Systems, the global leader in automated sliding doors, are working together to create an exciting, new digital environment," said Paik Ki-mun, senior vice president and head of the Information Display business unit of LG Electronics Business Solutions Company. "Our previous large-size transparent OLED displays, which can be found around the globe, proved that transparent OLEDs were a very effective medium and we're now taking that to a whole new level."

Customising brand experiences

"Innovation is at the core of everything we do," said Christopher Norbye, executive vice president and head of Entrance Systems Division at ASSA ABLOY. "I am really proud that we, together with LG, can offer our customers this ground-breaking product with the new transparent OLED automatic sliding door. It will put our customers in the forefront providing them with a fantastic new solution when it comes to customising brand and customer experiences."

Image sources: LG Electronics

Electronic ink for smart badges

E Ink and Atmosic announce a reference design for eBadges

E Ink Holdings (Billerica, Massachusetts), a leading innovator of electronic ink technology, and Atmosic (Campbell, California), a provider of extreme-low-power Bluetooth Low Energy semiconductor technology for IoT, have recently unveiled a reference design for eBadge applications.

The growth of the smart badge market can be attributed to the convenience and transaction security they provide, as well as their capability for tamper-proof storage of information and account identity of users.

Power-optimised design

Through the joint project with E Ink, Atmosic will offer a power-optimised eBadge reference design, featuring one of E Ink's 2.9" or 3.7" black and white displays, or 4.1" Gallery Palette colour displays. The kit utilises Atmosic's M series extreme low-power Bluetooth LE platform, enabling long, multiyear battery life which can be extended by using optional on-chip energy harvesting.

The kit can be used in landscape or portrait mode, and under a typical eBadge use case of three image changes per day, a small CR2032 coin cell battery will last over three years. This low-power eBadge can also provide visual updates including a photo, location information, alert messages, and text messages. The use of energy harvesting can give the eBadge virtually unlimited battery life.

"This innovative reference design combines E Ink's low-power electronic ink technology with the industry's absolute lowest power Bluetooth LE platform, the M series from Atmosic, to enable the rapidly growing eBadge market segment," said Thomas Lee, executive director of sales at Atmosic. "With such a low-power budget, developers can add a host of features to build a secure, cost-efficient eBadge solution that can run on the same battery for multiple years or even have unlimited battery life with energy harvesting."

E Ink and Atmosic announce eBadge reference design

Visual data without bulky batteries

"With the increased popularity of connected devices featuring displays, the need for enhanced functionality while balancing battery life is a key concern for many product designers," said Timothy O'Malley, AVP of the US Regional Business Unit, E Ink. "The combination of E Ink's low-power display and Atmosic's low-power Bluetooth solutions gives product designers a solution that enables visual data without the need for bulky batteries or device charging challenges. We are excited to work with Atmosic to enable a new level of functionality for eBadges and to free product designers from power constraints."

Image source: Business Wire

Ideal for particularly small areas

Dracula Technologies (Valence, France) has achieved a new fill factor record for an OPV module with fully inkjet-printed layers. These small-area modules target indoor applications

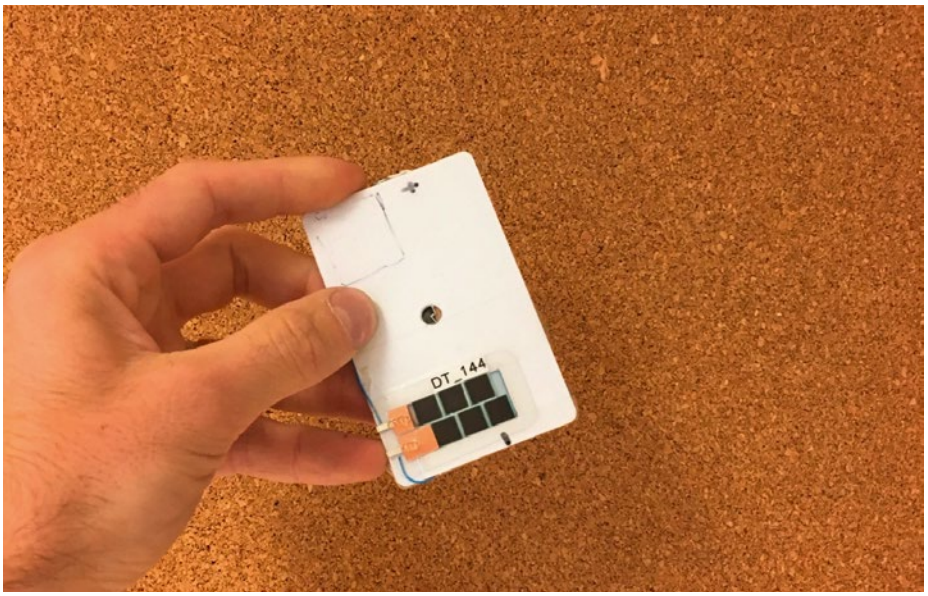
The LAYER technology stands for "light as your energetic response" and consists of printing different layers, of which each has different physical properties.
The "fill factor", more commonly known by its abbreviation "FF", is a parameter which, in conjunction with Voc and Isc, determines the maximum power from a solar cell.
A small-area flexible module (active area = 1.5cm²) delivers a power of 43µW/cm² at 1000 lux under indoor lighting conditions using LED illumination. The light intensities are measured carefully using a suitable system.

Diagram with current and voltage parameters

Equally important, a high fill factor of 74% was achieved for blends processed in ambient from environmentally friendly solvents.

