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ORGANIC AND PRINTED ELECTRONICS

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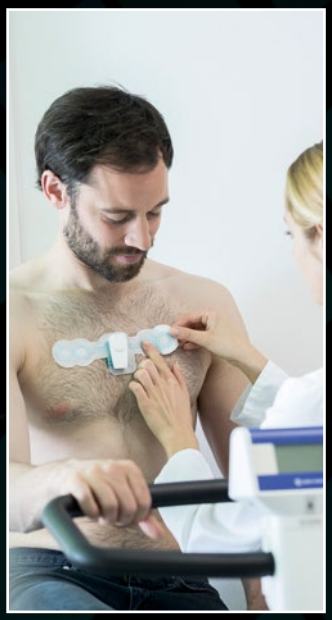

OPE journal Issue 34

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9 February 2021

INPRINT, Munich
09-11 March 2021

LOPEC, Munich
23-25 March 2021
Online-Event

OPE journal Issue 35

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Editorial deadline:
13 April 2021

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24 August 2021

Labelexpo Europe, Brussels
21-24 Sept. 2021

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Dear Readers,

A few days ago, the German actor and comedian Aurel Mertz tweeted this: "In retrospective, shaking hands has always been a bit disgusting." This statement made me think about all the things we took for granted only 12 months ago: We were pushing ourselves through the crowded halls of some tradeshow, shaking hands with dozens of business partners, all breathing the same air in close proximity without giving it any second thought.

What happened in 2020, will influence our behaviour and our internal concept of what is 'safe' even when the worst of it will be over. We can already start imagining what the post-corona world might look like – and technology plays a huge part here. In this issue of OPE journal, we will be highlighting some fascinating developments in the area of energy, flexible batteries and OPV. Take, for instance, the huge leaps that printed battery technologies have made in the last few years. I am certain that there are countless applications for this technology that will simplify existing devices and enable more portable technologies, among others.

Finally, I would like to say goodbye and wish all the best to Sophie Verstraelen, who will leave the OE-A at the end of the year. In many ways, she has shaped OPE journal with her ideas and contributions in many phone calls, personal meetings and video conferences that we have had over the years. Her personal parting words to the printed electronics community are also part of this issue.

As always: stay safe and healthy, and have a good start into the New Year!

Yours

2021		
CES 2021 www.ces.tech	6-9 January 2021	Location: All-digital event Organiser: Consumer Technology Association
interpack 2021 www.interpack.com	25 February- 3 March 2021	Location: Messe Düsseldorf, Germany Organiser: Messe Düsseldorf GmbH
InPrint Munich 2021 www.inprintmunich.com	9-11 March 2021	Location: Messe Munich, Germany Organiser: Mack Brooks Exhibitions
ICE Europe www.ice-x.com/europe	9-11 March 2021	Location: Messe Munich, Germany Organiser: Mack Brooks Exhibitions
LOPEC DRIVING THE FUTURE OF PRINTED ELECTRONICS	23-25 March 2021	All-digital event Organisers: Messe München, OE-A, www.lopec.com
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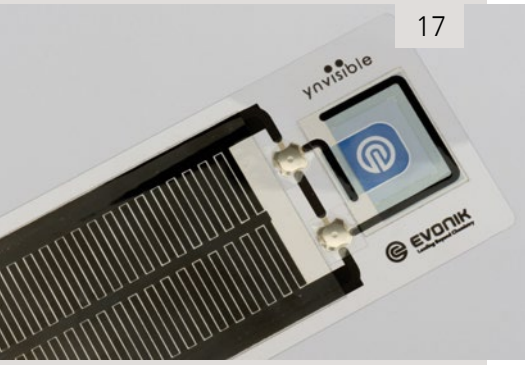

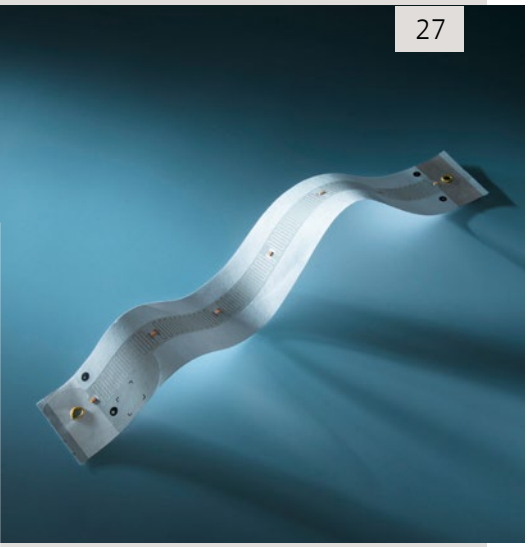

HIGHLIGHTS FROM OPE-JOURNAL.COM

New managing director at Coatema

NEWS

Dr Markus Deimel has been appointed as further managing director at Coatema Coating Machinery GmbH (Dormagen, Germany) on 1 August 2020 and will be responsible for the management of the company together with Dr Tarik Vardag, managing director of the ATH Group. Although Dr Andreas Giessmann and Detlev Dieke will leave the company as managing directors at the end of the year as planned, they will continue to work as consultants in the ATH group thereafter.

Dr Deimel, a 45-year-old mechanical engineer, has extensive experience in mechanical and plant engineering. After positions at ThyssenKrupp and Körber Group, he was most recently managing director at Vollert Anlagenbau GmbH.

Dr Deimel has broad expertise in business management with focus on engineering and project management as well as on procurement, production and after-sales services. "I look forward to apply my experiences to Coatema to shape actively the future of this innovative technology company together with the employees," he commented.

Dr Tarik Vardag (left) and Dr Markus Deimel (photo: Coatema)

Delta ModTech moves into new corporate headquarters

NEWS

The machinery manufacturer Delta ModTech (Minneapolis, Minnesota) has moved into its new corporate headquarters in Ramsey in the metropolitan region of Minneapolis-Saint Paul in mid-August 2020.

"We're excited to announce that our building is complete, and we've officially moved in," said Wendy Stromberg, marketing director and second generation owner. "There are so many things to consider with a build and move of this magnitude. Despite an aggressive schedule and a global pandemic, we're all moved in and fully operational."

Delta ModTech broke ground for its new site less than a year ago, on 8 October 2019. Located seven miles up the highway from their previous campus, the new Ramsey location gives Delta additional manufacturing capacity and room for growth. Set on a 43-acre lot, the new facility will house all phases of business for the converting machine manufacturer.

"This state-of-the-art facility has an efficient layout with Delta ModTech's customers in mind. An expansive production floor, enhanced training amenities, engineering and inspection laboratories, and larger machine demonstration area to support future innovation and allow us to better serve our customers," noted Evan Schiebout, COO and second generation owner.

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CSEM appoints new CEO

NEWS

CSEM is opening a new chapter. After 11 years at the helm of the Center, Mario El-Khoury, 57, is leaving his position as the head of CSEM to devote himself to personal projects. He is to be replaced by Alexandre Pauchard, who currently works for BOBST.

Arriving at CSEM in 1994, Mario El-Khoury, a Lebanese-Swiss engineer, held multiple leadership and executive positions before being appointed the role of CEO in 2009. Through his direction, he successfully managed to position CSEM as a key player in the development and transfer of cutting-edge technologies to benefit Swiss companies. A champion of innovation in all its forms and a passionate advocate for maintaining production in Switzerland, he has initiated several strategies aimed at digitising Swiss SMEs to guarantee their competitiveness.