Highest value reported

"It's currently the highest value reported to date for all inkjet-printed OPV modules," says Dracula Technologies' CTO Sadok Ben Dkhil. Small size OPV modules have unique advantages, including solution processability, flexibility, lightweight and tailorable design. Hence, they are considered the best solution for indoor light-harvesting applications and more suitable with IoT devices having low power consumption.
There is a growing demand for modules with a very small surface area capable of delivering only a few microwatts. Indeed, with the progress of low consumption electronics, more and more applications of this kind can be found.



Prototype of a smart card powered by LAYER technology

Dracula Technologies is working with manufacturers on topics related to electronic cards or access badges. Let's imagine cards capable of embedding electronics in order to offer new functionalities to users.
A smart card integrates a microprocessor, some memory, and some apps. It is estimated that between 30 to 50bn smart cards are in circulation today.

Authentication and identification

Smart cards allow to authenticate and identify people. They are used for:

- Public transportation
- Access points
- Subscriptions
- Healthcare
- Banking

For example, the bank card, created more than 50 years ago, is an indispensable tool for daily transactions. There were more than 800M bank cards in circulation in 2016 in Europe.

What a future credit card might look like

We saw new cards arrive with the CVC refreshing regularly, and this is just the beginning. With the rise of mobile payments, companies designing electronic cards need to innovate. Dracula Technologies' LAYER technology, which has the particularity of performing well in low-light conditions, offers the possibility of creating very small surfaces thanks to sheet-to-sheet inkjet printing.

Image sources: Dracula Technologies

Accelerating flexible, wearable electronics in Europe

The SmartEEs2 project aims at boosting the EU industry's competitiveness by forging collaborations around innovative flexible & wearable electronics solutions

SmartEEs2 aims to establish a sustainable EU-wide network in the field of flexible, wearable electronics (FWE). The objective of the project is to help European Industries strengthen their competitive advantage by enabling easy access to flexible and wearable electronics technologies, products, components, technologies and services throughout Europe.

Participate and benefit

Participating in the SmartEEs2 project is possible by applying with your own project idea and receiving up to €100 000, or making your technology and expertise available on the Marketplace and receiving up to € 60 000 if your technology is used in SmartEEs2 funded projects.

Two more cut-offs are available for project applications: 7 May 2021 and 31 August 2021.

The call is open to SMEs and mid-caps for small projects, called 'Application Experiments' (AEs) with a duration of 9 to 12 months. The AEs could focus on any area such as: medicine and pharmacy, textiles, packaging, energy, automotive, buildings, lighting, consumer electronics and logistics. Applications can be submitted via the SmartEEs2 website.

For the cut-off dates the SmartEEs2 partners organise web-seminars presenting the SmartEEs2 project, the funding conditions, and the application modalities in detail. The project's new ecosystem and the role of the individual catalogues are also explained.

In the second cut-off, eight proposals were selected. The projects are focused on integrating flexible and wearable electronics into advanced new products and/or series of products, utilising the technology partner from the SmartEEs2 ecosystem that provides the required technical products or component. A business partner supports both companies during the service provision. The evaluation reports are published on the website for each cut-off giving more insight into the selected projects.

The SmartEEs2 ecosystem

Within the first year the SmartEEs2 ecosystem has grown with new companies from the field of flexible, wearable electronics showcasing their technologies on the marketplace. The ecosystem consists of four pillars: The Technical Marketplace, the Organisation Registry, the Business Marketplace, and the Community.

The Technical Marketplace is a catalogue of flexible and wearable products, prototypes and technical devices provided by companies from across Europe. It shows a unique list of more than 100 available technologies and their use in various applications fields, such as OLED lighting, flexible displays, integrated smart systems and organic photovoltaics.

The Organisation Registry is a catalogue of ecosystem organisations. All partners and participating companies can register in the value chain with their company information and contact details.

The Business Marketplace shows strategy and business supports, community building, skills and trainings from the participating companies and partners. Companies can offer their services, such as project management, crisis management, business development and innovation coaching. In the Community Area, registered companies and institutions can publish and share relevant news, events, job offers, reports, funding, videos, information on training events or educational material.

The SmartEEs2 project is funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No. 872076. In the period from 1 January 2020 to 31 December 2022, 14 partners from 9 EU countries are involved in the project.

Image sources:
A, B: CEA - French Alternative Energies and Atomic Energy Commission
C: IMEC
D: EURECAT - Technology Centre of Catalonia

SmartEEs Application Experiment prototypes: ETS – Pressure sensor controlled e-skateboard (A) with printed pressure sensors; BOSET – Blood transfusion monitoring device for cold chain maintenance (C) ; RFLEX - Radio frequency based flexible care for rehabilitation (D)

The world of printed electronics – just one mouse click away

From the perspective of the printed electronics industry, 2020 was a somewhat patchy year. Following a Corona-related decline, the industry is now once again looking ahead with confidence: According to an OE-A member survey from October 2020, companies are expecting sales to increase by seven percent in 2021. The expected upswing will certainly also be boosted by the online edition of LOPEC 2021, the international exhibition and conference for the printed electronics industry, held from 23 to 25 March.

After a year without any events and trade fairs, the international industry will once again get together at LOPEC – at least virtually. In cooperation with the OE-A, exhibition director Lena Haushofer and her team at Messe München have developed a convincing concept, implementing a secure opportunity to exchange ideas and foster contacts: "Conversations with customers revealed just how much they missed networking with industry representatives and consequently external impulses and inspiration. We are therefore all the more pleased to be able to offer the industry the digital Conference as well as the online exhibition as a platform for exchange."