Head of group R&D at BOBST, Alexandre Pauchard, 49, will take over the reins of the Center on 18 January 2021. He will jointly manage CSEM alongside Mario El-Khoury until his departure on 28 February 2021. Alexandre Pauchard has lived in both California and Zurich, graduated with a degree in physics from ETH Zürich, and holds a doctorate in microengineering from EPFL. He brings with him to CSEM extensive technical and managerial experience, and his dynamism is said to perfectly complement the Center, whose future operations seem set to continue along a steady path. "We are very enthusiastic about Alexandre's appointment and look forward to working with this competent new leader," says Claude Nicollier, CSEM's chairman of the board of directors. "His past activities align exactly with CSEM's areas of expertise, and his strong motivation to pursue the Center's objectives, ensuring it remains a centre of technological excellence and innovation, and guaranteeing the transfer of our products and research to the Swiss industry gives us full confidence in CSEM's future."

Alexandre Pauchard (photo: Keren Bisaz)

SunCurtain presents OPV technology for shading solutions that generates sustainable electricity

NEWS

The start-up SunCurtain, founded in 2018 in Kitzingen, Germany, pursues the vision of making a meaningful contribution to a sustainable energy future through environmentally friendly OPV technology and converting every window into a power plant.

Thus, SunCurtain has successfully developed OPV lamella curtains which serve as an efficient shading solution within buildings. In addition, they offer a pleasant atmosphere, higher building efficiency and energy savings. The energy generated by the OPV slats can be integrated into the existing power grid, temporarily stored or used to supply surrounding devices directly. The SunCurtain shading systems generate electricity all year round. The right sun protection strategy is particularly important in summer. Everyone wants their rooms, whether at home or in the office, to be filled with natural daylight. But nobody seems to take into account the excessively high indoor temperatures that occur on some summer days due to lack of shading. With the shading system, which not only protects against overheating due to incident sunlight, but also uses this solar energy to generate electricity, the young company SunCurtain GmbH wants to contribute to increasing energy efficiency and at the same time enhance comfort.

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Flexible solar cells on ultra-thin glass

ZOEK gGmbH at COPT Center for Organic Electronics (Cologne, Germany) report on their latest development: flexible perovskite and polymer based solar cells on ultra-thin glass

Thin-film and thus flexible solar cells have great potential to revolutionise the solar power generation. They expand the range of possible applications and generate the power exactly at the spot where it is needed. Lightweight, coloured or semi-transparent solar foils enable applications in architecture, electro mobility, and energy self-sustaining devices for the Internet of Things (IoT). Because of their excellent behaviour under low and diffuse light conditions and record efficiencies of more than 20% PCE, organic and perovskite solar cells are the most promising technologies. Both technologies use related materials, substrates, electrodes, and barrier foils. Consequently, research yields significant synergies to transfer either one to production.

EnerScale, a 36-month collaborative project of the partners ZOEK gGmbH, Enerthing GmbH and Forschungszentrum Jülich funded by EFRE.NRW, is focusing on the topic "Solar Foils for the Internet of Things". In order to secure the growing demand for solar foils in the future, the leading target of this project is to develop roll-to-roll manufacturing processes as well as scalable solar modules. In addition, fundamental questions need to be answered, which include cell architecture, material development, and optimised process parameters.

Within EnerScale, ZOEK gGmbH at COPT Center for Organic Electronics, is developing flexible perovskite and polymer based solar cells using another technological innovation as substrates: ultra-thin glass, kindly provided from SCHOTT. With respect to organic electronics this glass has the big advantage of providing intrinsic barrier properties compared to PEN or PET foils. The latter are commonly used for flexible solar cells.

Figure 1: ITO-coating on ultra-thin glass (left) and cut structure in ultra-thin glass (10mm in diameter) (right).

Dealing with ultra-thin glass

Using ultra-thin glass substrates for thin film devices such as OLEDs or solar cells requires a detailed process including steps such as cleaning, cutting, and coating. The sensitive nature of ultra-thin glass required the development of a new process which includes the temporary bonding on an adhesive foil and later-on debonding by UV light. Customised cutting for structures down to 100µm became possible using a CO_2 laser which was shown to enable a crack free cutting. This work was a result of a successful joint development with Bergfeld Lasertech who supported us with knowledge and access to several laser sources.

The next step was to provide new ITO-Sputtering process for the transparent electrodes. For use in OLEDs and solar cells the conductivity of this layer is highly crucial. In-house, we are able to process ITO-coatings on ultra-thin glass that feature <17 Ohm/sq, a mean roughness of 0.7nm, and a transmission of 86%. With a further ultrashort pulse (Picosecond) laser ablation process, we structure these ITO-coating in the desired design for OLEDs and solar cells (i.e. separation of active and non-active areas).

Fabricating large-area solar cells

While working on large-area solar cells, there are three major challenges that needed to be addressed: (1) up-scaling, (2) efficient monolithic interconnection and (3) encapsulation. So, even after establishing suitable processes in the laboratory, the transfer from the laboratory to industrially usable production processes still remains a challenge, specifically when working with perovskite materials. One of the biggest problems in the production of perovskite solar cells is the optimisation of the crystal structure to achieve a homogeneous, smooth and pinhole free layer in one step. This becomes a challenge when increasing areas as even a small number of possible defects starts to become a problem. Such defects inevitably result in a lower overall solar cell performance. Another difficulty results from the fact that the perovskite crystal quality formed during the deposition process highly depends on the process parameters such as humidity, temperature and particle concentration in the surrounding atmosphere. Even small changes impact the formation of perovskite crystals and cause defects. Therefore, the overall control is highly crucial for the process reproducibility.

An additional important aspect of making large-area perovskite solar cell modules is the provision of an efficient monolithic interconnection. Here, we have used the advantages of the ultrashort pulse laser to master the challenges: fast and selective scribing and reducing the "dead zone", an inactive area between the respective solar cells.

Patterning steps

Similar to inorganic solar cells, different patterning steps called P1, P2 and P3 have been found to be essential to lower the current and to increase the voltage. This kind of structuring involves complete and selective ablation of exceptionally fine lines (<30µm) within the ultra-thin layers (300 – 400nm). These steps will be described in the following.

Process P1 structures the ITO-coating by isolating subsequent areas from each other. Process P2 results in serial interconnections between the front ITO-coating and the subsequent back metal electrode by removing the active layer down to the ITO-coating. Finally, process P3 electrically isolates the individual solar cells. Since the metallic back electrode requires P2 and P3 processing from the active layer-side, the challenge is to selectively remove the respective material without damaging the underlying ITO-coating and not leaving debris behind. This is specifically crucial within the P2 process, since the accumulation of debris would result in poor connection to the back electrode and, consequently, in poor overall solar cell performance.

By employing this patterning method, a so called "dead zone" between the P1 and P3 line is automatically formed reducing the active area of the solar cell. The challenge becomes the minimisation of the "dead zone" to utilise the recovered active area to optimise the solar cell efficiency by shrinking the distance between both lines P1 and P3. This optimisation was facilitated by the fact that our ultrashort pulse laser enables structures down to 10µm.

Once all films are processed and the perovskite solar cell module has been structured, an encapsulation is required as the final step.