LOPEC Conference – printed electronics for insiders and newcomers

The LOPEC Conference will live up to its role as the most important communication platform for applications, solutions, research and knowledge. In addition to application examples, including examples from the automotive and energy sectors, technical innovations such as biocompatible materials, 3D printing processes and other manufacturing processes will be on the agenda. With the proven format, the LOPEC Conference offers both insiders and newcomers orientation in the growing market for printed electronics: The popular mix of plenary lectures and sessions in the three modules Business, Technical and Scientific Conference, will remain unchanged. Short Courses and Poster Sessions will provide in-depth and compact information on the multi-faceted topics of printed electronics, on new products and ideas.

Around 180 conference contributions from major industry players as well as startups and renowned research institutes will provide insights into innovations and processes.

LOPEC will be held as an online event this year, starting 23 March. Around 180 Conference contributions have been confirmed. The online exhibition will feature around 100 companies

Some examples:

- Prof John A. Rogers of Northwestern University in the U.S. as well as Esmeralda Megally, founder of the Swiss startup Xsensio, will address printed electronics in health monitoring.
- Among other contributions to the trend topic of 'wearable electronics', Dutch fashion technologist Marina Toeters, founder of by-wire.net, will present garments with integrated sensors and actuators that sense and respond to environmental stimuli. Ralf Michalczuk, senior technology & funding manager at Swarovski, will describe how his company adds functionality to its crystals through printed electronics.
- "Moving forward in uncertain times: innovation is more important than ever": Stan Farnsworth, chief marketing officer of U.S.-based NovaCentrix, will provide an outlook for the industry. This presentation will be held as an Open Plenary Session, which will thus also be accessible free of charge to participants of the online exhibition as a special offer.

Wolfgang Mildner, general chair of LOPEC:

"With the proven conference format of plenary lectures, Business, Technical and Scientific Conference, Short Courses and Poster Session, we offer both insiders and newcomers orientation in the growing market for printed electronics."

Online exhibition with approximately 100 companies

In addition to the Conference, LOPEC also features an exhibition that will be held online. It features international exhibitors presenting their solutions and products from the field of printed electronics. These are also available for viewing on a 365-day platform after the three LOPEC event days. In addition, the companies can be contacted directly through the exhibitor profiles of the platform.

Participation with Conference ticket or free Digital Pass

Participants can choose between two ticket options. The Conference ticket allows for the virtual attendance of the Conference – both live ("Conference Stage") and on demand for up to six weeks after the event ("Conference on Demand"). With the free Digital Pass, several options are available to registered online visitors: Direct exchange with participating sponsors, speakers and participants of LOPEC through the digital industry directory.

Image sources: Messe München

A new virtual platform for organic and printed electronics

OPE journal sat down with Dr Khasha Ghaffarzadeh, CEO at TechBlick, to talk about his company's new, fully virtual conference concept that debuts in 2021

OPE journal: Dr Ghaffarzadeh, can you describe the concept of TechBlick? How does it work?

Dr Khasha Ghaffarzadeh: TechBlick organises online events focused on printed and flexible electronics as well as advanced materials. Each year we bring our subscribers 350+ analyst-picked live online presentations and 10+ industry-led masterclasses. These take place as regular live online conferences throughout the year in our community-centric fully integrated virtual events platform. Our agenda is developed based on our comprehensive knowledge of the technologies and applications. Our team is always researching the technology and market landscape to identify the key players from OEMs and end users to innovative start-ups and commercially relevant researchers.

TechBlick's approach is unique, building on the key advantages of an online event. I outline some of the unique characteristics of our approach:

- All-year-around: TechBlick's events are, in a sense perpetual events. There are live online conferences at approximately four-week intervals. Each conference will consist of approx. 40 speakers organised as two live sessions. This means that the polls and Q&A sessions will also be live, giving opportunity for further interaction.
- Annual pass model: Buy an annual pass, and for one full year you will have access to all our past (on-demand) and future (live + on-demand) conferences and presentations as well as all our mastercasses. Of course, you can visit the booths, watch demo talks, and do online networking without limits.
- On-demand: You will not miss any talk regardless of how busy you are or in which time zone you are located. The talks will be available to download shortly after they are broadcast, giving you access to our growing library of content.
- Community centric platform: Our online platform is fully integrated meaning that it brings together the agenda, the streaming, the on-demand, the booths, the attendee-to-exhibitor video links, and, crucially, the community in one easy-to-use online platform which is accessible anytime, anywhere, and on any device. Ultimately, building a thriving community online is our goal.

We have announced the first virtual conference of our event series on 10 & 11 March covering printed, flexible, hybrid and in-mould electronics. The compelling speaker line-up includes leading global organisations such as JCDecaux, GE Research, Fiat, Jones Healthcare, Geely Design, SWAROVSKI, Jabil, Eastman Kodak and many more.

We have announced our event themes until mid-July all accessible with the annual pass. Further events for Q3/Q4 and details of our online masterclasses will be announced in early Q2.

- 10 & 11 March: Printed, Flexible, Hybrid, and InMold Electronics (I)
- 14 & 15 April: Graphene, 2D Materials, and Carbon Nanotubes
- 11 & 12 May: Printed, Flexible, Hybrid, and InMold Electronics (II)
- 11 & 12 May: Quantum Dots: Material Innovation and Emerging Applications
- 15 & 16 June: Innovations and Trends in Displays and Lighting: OLEDs, Flexible, Printed, microLED, and beyond
- 14 & 15 July: Skin Patches, Wearables, E-Textiles, and Stretchable Electronic

OPE journal: Who are the people involved in this project? What is their expertise and experience?