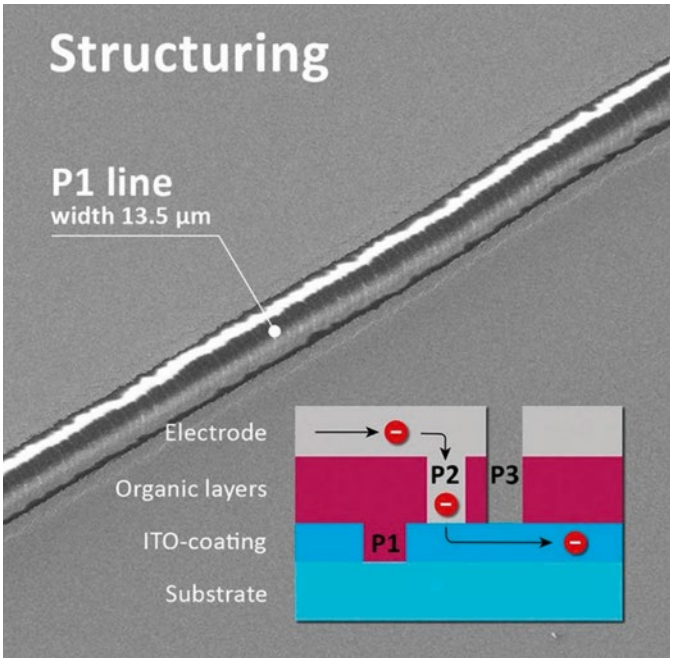


Figure 2: SEM image of a P1 line (width 13.5µm) scribed into the ITO-coating and a schematic illustration of the P1, P2 and P3 patterning steps (inset).

This layer is highly crucial on the device life time, since the film layers, specifically the perovskite layer, are sensitive towards water and oxygen.

Our results and the obtained progress have demonstrated that the use of ultra-thin glass substrates has clear advantages over plastic ITO-foils. Despite the fact that plastic film exhibits mechanical advantages, post-annealing of the sputtered ITO-layer on glass allows to drop the surface resistance to less than 20 Ohms per square. In addition, plastic foils have very low intrinsic barrier properties and require an additional encapsulation layer on both sides. Building such a barrier layer requires several additional process steps and consequently adds significantly to the manufacturing cost. Therefore, using the ultra-thin glass provided by SCHOTT for our perovskite solar cells we obtained a highly thermal stable, flexible encapsulation inherently provided by the substrate. In addition, the substrate helps to improve the performance of solar cells due to its low resistivity with a thickness of just 50µm, flexible glass is compatible with a roll-to-roll production. Finally, using ultra-thin glass as a substrate avoids the need of a separate encapsulation layer and helps to lower the production cost of ultra-thin, flexible, and long-lasting perovskite solar cells.

Figure 3: Flexible perovskite solar cell demonstrator using ultra-thin glass and a schematic illustration of the used device stack.

Solar cell demonstrator

Using the described processes to manufacture substrate, active layers, and cathodes combined with an encapsulation layer consisting of a laminated second ultra-thin glass using a pressure sensitive adhesives (PSA) foil, we were able to build flexible solar cell demonstrators (7,6x7,6cm²) with polymers and perovskites as active materials. At present, the performance of these cells is 2% (3V) for polymers and depending on solar cell geometry 7% – 11% (5 – 20V) for perovskites. Despite the progress achieved, we clearly see options for further improvements in the ongoing project.

Current and future challenges

In order to bring the Perovskite solar cell to the next level we focus on four areas:

(1) We aim to increase the size of the active area to a size of 21x14,8cm² (DIN A5) resembling an industrially usable size employing scalable, cost-effective liquid coating processes. Such processes require additional optimisation of process parameters to further eliminate sources for defects.

(2) We will replace the ITO and PEDOT:PSS layers with a newly developed ink with the target to reduce the overall solar cell cost and substituting sputtering by a scalable coating step.

(3) We will further modify the solar cell module to optimise the power efficiency under low-light conditions (ca. 200 Lux). Further enhancing the low-light capability is essential for devices of the Internet of Things, having a steadily growing demand for energy self-sufficient devices, so called beacons. Combining new materials with improved serial interconnects is seen as a very promising approach to achieve this goal.

(4) The present disadvantage of perovskite solar cells is the presence of lead. To date only lead-based perovskites yield highly efficient solar cells. The material development of lead-free perovskites yielding an improved power efficiency and long-term stability has started, but still is in its infancy. At present, efficient and long-term stable lead-free have clear deficits and need further improvements. Nevertheless, we will plan to evaluate the potential of lead-free perovskites in solar cell modules as part of this project.

Overall, it has been an exciting journey which has yielded promising results on the way from laboratory experiments to scalable manufacturing process. Progress and deep insights have made us curious and optimistic where the journey will lead us.

About ZOEK

The ZOEK is a non-profit research organisation focusing on cost-effective, conformable, and flexible components made by printing. We are an integral part of COPT Center in Cologne, Germany, being partner in a number of public funded projects and contract research.

Within technology transfer, the scope is to advance technology from the laboratory to the demonstrator level. In projects to come, we efficiently support our partners with our hands-on experience. Our current activities working in printed electronics target the markets: (1) automotive, (2) Internet of Things, (3) sports/health, and (4) energy.

Written by: Dr Anne Umbach, Dr Christoph Patron, ZOEK gGmbH at COPT Centre for Organic Electronics

Image Sources: ZOEK gGmbH, Dr Christoph Patron

Why battery technology and slitting and winding machinery actually are a perfect fit

KAMPF (Wiehl, Germany) and Kampf LSF bundle and increase their activities for the production of lithium-ion batteries

The announcements by car manufacturers to replace combustion engines with electric motors in the medium term have led to an enormous demand for high-performance batteries with ever greater energy densities and shorter charging cycles. In addition to the already established manufacturers of lithium ion batteries in Asia, numerous new projects are already under way, especially in Europe and North America, and new battery factories, so-called 'Giga-Factories' are already in various stages of implementation.

Many factories are being developed in close cooperation with European car manufacturers. In the planning of the new production facilities, Asian production lines are sometimes used as blueprints. But German mechanical engineering companies with their high level of expertise also have a good chance of qualifying as suppliers of the new production lines.

Innovative solutions for LIB production

The machinery experts at Kampf Schneid- und Wickeltechnik GmbH & Co. KG, together with their subsidiary Kampf LSF GmbH & Co. KG offer innovative solutions for LIB production.

Non-technical versed observers may ask themselves the question: "Batteries and slitting and winding technology – does that go together?" The answer is simple and more than clear: "Yes. Not only does it fit, but lithium-ion batteries cannot be produced at all without a secure mastery of slitting and winding technology," says Michael Strathmann, sales manager for the Energy & Technical Applications division at KAMPF and Kampf LSF. "Web-shaped materials – i.e. "films" are the basic materials of the batteries. The electrodes are coated aluminium and copper foils, which are separated in the batteries with a special plastic foil – the battery separator foil – to prevent short circuits. KAMPF has more than 100 years of experience and is a worldwide recognised competence and technology leader in the processing of demanding materials such as paper, various plastic films and laminated film composites and the above-mentioned metal foils. So it is obvious that the manufacturers of the LIB production

A glance into the Kampf LSF production

lines use machines and components from KAMPF, especially when know-how, quality and reliability are required."
Already more than 10 years ago KAMPF sold the first special slitting and winding machine for battery separator film (BSF). Consistent further developments led to the new BSFSlitter, which is successfully in use at the leading BSF manufacturers with many technical solutions specially developed for processing these very sensitive films. The latest development is the direct pairing of the BSFSlitter with the KAMPF BSFWinder and an integrated material handling between the machines. The concept has been convincing; therefore four of these units are currently being delivered to a new plant of a Korean group in Eastern Europe.

Cooperation with Hirano

Kampf LSF machines and components are used in the production and processing of LIB cathodes and anodes. "Our cooperation with Hirano, the leading Japanese manufacturer of LIB coating systems, has already convinced the first well-known customers in Europe," explains Dr Stephan Witt, CEO of Kampf LSF and COO at KAMPF in Wiehl. "In our Laußig plant, in addition to numerous slitting machines for LIB applications, automatic turret unwinders and turret rewinders, each with an integrated slitting unit for three cathode coating lines, are just about to be accepted. The control of the components and the integration into the overall system are realised in close cooperation with the company Lebbing. Like KAMPF, Lebbing is a company of the Jagenberg Group. Preliminary acceptance tests are currently taking place at the Laußig plant near Leipzig. Kampf LSF sees a good project situation here and is well prepared for further orders.
For many LIB types, the cathodes and anodes must be slit into narrow strips after calendering. For this application Kampf LSF and KAMPF have jointly developed the slitting machine type EvoSlitter. Initially designed for pilot plants and small series production, this slitter is now also used in regular production. The EvoSlitter achieves the required high qualities with very precise slitting units. Each machine has two or three mobile slitting cassettes, which can be easily exchanged when changing the slitting programme. This means that the machine, which was deliberately built very compactly, impresses with its high flexibility. In addition to four web cleaning systems after the slitting section, the machine has two winding stations. The friction winding shafts ensure the correct winding tension at all windings, and with the sensitive contact system with individual contact rollers, the machine guarantees the best winding quality. Currently, the KLSF designers are working on the next stage of the EvoSlitter. "We don't want to reveal too much yet," explains Sven Lasch, COO at Kampf LSF since September 2020, "but we can already say that we will integrate further modules, such as inspection systems. Furthermore, it is our goal to be prepared for the coming larger working widths."

Sven Lasch with the EvoWinder

Michael Strathmann with the EvoSlitter

Energy storage market build-up

It is obvious that the market of energy storage production already plays an important role at KAMPF and Kampf LSF and is also a central point for future planning. "We have built up good market and process knowledge at our sites in Wiehl and Laußig – this knowledge must be used and expanded together. For this reason, a few months ago we merged the 'Technical Applications' sales group in Wiehl with Kampf LSF sales and entrusted Mr Strathmann with the management of the new 'Energy' sales cluster," explains Dr Witt. "By bundling the activities, we want to be even closer to the market and to our customers in the future. Not least due to the LIB process experience of employees of a former LIB production facility in Saxony, who now work for Kampf LSF, we are very well positioned for further developments."

The new Kampf LSF COO Sven Lasch is a proven practitioner and brings with him many years of experience in manufacturing and mechanical engineering. "Our main focus here at the Laußig location will be on the energy sector in the coming years. Furthermore, we will expand our range of products in the field of winders for digital printing machines and will keep components for equipment such as laminating lines in our programme. We have a clear commitment, not only from KAMPF but also from the Jagenberg board of directors, to the continuous expansion of our site."
The sales staff of the new Energy-Cluster very much regret that the Battery Show in Stuttgart, like so many other fairs, could not take place this year and was postponed to May 2021. "We would have liked to have presented our new products and developments to the trade visitors, as it was not easy to keep in touch due to the COVID-19 pandemic in the last few months," explains Michael Strathmann; "but we hope that we will possibly be able to meet all interested parties next March at the ICE in Munich and then in May in Stuttgart."

Image sources: KAMPF

Dr Stephan Witt

Extrusion dies and their critical role in lithium-ion batteries

Patrick Meinen, global product line manager at Nordson Extrusion Dies Industries, provides an overview on the design of extrusion dies to optimise battery separator films

Beyond today's widespread use in consumer electronics, lithium-ion batteries are expected to grow rapidly in automotive and energy storage applications. These uses pose great challenges because of stringent requirements for efficient and reliable battery performance. At the same time, global competition forces battery manufacturers to achieve ever higher levels of operational economy and productivity.

Key components in these batteries are the separator films that keep the electrodes apart to prevent short circuits. These films are permeable membranes with 40 to 50% void volume to facilitate ion transport. A common method of producing them is the so-called "wet" process, in which a polyolefin such as HDPE that has been impregnated with oil or wax is extruded from a flat polymer die, then subjected to machine- and transverse-direction orientation before the oil is removed with a solvent to produce a uniform fibrous network. The extrusion dies are typically 600 to 780mm wide at outputs from 200 to 550kg/hr.

Die design is critical to film uniformity

Even though the separator film provides a passive function in the lithium-ion battery, the cost of the film is a significant part of the overall cost of battery production. The film plays a critical role in the electrical efficiency, longevity, and safety of the battery. For compactness it must be as thin as possible – typically 30µm or less – yet strong enough to withstand the winding process of battery construction and to maintain the mechanical and electrical separation between the electrodes. Permeability must be uniform throughout the area of the film. And dimensional consistency is essential for ensuring an effective interface with other battery components.

Meeting these requirements calls for – among other characteristics – exceedingly precise thickness uniformity. There are two aspects of die design that help make this possible.

Uniform melt distribution: The function of the flow channel, or manifold, inside the die is to distribute the molten polymer that enters the manifold to the final required width as it exits the die. For battery separator film, it is especially critical that the thickness and physical properties across the width of the film are uniform. This presents a challenge to manifold design, since the tendency of molten polymer is to exhibit variation in pressure drop across the width of the die as the melt travels from the manifold entry to the die exit. Designing a manifold that overcomes this tendency and

A coathanger manifold

Surface Energy of Various Alternatives for Flow Channels

Flow Channel Material	Contact Angle of Droplet on Surface		Component of Surface Energy		Total Surface Energy[b]
	Highly Polar Fluid (Water)[a]	Highly Non-Polar Fluid[a]	Non-Polar[b]	Polar[b]	
	Degrees	Degrees	Dynes / cm	Dynes / cm	Dynes / cm
Tool Steel	67.1	50.6	28.4	13.0	41.3
Stainless Steel	79.4	55.7	27.3	06.9	34.2
Nickel (on Stainless)	68.7	46.3	31.1	10.9	42.0
Chrome (on Stainless)	98.4	71.4	20.6	01.9	22.5

a) Lower angle means droplet sticks more and cannot bead up as high. b) Lower surface energy means more slippery.
Source: Nordson Corporation

Nordson's EverSharp lip land coating

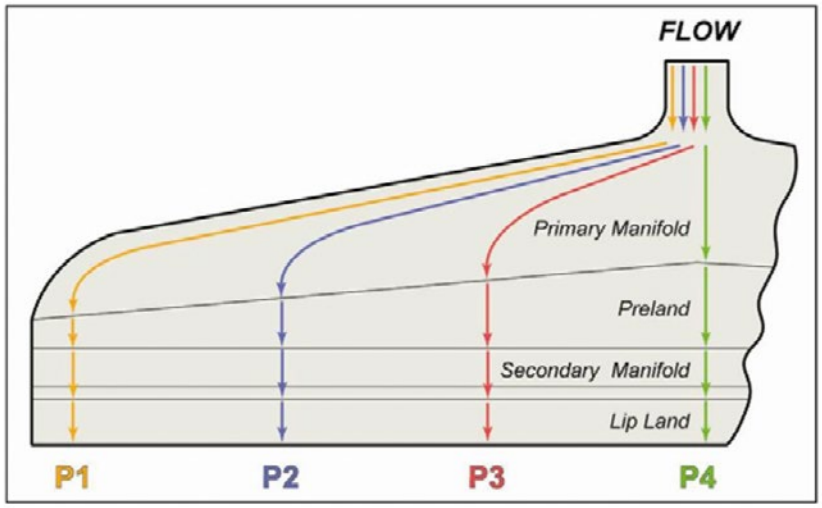
yields a uniform pressure drop across the width of the die requires custom engineering. This is because different polymers exhibit different flow behaviours. Die designers use flow calculations based on a polymer's viscosity, which can be characterised through use of a capillary rheometer.