K. Ghaffarzadeh: Our team has deep roots in printed and flexible electronics. I spent a decade as an analyst researching this space. I researched and published leading market reports on all aspects of printed, flexible, hybrid and in-mould electronics. I also presented at all the key conferences and visited most players worldwide. Also our event director has been involved in the industry for a decade and previously organised the largest global tradeshows and conferences on the topics in Europe and the USA.

OPE journal: Will your event schedule remain fully virtual even after the pandemic, or do you also intend to offer in-person conferences at some point?

K. Ghaffarzadeh: Our plan is to remain virtual for 2021 and our business model is also based upon the characteristics and benefits of online events. We believe that in 2022, even if international travel resumes – there will be space for virtual as well as hybrid events.

This trend is to be seen in every other aspect of life. For example, you can buy a shoe online or in a store, and yet the two experiences are not the same, or you can receive your university education on a campus or attend virtually. In fact, it is surprising that it took a catastrophic abrupt event like Covid to force more digitisation upon the event industry. Previously there had been too much momentum and people were afraid to stop and ask questions.

Interestingly, by the end of 2021, the world will have had some two years of collective learning so this genie is out of the bottle and there won't be any going back. And rightly so, because there are certainly benefits to online events that outperform physical ones. In parallel, virtual event technology is fast improving, and I don't see these improvements plateauing anytime soon. In fact, I think online

"The printed and flexible electronics field is very diverse and there is innovation in every aspect."

Dr Khasha Ghaffarzadeh

experiences will be vastly improved in the next five years, overcoming many shortcomings that online-only events experience today.
Having said that, we do believe that there will also be space for physical events, especially in terms of overall memorable experience, serendipitous meetings over coffee, or touch and feeling of some products. Overall, we feel that online and physical are complementary and by no means mutually exclusive.
It is possible that there will be video call fatigue and pent up demand, and many will be itching to get back to international travel provided shrunk company travel budgets return to normal levels! Therefore, we will closely listen to our customers and to members of our online community. If there is interest, we will certainly consider holding physical or hybrid events because we have the required experience and the organisational capability, but first let's see how the situation evolves.

OPE journal: How would you evaluate the current market for printed and flexible electronics? What are developments that people in our industry should keep in mind while doing business right now?

K. Ghaffarzadeh: There are many interesting trends and it is hard to know where one should start. In-mould electronics is nearing the point of take-off, even in the automotive industry. The learning curve and the qualification has been long, as expected, but we are not far. There are of course already products in the consumer and wearable electronics sectors using the in-mould platform. Our online event on 10-11 March 2021 has some fantastic speakers on the topic if you are interested including Suunto, Fiat, Geely, Covestro, Arburg, Lightworks, TactoTek, and others.
An interesting application area is in electronic packaging, and I mention this because the packaging and the semiconductor industry are booming now as manifested by the part shortage that recently brought some auto production lines to a stop. Printed electronics can be used in die attach, in package-level EMI shielding, in wire-bond replacement, in thermal vias, in bumping, etc. Some are even attempting to prototype re-distribution layers (RDLs). Our programme highlights some interesting works including inkjet-printed package-level EMI shielding by Heraeus, magnetic shielding paste by Fujikura, wire-bond replacement for RF packages by Optomec, and Cu die attach and bumping by Kuprion. We even highlight other semi-additive approaches based on laser direct structuring (LDS) developed by LPKF.
Flexible Hybrid Electronics is also an exciting topic. Here we focus on all the key innovation and development trends including ultra-thin flexible ICs with increasingly complexity, low-T die attach materials/methods, PI to PET substrate transition, roll-to-roll production and rapid pick-and-place, and application development. We have lined-up great speakers highlighting all these trends including Jabil, American Semiconductor, Alpha Assembly, CondAlign, Safi-Tech, CPI, Panasonic, and many others.
Smart packaging remains an active topic despite all the ups and downs. In particular, high-value pharmaceutical packaging is where printed electronics can deliver value. We have a number of great speakers here including Information Mediary. Corp and Jones Healthcare Group.
A hot topic is of course medical and biosensors these days, especially given the pandemic. Printing, especially R2R, is really a fantastic means of mass producing sensors. Some suppliers have been scaling up their teams as fast as they can. In parallel, the topic of printed electronic skin patches remains also very active, with more products on the way to the market. We have dedicated a full two-day conference to these topics in July 2021. This would also be accessible with a single annual pass. We will announce more on this in the coming months.
The printed and flexible electronics field is very diverse and there is innovation in every aspect. There are companies commercialising printed memory again (e.g., Australian Advanced Materials), there is fantastic progress in printed battery technologies and a great example is Evonik, there is real innovation on copper inks after multiple false hopes and false starts (e.g., Copprint and PrintCB), there is rejuvenation in printed organic photovoltaics from the material side (e.g., Brilliant Matters, Raynergy Tek, etc) as well as the production side (e.g., Armor, Sunew, etc). Printing of perovskite is also a trendy topic (e.g., Saule). Interestingly, companies can print transparent heaters in the form of metal mesh or carbon nanobuds (e.g., PERC, Canatu) with many applications including in ADAS and autonomous driving.
There are too many trends to mention. I just want to highlight one last trend which is not often considered in the printed electronics world: hybrid CMOS based NIR and SWIR sensors. Here, for example, quantum dots can be solution cast atop CMOS sensors to make silicon imagers sensitive to NIR, SWIR, and MWIR- this is a fantastic development and the state-of-the-art is rapidly advancing.
In general, we carefully curate our programme to highlight the key innovation and market trends in the field. Here, we leverage our years of deep market insight and fantastic network of contacts worldwide.

Image source: TechBlick

Printed electronics builds on its literal flexibility during the pandemic

Wolfgang Mildner

For an entire year, the crisis surrounding the COVID-19 pandemic has dominated public discussion and caused changes in our personal or business lives. Even the – still – small world of printed electronics has been forced to change or has actively decided to set new priorities – including actively helping in the fight against the pandemic.

New development ideas have been implemented and research priorities shifted.

Examples include smart protective masks equipped with sensors (like the one from Holst Centre), T-shirts with sensors to monitor vital signs such as lung activity, or smart patches that use sensors to monitor body temperature.

New combinations

In most cases, developments and technologies were involved that have already been fully developed and are now being used in new combinations for these new applications. This is a sign that printed electronics is rightly classified as an enabling technology that can be used for many different applications.

There are also materials such as nano silver, which have been known for some time for their antimicrobial capabilities (for example from RAS AG, with approval already for medical use). These nano materials now even have the potential for dual use in applications with conductivity and antiviral/ antimicrobial properties (an example for this comes from COPPRINT).

So, while the OE-A economy forecast of its members showed a sharp business cut in 2020, it also provided promising signals for the future. From my point of view, the situation indicates that the organisations that are actively pursuing printed electronics can respond quickly, creatively, and flexibly to changing requirements. The event industry and all organisers of live events were also forced to undergo dramatic changes. LOPEC 2020 could not take place, whereas for LOPEC 2021, we already agreed in October 2020 that we needed to prepare for a virtual event. LOPEC 2021 will showcase and have presentations on the state-of-the-art of printed flexible, hybrid electronics. It will focus on the two application topics:

Mobility and smart living

The feedback from the submitters to the congress was promising, as, quite obviously, there are many new insights worth sharing with users and colleagues from all over the world. LOPEC 2021 will have as many contributions to offer with almost 200 speakers and presentations as the most recent in-person LOPEC events had.

However, due to the international nature and thus the different time zones of the speakers and the audience, the programme will not only be available live, but also on demand for up to six weeks. This is even an advantage compared to purely live lectures.

Also, the online exhibition offers new functionality, as all exhibitors are part of a platform that is available for 365 days for networking and contacting. Some of the talks – such as the introductory talks or the open plenary talk by Stan Farnsworth – are available for free for everyone, as well as the access to the online exhibition.

See you all at LOPEC 2021 – Online, 2021, 23-25 March!

For the future, evaluating the experience of these new opportunities and possibly combining it with the undeniable benefits of networking in a real exhibition will be interesting and challenging at the same time. Or we will be surprised by further new requirements and use our creativity to make the best of the situation and offer new concepts once again.

Image source: Messe München/ Wolfgang Mildner

Print your surround sound!

Researchers at TU Chemnitz are working on light, roll-printed speaker paper – with impressive results

If the Institute of Print and Media Technology at Chemnitz University of Technology in Germany has its way, many speakers of the future will not only be as thin as paper, but will also have an impressive sound. This is a reality already in the laboratories of the Chemnitz researchers, who developed the multiple award-winning "T-Book" back in 2015 – a large-format illustrated book equipped with printed electronics. If you turn a page, it begins to sound through a speaker invisibly located inside the sheet of paper. "The T-Book was and is a milestone in the development of printed electronics, but the development continues," says Prof Dr Arved C. Hübler, under whose leadership this technology trend, which is becoming increasingly important worldwide, has been driven forward for more than 20 years.

Five years ago, the sonorous paper loudspeakers from Chemnitz were still manufactured in a semi-automatic single-sheet production process. In this process, normal paper or foils are printed with two layers of a conductive organic polymer as electrodes. Between them is a piezoelectric layer as the active element, which causes the paper or film to vibrate. Loud and clear sound is produced by the displacement of air. Both sides of the loudspeaker paper can be printed in colour. Since this was only possible in single sheets in limited formats, the efficiency of this relatively slow manufacturing process is very low. Therefore, researchers at the Institute of Print and Media Technology have been looking for a new way since May 2017 – towards cost-effective mass production.

Converting sheet into roll production

The goal of their latest project, "roll-printed speaker paper" (T-Paper in short), was therefore to convert sheet production into roll production. "Researchers from the fields of print media technology, chemistry, physics, acoustics, electrical engineering and economics, coming from six nations, developed a continuous, highly productive and safe roll production of loudspeaker webs," reports project leader Georg C. Schmidt. Not only did they use the roll-to-roll (R2R) printing process, but they also developed inline technologies for other process steps, such as the lamination of functional layers. "In this way, electronics can be embedded in the paper – invisibly and protected," says Hübler. In addition, inline polarisation of the piezoelectric polymer layers has been achieved for the first time and complete inline process monitoring of the printed functional layers is possible. The final project results were published in the renowned journal "Advanced Materials" in January 2021.

Metre-long installations

The potential of loudspeaker paper was extended to other areas of application in the T-Paper project. For example, metre-long loudspeaker installations can now be manufactured in web form or as a circle ("T-RING"). "In our T-RING prototype, an almost four-metre-long track with 56 individual loudspeakers was connected into seven segments and formed into a circle, making a 360° surround sound installation possible," says Schmidt. The loudspeaker track, including printed circuitry, weighs only 150 grammes and consists of 90 percent conventional paper that can be printed in colour on both sides. "This means that low-cost infotainment solutions are now possible in museums, at trade fairs and in the advertising industry, for example. In public buildings, for example, very homogeneous sound reinforcement of long distances such as corridors is possible. But the process technology itself could also become interesting in other areas, for example in the production of inline measuring systems for Industry 4.0," the project manager says.