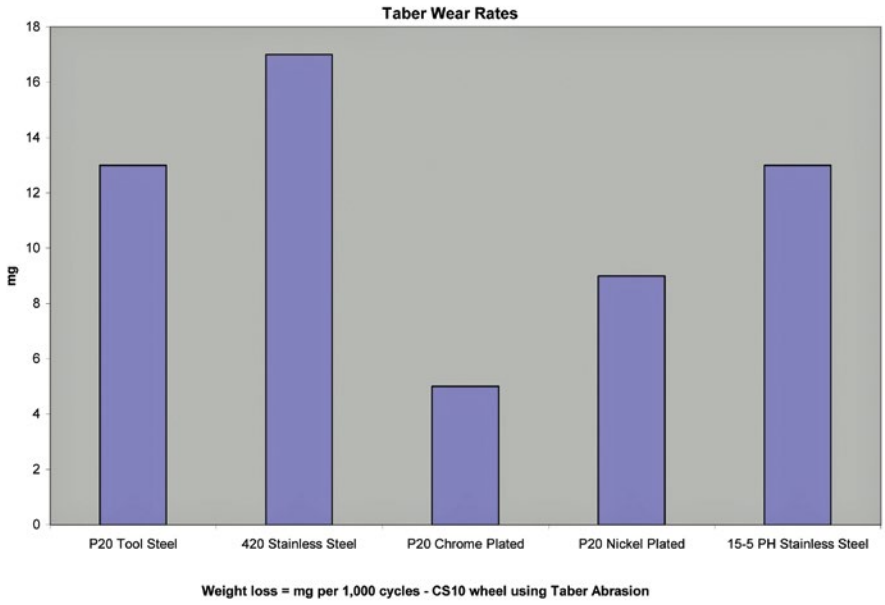
Fine-tuned gauge profile: Even with a properly designed manifold, some variation in film thickness can occur across the width of the die. An automatic profiling system that adjusts film thickness as variations occur can overcome this problem. In response to signals from a computerised downstream thickness scanner that detects variations at points along the width of the film, the profiling system adjusts the thickness at those points. This is possible because the upper lip of the die has an array of adjusters, giving rise to the term "flexible upper lip." In the profiling system offered by Nordson, these adjusters are thermally actuated bolts that expand or contract to adjust the lip gap in areas of the film that are thicker or thinner than the target dimension. While standard versions of this system are air-cooled, use of ambient cooling has recently become an option. In wet-process production of separator film, the oil from the polymer melt may condense on the air cooling component and subsequently drip onto the film, causing product defects.

Multiple measures to prevent film defects

Defects such as pinholes, gels, carbonised polymer, and contaminants could compromise the performance of the battery, leading to mechanical failure, internal shorts, and even safety issues. For this reason, separator film manufacturers employ rigorous process controls and quality monitoring to prevent defects. A properly designed flat die system can play a valuable role in this effort while at the same time maximising "uptime" for producing saleable film. An expertly engineered die system is sufficiently stable, mechanically and thermally, to minimise the residence time of the polymer within the die, improving product consistency and helping to avoid defects such as gels and degraded polymer. A properly designed system also provides faster purging of the die during a product changeover, preventing contamination and reducing the time needed to reach desired tolerances.

One key to reduced residence time and faster purges is a diminishing-volume manifold, called a "coat-hanger" manifold because of its overall shape (see schematic). This manifold has a flow channel





Top: uniform melt distribution
Bottom: wear rates

whose volume decreases toward each end of the die, resulting in reduced pressure drop and promoting uniform flow across the width of the die. Besides helping to achieve uniform film thickness, this design provides streamlined, flow enhancing uniform film properties across the full width.

The quality of the flow surfaces in the die also affects development of defects. It is recommended that flow surfaces be polished to a mirror finish to provide improved release properties and prevent the mechanical transfer of defects.

Selection of an appropriate plating for flow surfaces prevents polymer build-up while reducing production downtime. Polymer build-up can contaminate the finished product unless the line is periodically stopped for cleaning. To maximise the run time between die cleaning, a flow channel surface with low surface energy is needed. Chrome plating has nearly half the surface energy of nickel plating, so that surface build-up takes longer to accumulate (see table).

Surface lubricity and length of runs

Plating also affects surface lubricity and the length of runs between cleanings. Chrome plated surfaces are hard, around 65 Rockwell C, and resist wear from cleaning and handling. In a standard Taber Wear Abrasion Wheel test, chrome plated surfaces wear the least, so surface finish remains highly polished for longer periods for durable, build-up-resistant performance (see graph).

Another defect encountered in film extrusion is that of die lines – striations in the film caused by carbon or other build-up at the die exit. A frequent cause of this build-up is extended contact of the exiting polymer with the lip face. This can be minimised by means of a sharp lip edge, which provides a precise release point for the polymer. It is recommended that the edge have a radius of less than 25.0µ, be highly polished and uniform, and be made of durable material.

One material option offered by Nordson for die edges is a coating for the lip lands (the areas just before the exit) and lip faces. Called EverSharp, it lasts eight times longer than standard chrome plating, enabling the film producer to gain several days of added machine uptime each year. Compared with chrome plating, this coating is substantially more resistant to micro-fractures during initial sharpening, abrasion during normal use and cleaning, and corrosion.

A lower-cost lip edge option is that of laser hardening. The process involves machining away the chrome plating on the lip lands and faces and replacing it with a hardened area that is 0.8mm deep and has a hardness of 55 Rockwell C. The lip edge can be re-sharpened frequently.

The measures outlined in this article have been employed in numerous battery production facilities around the world. Die technologies are available for budget-sensitive applications as well as those that require the most sophisticated and advanced tooling. With demand for lithium-ion batteries likely to be strong for years to come, there is little doubt that die engineers will continue to develop new ways to enhance productivity and quality in separator film production.