The "T-Paper" project was funded by the Federal Ministry of Education and Research with €1.37M from 2017 to 2020 as part of the funding measure "Validation of the technological and societal innovation potential of scientific research - VIP+".

Varvara Bachul from the Institute of Print and Media Technology at Chemnitz University of Technology analyses the sound generated inside the T-RING

Image source: TU Chemnitz

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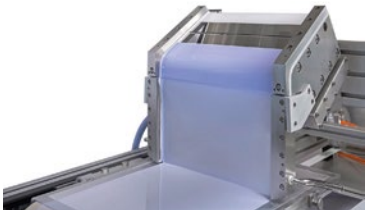

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Stan Farnsworth
Chairman OE-A Board, NovaCentrix

Dr. Klaus Hecker
Managing Director OE-A

Dear Reader,

Connect, communicate, cooperate, innovate – always key concepts and especially in these current circumstances. The restrictions brought about by the pandemic challenge all of us to find new ways to uphold these concepts, to continue our drive for developing and implementing innovation. Our answer to the pandemic is itself innovation: go digital! Normally, the beginning of the new year would have seen us heading to CES in Las Vegas, USA. Instead, CES 2021 came to us, as the first all-digital format of this global event, allowing us to remotely explore innovations and trends in consumer electronics. We continued our virtual journey in February with ISPO - the world's largest trade fair for the sports industry. OE-A represented our industry by organizing a web-seminar at the ISPO Online Conference. In this well-attended web seminar OE-A members demonstrated how we enable new features for the sports and well-being industry as well as digital health solutions. Getting healthier, getting fitter with organic and printed electronics!

The next destination on our virtual journey will be the OE-A General Assembly scheduled on March 16, 17 and 19, 2021. We invite all OE-A members from around the world to join online for a range of important content, including a hot topic talk on "Smart Cities. We will also meet the updated OE-A board of directors, who will have been elected, of course, remotely.

'Smart Living' and 'Mobility' are the focus topics of the next destination on our virtual journey, which is just around the corner: LOPEC 2021.The fully digital format allows LOPEC to continue to serve as the central, international meeting point for the industry, even under the current conditions. The key element of LOPEC Online will be the LOPEC Conference, with more than 180 contributed papers and talks. In addition to the digital conference, participants can look forward to an online exhibition featuring more than 100 companies. Every year at LOPEC we see compelling innovations which utilize printed electronics products to make our everyday lives easier, smarter, and more environmentally friendly. Every year the demonstrators submitted for the OE-A Competition are more advanced and creative, making the job of the judges difficult indeed. Learning more about each of the demonstrators is another reason to tune in to the all-digital LOPEC 2021.

So, join us as we make our way along on our virtual travel, with our next stop at LOPEC 2021. Learn from innovative content and reconnect with remote networking. For OE-A members there are plenty of opportunities to connect, communicate, and collaborate in the first quarter 2021. Innovation, like our digital journey, continues!

Stan Farnsworth
Chairman OE-A Board
Chief Marketing Officer NovaCentrix

Dr. Klaus Hecker
Managing Director OE-A

OE-A

Organic and Printed Electronics Association
A working group
within VDMA

Lyoner Straße 18
60528 Frankfurt am Main,
Germany

Contact
Dr Klaus Hecker
Managing Director
klaus.hecker@oe-a.org

Editor
Isabella Treser
Press &PR Manager
Isabella.treser@oe-a.org

www.oe-a.org
www.lopec.com
@OEAonline
linkedin.com/company/oe-a

OE-A at ISPO 2021:
Get healthier, get fitter with Printed Electronics

OE-A represented Printed Electronics at ISPO, the world's largest trade fair for sports business.

On February 2, OE-A organized a web-seminar at the ISPO Munich Online Conference. The seminar 'Printed Electronics Enabling Wearables' presented latest developments and use-cases of printed and flexible electronics for wearable applications that increase e.g., the range of functionalities of garments and optimize the efficiency and health of the wearer.

After an introduction by our colleague Jan Krausmann, OE-A, Mohammad Behfar, Senior Research Scientist at VTT Technical Research Centre of Finland, focused on hybrid integration for soft electronics-based wearables. He showcased a wearable biosensor that enables real-time monitoring of biomarkers on physiological changes as well as a stretchable skin sensor for ECG measurement developed by VTT. In this regard, Mohammad also presented key concepts for the development of stretchable wearables and emphasized the enabling role of hybrid electronics, where cost efficient production is facilitated by high-thoughput integration of the latter.

Photo: © Quad Industries

Wearable skin patches by Quad Industries
www.quad-ind.com

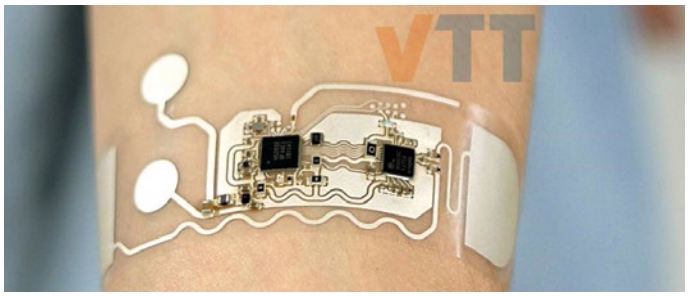


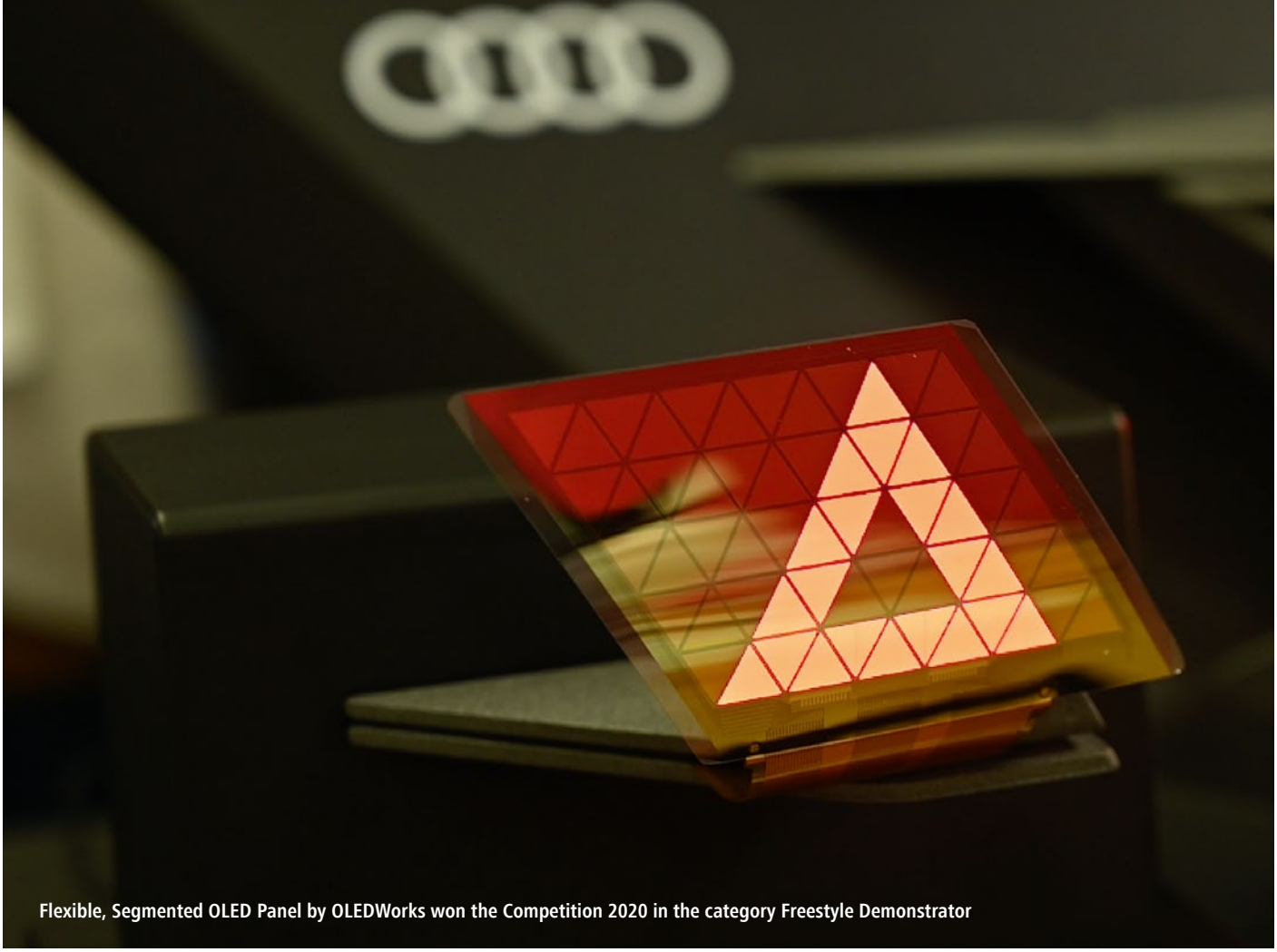
Photo: © VTT

Stretchable electrocardiogram skin sensor by VTT

Following, Wim Christiaens who is the R&D Director at Quad Industries based in Belgium, demonstrated how Printed Electronics is a key enabler for wearables and smart textiles. Besides a smart shoe sole to monitor the interaction between foot and ground, he showcased a medically certified smart patch, developed by Quad Industries and partners, that is used for the monitoring of vital parameters of patients recovering from COVID at home. In this regard, Wim emphasized the increasingly important role of such smart monitoring systems that are small sized, lightweight and thus comfortable for the wearer, all enabled by printed electronics.

After the lectures Wolfgang Mildner, General Chair of LOPEC as well as Owner & CEO of MSWtech, gave an outlook on LOPEC 2021 Online and its top-class conference program. Tickets for the online exhibition and the 3-day conference program are available at www.lopec.com.

OE-A members find all presentation slides in the OE-A member area my.oe-a for download. \\



Flexible, Segmented OLED Panel by OLEDWorks won the Competition 2020 in the category Freestyle Demonstrator

Photo: © OLEDWorks

OE-A's Activities at LOPEC 2021 Online

Again, this year, OE-A will organize exciting, printed electronics related activities at LOPEC 2021 Online.

OE-A Competition 2021: Inspire – Create – Innovate

Following the huge success during past LOPECs, we have decided to continue the popular OE-A competition 2021 as online format. 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.

Participants of the OE-A Competition 2021 show the many possibilities of organic and printed electronics with creative ideas, prototypes, and fresh designs. Get inspired by more than 20 innovative products, prototypes, and technologies participating in the OE-A Competition 2021.