Image sources: Nordson

Power in any shape you can imagine

The world is going digital and technologies get more and more sophisticated and powerful. As the Internet of Things is based on everyday items to become increasingly interconnected, printable electronics take on a key role. Connecting the physical and the virtual worlds and thus enabling a fluent exchange of information between objects is still a major challenge. It often fails because of too large, inflexible energy storage devices

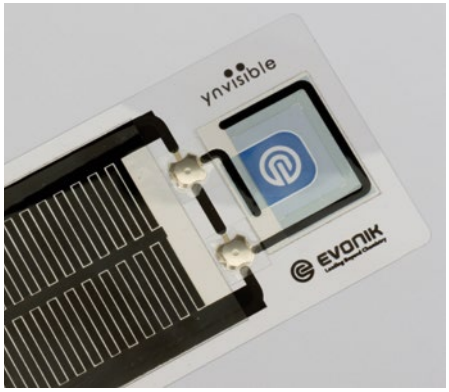
The battery form factor has a significant influence on the device design. Cylindrical or coin cells are bulky and cannot be bent. Device designers and manufacturers struggle to get over the form factor restrictions and often have to build the device around the battery. At the same time, there is a growing demand for energy storage solutions with a favourable environmental profile.

Evonik technology development

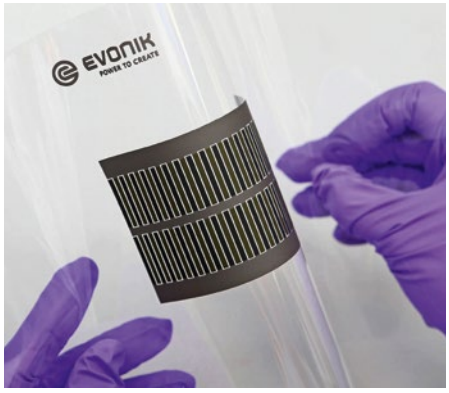
First introduced to the market at LOPEC 2019, Evonik launched its new materials technology for printed rechargeable battery cells, named TAeTTOOz. Now, with the new technology these obstacles will be a thing of the past, as flat printed batteries open up completely new design and application possibilities in the "Internet of Things".

The solution adapts to every imaginable product design of intelligent devices. Using standard printing processes, the inks based on redox polymers can be processed into very thin and flexible battery cells of almost any geometrical shape. This freedom of design allows developers to integrate electronics into everyday objects. The battery cells store electrical energy without the use of metals or metal compounds as active materials. As an additional highlight the batteries are all solid-state. They do not contain any liquid electrolytes and are therefore leak-proof. "This technology has great potential," says Michael Korell, responsible for the development of the new technology at Creavis. "Combined with our electrolyte ink, metal-free solid-state batteries can be printed on almost any surface. The batteries can be integrated seamlessly, are free of toxic substances and are rechargeable."

When the batteries are integrated into IoT devices, like energy-autonomous sensors or patches, they enable an overall system characterised by a seamless integration of the energy storage function, low weight and high flexibility.



An electrochromic display



Evonik's flexible battery

An ultra-thin and flexible design

Printed electronics technologies are developing steadily, and products containing printed electronic components are being introduced in many new applications.

The options are almost unlimited: in logistics and retail, for example, the printable battery cells enable the development of intelligent packaging. Smart sensors powered by printed batteries can be used to monitor supply chains of sensitive goods, such as food or vaccines. In another case, smart drug packaging can register the withdrawal of tablets and inform the patient or doctor if they are taken incorrectly.

In the so-called smart factory, TAeTTOOz can ensure optimised capacity utilisation and reduced energy consumption. In smart buildings, networks of smart flat sensors allow for a comfortable aesthetical interior design while assuring safety and keeping costs on track.

Wearables are another suitable field of application for this technology, like smart patches. They are not only more comfortable to wear than regular medical diagnostics equipment, but they allow for a more economical digitalisation of the point of care and enhanced patient adherence to health care treatments. In livestock management, wearables powered with TAeTTOOz enable real time behaviour analysis and better health management, improving the yield of the farm.

Outlook: the future is partnering

A technology demonstrator "rechargeable power for electrochromic displays" has been developed to showcase the integration synergies and potential of the new technology. Evonik is looking for partners to integrate the TAeTTOOz technology into existing and new applications, enabling a seamless integration of electronics into everyday objects and thereby making ubiquity become reality.

Image sources: Evonik

Organic solar cells and sustainability

The environmental benefits of organic solar technologies are often overlooked. Alexander Colsmann, Holger Röhm, Jens Czolk, and Christian Sprau from the Material Research Center for Energy Systems at Karlsruhe Institute of Technology (KIT) discuss this aspect of the emerging technology

Organic Solar Cells (OSCs) are often advertised by their free-form design, their arbitrary colours, their low weight and their mechanical flexibility, all of which render a bright perspective for novel photovoltaic applications in architecture and the mobile power supply sector. [1] However, the most intriguing but often forgotten unique selling point of OSCs is their almost negligible environmental footprint all along their value chain from materials and processing to disposal.

State-of-the-art high-performance OSCs comprise a photoactive blend of two organic semiconductors for light-harvesting and charge carrier separation, one of which is most often a polymer ("donor"). The second semiconductor ("acceptor") is either a fullerene or, more recently, also a polymer or an organic macromolecule ("non-fullerene acceptors"). The thin-film nature of OSCs inherently requires only very little amounts of photoactive semiconductors: typically, one gramme is sufficient to coat about 10sqm of solar cells which is an unsurpassed efficient use of commodities. The vast majority of organic semiconductors comprise only hydrocarbons enriched with some nitrogen, oxygen and sulfur. These elements are abundantly available, can be extracted from natural resources and do not require any mining efforts. And even if the educts are extracted from crude oil, the very small amounts needed hardly affect the environmental balance sheet. The scientific community works hard to investigate synthetic processes such as direct arylation for polymerisation to avoid toxic byproducts and environmentally detrimental catalysts. While numerous efforts have produced good results on such environmentally friendly synthesis routes for selected polymers, a lot of work remains to be done in the future to also produce the best performing organic semiconductors on large scale. In particular, industrial upscaling would benefit from an eco-friendly synthesis for best workspace safety and hence lowest production costs.

Unproblematic disposal

The small amounts of organic semiconductors used in OSCs renders a recovery of the organic semiconductors at their end-of-life rather unattractive, and the prevailing degradation mechanisms such as oxidation or molecular decomposition challenges the usability of the semiconductor leftovers. But the lowest material consumption and the absence of heavy metals or other critical elements warrants an unproblematic disposal of organic semiconductors. The end-of-life decomposition products after a projected lifetime of 10-20 years of the organic compounds are small amounts of mostly carbon dioxide and water, knowing that only about 1 gramme of semiconductors was used per 10sqm of solar cells.

These days, the world discusses how to ramp up solar power harvesting with lowest environmental impact. While, as of today, only silicon solar cells are mature enough for an economically viable production at reasonable scale, it is also true that the production of silicon solar cells requires huge amounts of energy. This energy has to come from fossil sources, conflicting with the goal of reducing carbon dioxide emission, or nuclear power bringing along its known problems. The heavy use of energy for their fabrication manifests in an energy payback time of about two years, i.e. a silicon solar cell has to operate for about two years to harvest the energy that was required for its production. Here, OSCs can make a difference. Their low material consumption paired with a production through printing and coating processes leads to an energy payback time estimation between a few days and a few weeks, [2] which would eventually allow a much faster production ramp up for a more sustainable energy supply.

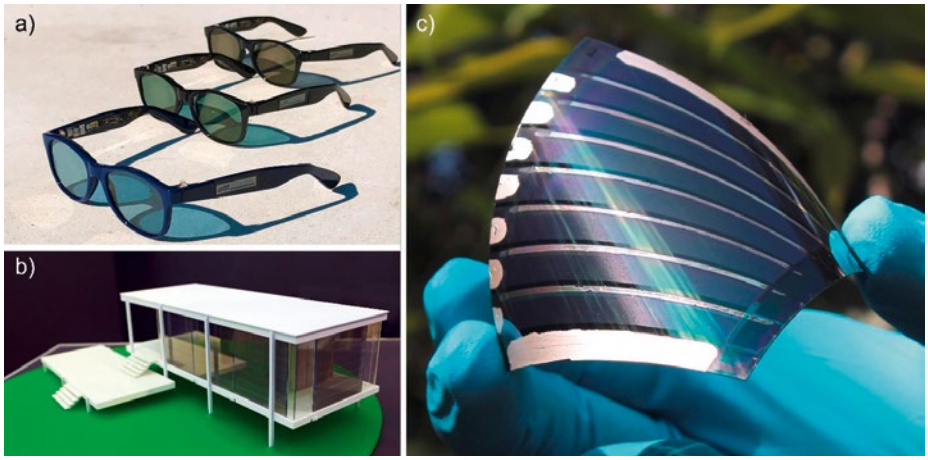


Figure 1: (a) Example for mobile energy supply: The lenses of solar glasses harvest sunlight while protecting the eye. (b) Likewise, this model house demonstrates photovoltaic shading elements in glass facades. (c) Their mechanical flexibility, their freeform design and their low weight render organic solar modules perfect enablers for novel applications [1]

Coating and printing as production methods

Coating and printing are widely envisaged as the OSC production method of choice although, notably, industrial vacuum processing was also successfully implemented. Early works on the principal implementation of OSCs from solution in research labs, and later works on novel material concepts, by default used chlorinated aromatic and

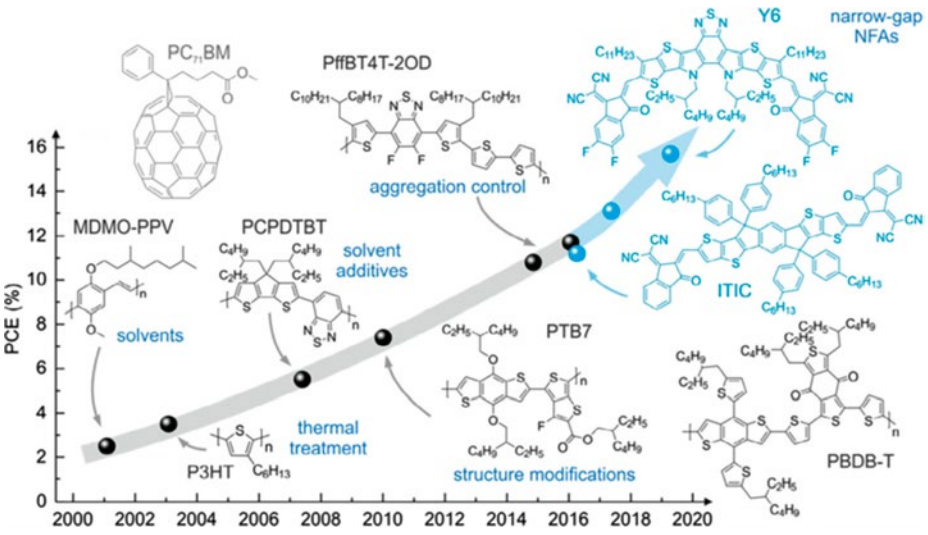


Figure 2: Milestones in the conceptual development of light-harvesting semiconductors, in recent years focusing on novel non-fullerene acceptors [1]

non-aromatic solvents to produce the organic semiconductor inks that are required for solution deposition. While these solvents quickly raise excellent results, they are inacceptable for industrial processes. Although technically possible, the use of toxic and carcinogenic solvents would incur significant costs for work safety, conflicting with the goal of reducing production and eventually energy costs. In recent years, the community made significant progress in replacing the chlorinated solvents by non-chlorinated aromatic solvents, and even some non-aromatic solvents can be used for the processing of certain organic semiconductors.

Often, solvent combinations had to be used to resemble the solubility in and the properties of the original chlorinated solvents. Today, organic semiconductors can be deposited from non-chlorinated solvents, producing solar cells with equally good power conversion efficiencies and demonstrating that OSCs are indeed on their way to become a fully sustainable technology. More recent concepts take the environmental compatibility of OSCs production on an even higher level. By dispersion of organic semiconductors in water, alcohols or other similarly non-toxic agents, the use of critical solvents during printing can be fully avoided. This concept mirrors the concept of wall paints where pigments float in an agent before they consolidate in a homogenous paint on the wall. Likewise, organic semiconductor particles are deposited from alcoholic dispersion. A subsequent thermal annealing step which is part of any organic semiconductor deposition anyway, warrants the merging of the particles for a homogenous film. Principal laboratory tests have shown that the corresponding solar cells exhibit power conversion efficiencies that almost resemble the power conversion efficiencies of solar cells deposited from chlorinated solvents. While, to date, this approach is limited to certain classes of organic semiconductors, current research encompasses the extension of this concept to almost arbitrary compounds. Notably, this dispersion approach also presents a solution to another ubiquitous problem: once the layers are deposited, they are insoluble in the processing agent. By this decoupling of the need of solubility from solution processing, it enables the sequential deposition of multilayers from solution and hence the realisation of advanced device architectures.

On the other hand, it would be fair to say, that OSCs do not only comprise light-harvesting layers but also charge carrier transport and extraction layers as well as electrodes, which must also be critically assessed towards their environmental sustainability. For example, the transparent electrodes made from indium tin oxide (ITO), which are often employed in research labs, comprise the non-abundant indium which most large-scale applications probably do not want to rely on. Alternatives based on other conductive oxides or even conductive polymers are being heavily explored across different technologies these days, including displays and other solar cell concepts.

Perspectives

In a world of climate change, photovoltaics in general is a beacon of hope towards sufficient and sustainable energy supply for mankind. In light of ceasing raw materials, (production) energy austerity and an increasing appreciation of sustainability, OSCs can make their case in the future. These days, the record power conversion efficiencies of OSCs exceed 17% [3] which is much more than even the most optimistic predictions lured with a couple of years ago and which was facilitated by the advent of non-fullerene acceptors. Likewise, first reports on an extrapolated lifetime exceeding 10 years have been presented in the scientific literature. Ironically, most recent breakthroughs in OSC research crossed with significant funding cuts in Western countries. As a consequence, after Europe and Northern America had been leading the field on OSCs (and organic semiconductors in general) for many years, nowadays, best results are produced in Asia – China in first place. Yet, a light-weight and sustainable solar cell technology for the integration into building facades, roofs with delicate building statics or even glazings is of particular interest for many densely populated Western countries where crop land is needed for other purposes. While it is certainly true that the development of high-performance OSCs has taken more time than originally anticipated (and may well continue to take time), such a versatile energy harvesting technology should not be set aside carelessly. The chances of this technology remain unique and, to date, no physical reason exists why the technology should not continue to improve.