The submitted projects will be rated in three categories by a jury of representatives from well-known international companies and institutes:

- Prototypes and New Products
- Freestyle Demonstrator
- Publicly Funded Project

Photo: © IEE

Award Winner OE-A Competition 2020, category Products & Prototypes: ActiSense – Smart Footwear Sensor, IEE

Public Choice Award: Voting period starting from March 18

Now, it`s your turn, cast your vote in the public category! Choose from all three categories which demonstrator deserves the "Public Choice Award". The voting period will start March 18 (voting open for one week). Voters also have the chance to win an exemplar of the book "Unfolding Fashion Tech: Pioneers of Bright Futures" by Marina Toeters.

Photo: © Heliatek

Competition winner 2020 of the category Publicly Funded Project Demonstrator was OPV Façade by Heliatek

We are glad to present all submissions to the international community during LOPEC – this time in an online showcase. Starting from March 18 you will have the opportunity to visit all demonstrators online at **oe-a.org.**

OE-A Exhibition

For detailed information on OE-A's work visit our online booth at LOPEC 2021. At our virtual booth we will give you an overview of printed electronics applications and extensive information on all our services. In short videos you will learn everything about OE-A's activities:

- International networking & communication platform
- Market & technology information
- Education & training
- Advocacy & funding
- Global visibility

Meet us online at the OE-A booth and get to know the many OE-A activities to further strengthen and develop the organic and printed electronics industry.

For more information about OE-A's activities at LOPEC 2021, visit www.lopec.com or www.oe-a.org. \\

Save the date: Web-Seminar OE-A Competition 2021 – The winners

The Award Ceremony of OE-A Competition 2021 will take place in a web-seminar on April 15, 2021. Be sure to mark your calendar and take part when the winner of the Public choice award as well as the winners of the three other categories will give their presentation and introduce more details of their demonstrators. So, save the date!

OE-A Web-Seminar | OE-A Competition 2021 - The winners

- Date: Thursday, April 15, 2021
- Time: 15.30 – 17.00 (CEST)
- Registration will be open in March

More detailed information on the submitted demonstrators of the competition 2021 soon available at oe-a.org or lopec.com. \\

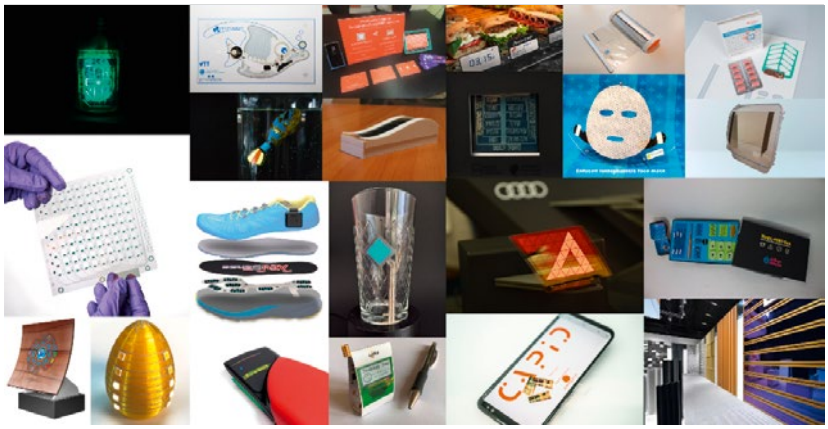


Photo: © OE-A, OE-A Competition 2020

OE-A Competition 2020

OE-A Calendar of Events

The OE-A Working Groups meet regularly in Europe, North America and Asia.

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. \\

General Assembly / OE-A Meeting Europe	
March 16 – 17 &19, 2021 (one week before LOPEC)	**Online**
OE-A Meetings Europe	
October 19-20, 2021 (preliminary)	**Tampere (FI)** Hosted by Tampere University
OE-A Meetings Asia	
October 27, 2021 (preliminary) (day before ICFPE)	**Toki Messe, Niigata (JP)** Jointly organized with AIST, and JAPERA, JAPEC and FIoT network
OE-A Meeting North America (US)	
Q3/Q4, 2021 (preliminary) date and venue to be determined	**Bay Area (CA, US)**

Trade fairs and conferences where you can meet the OE-A. Members benefit from reduced fees for several conferences	
LOPEC DRIVING THE FUTURE OF PRINTED ELECTRONICS **LOPEC 2021 Online** **March 23-25, 2021**	**Messe München, Germany** Messe München and OE-A jointly host the leading international trade fair and conference. This time online. The event offers a high-quality platform to all manufacturers, industrial customers and research institutions engaged in the field of organic and printed electronics **www.lopec.de**
virtual.drupa 2021 **April 20-23, 2021**	**Düsseldorf (DE)** OE-A will will host free seminars on flexible, organic, and printed electronics at the drupa cube **virtual.drupa.de**
IFETC 2021 **August 8-11, 2021**	**Columbus, OH (US)** OE-A is partner of IFETC and organizer of a conference session on flexible and printed electronics
ICFPE 2021 **September 28-October 1, 2021**	**Toki Messe, Niigata (JP)** OE-A is partner of ICFPE and organizer of a conference session
productronica 2021 **November 16-19, 2021**	**Munich (DE)** OE-A will have an exhibition booth and will host free seminars on organic, flexible and printed electronics

OE-A Web-Seminars Printed Electronics Insights	
OE-A Competition 2021 - The winners **April 15, 2021, 15:30 – 17:00 (CEST)**	The winners in three categories as well as the winner of the "Public Choice Award" will present their demonstrators in this Web-Seminar.

The latest information regarding the events can be found at **oe-a.org/web/oe-a/events**

oe-a

Messe München

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