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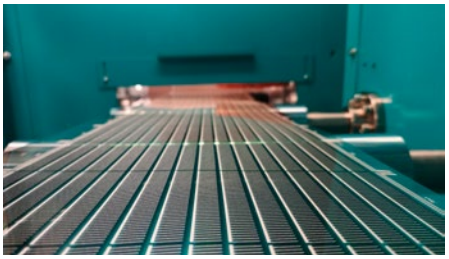
Image sources: KIT

Printed energy

OET's production & quality control manager Evangelos Mekeridis provides you with an update on OPV technologies developed by his team



R2R manufacturing of OPVs

The global energy demand has been growing exponentially, whereas the traditional and established energy resources used for several centuries (such as coal, oil and recently natural gas) have contributed to a strong increase in worldwide pollution, initiated global warming, and deteriorated human health. The global demand for energy is increasing rapidly and is estimated to double in the middle of the 21st century. Organic Photovoltaics (OPVs) can become the solar technology of the future, as they offer design versatility and a wide range of new applications while also boasting the lowest energy payback time and environmental sustainability.

OPVs are ideal for a wide range of niche and emerging applications, extending from portable electronics and smart packaging to wearables, IoT and indoor applications to automotive, greenhouses and building integrated systems (BIOPVs). Especially, BIOPVs can provide shade, energy autonomy and a better working environment all in an aesthetically pleasing package. They can be implemented in windows, glass facades, sunshades, curtains or walls.

R2R production for large-scale manufacturing

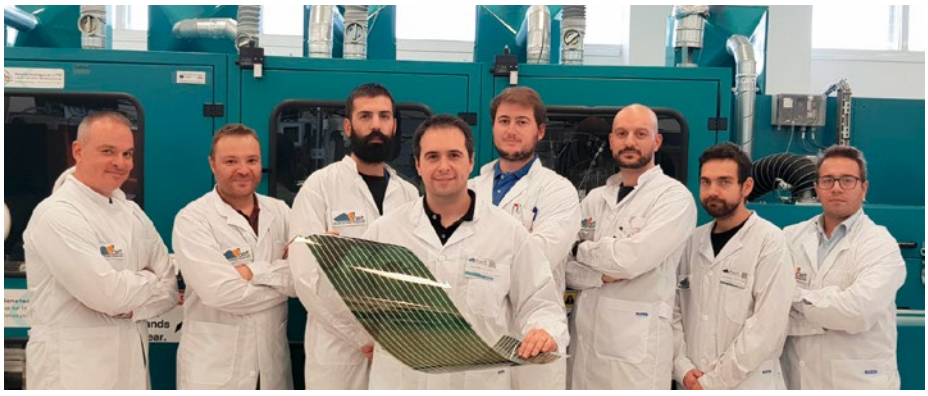
Organic Electronic Technologies P.C. (OET) is a high-tech SME located in Thessaloniki Greece. OET is a leader in roll-to-roll (R2R) manufacturing and technologies for flexible organic and printed electronics (OEs) and holds more than 30 years of experience in thin film technologies and processes. OET has access and built together the unique facilities of the Nanotechnology Lab LTFN of the Aristotle University of Thessaloniki. They own patents and IPs in R2R manufacturing, in-line and real-time metrology, in-line pulsed laser processes, and OPV applications. Moreover, the company holds strong collaborations with international industrial entities, since it is the co-founder of the Hellenic Organic & Printed Electronics Association (HOPE-A).

In order to exploit the advantages of OPVs to real-world applications and to enable their commercialisation, it is essential to optimise all the steps of print processing, laser nanostructuring and encapsulation. OET's R&D Center includes printing pilot lines integrated with in-line optical metrology for quality control and in-line pulsed laser tools, available for process development, prototypes and low-to medium-volume production.

R2R printing manufacturing plant

OET's experienced engineers, in collaboration with its worldwide network of partners, have designed, developed and optimised a unique and versatile R2R printing manufacturing plant. OET designs and develops R2R printing, laser processing and quality control technologies aiming at cost effective high performance and high throughput production of OPVs over flexible and plastic substrates with nanoscale precision. OET targets building a production line with a capacity of 1M m² per year in the following years according to the market needs. Its progress in scalable production and achieving the nanoscale precision in R2R printing machines, optical engineering, reduction of manufacturing costs and increasing yield and efficiency of OPVs is based on a huge R&D investment that took place during the last years in developing unique production lines, laser scribing technologies and in-line optical precision metrology and quality control tools.

OPVs can be easily manufactured by wet processing techniques like slot die coating, inkjet and screen printing over large areas. They can be provided with any custom shape and size in a variety of colours, transparencies and flexibilities targeting both existing and mainly new emerging markets. OET's core activities include thin film manufacturing processes, pulsed laser patterning and encapsulation technologies for the production of OPVs. This R2R PPL implements automated decision processes based on a digital closed loop manufacturing approach under in-line quality control tools. The production is controlled by a novel Metrology Control Platform connecting the in-line quality control tools with the operation systems of the R2R production line for the automated control of the process parameters. OET targets to transform the traditional manufacturing and industrial practices by combining the latest smart technologies, using machine to machine communication in order to launch this intelligent, zero-defect manufacturing process to reduce material waste and cost and increase yield and product quality.



The OET team

"Sustainable electricity from any surface"

OPVs are lightweight, flexible and translucent while R2R manufacturing allows fast

manufacturing in large production volumes and low cost. Their unique advantages include tunable transparency, excellent environmental profiles (non-toxic elements, recyclability potential) and freedom of design, which make them ideal for easy adaptation to every surface. OPV products are ideal for a wide range of niche applications extending from BIOPVs to greenhouses, automotive, portable electronics, smart packaging, and wearables. OPVs as the third generation of solar energy harvesting:

- Lightweight (<0.5 kg/m²)
- Thin (<0.6mm)
- Semi-transparent (up to 40%)
- Colour variety
- Flexible and rollable
- Easy adaptation in various environments
- Ideal for indoor and low light applications
- Lowest carbon footprint (<1/10 of Si-PVs)

3rd Generation PVs are the new emerging technology to be adopted for building applications. The intrinsic characteristics of OET OPV panels (lightweight, flexibility) make them easily integrable in challenging architectural designs as renewable energy source elements, while the high transparency and colour uniformity make them the most suitable and attractive for BIOPV products. OET, through its latest successful R&D developments, has implemented an innovative OPV panel with high transparency and uniformity using laser processes (with minimum discontinuities instead of the existing stripe-patterned panels). This product is most suitable and attractive for the BIOPV segment because of its unique aesthetics design, performance and payback period.

OET's smart solar bus station

Pooling resources

The innovation is supported by the EU funded H2020 Projects:
SMARTLINE – "Smart in-line metrology and control for boosting the yield and quality of high-volume manufacturing of Organic Electronics", CORNET – "Multiscale modelling and characterization to optimize the manufacturing processes of Organic Electronics materials and devices", RealNano – "In-line and Real-time digital nano-characterization technologies for the high yield manufacturing of Flexible Organic Electronics", FlexFunction2Sustain – "Open Innovation Ecosystem for Sustainable Nano-functionalized Flexible Plastic and Paper Surfaces and Membranes", as well as by the National Projects: EKOBuil – "Organic Photovoltaics System Integrated in Buildings", OPENERGY – "Roof Integrated Conformable OPV Products for Energy Generation", PHOTOkipia – "Semitransparent Organic & Printed Photovoltaics for Energy Efficient Mediterranean Greenhouses", and AgroRes – "Energy Autonomous Greenhouse based on Renewable Energy Sources"
OET invests in young professionals with high expertise in rising and contemporary scientific fields, while matchmaking its human assets with established business professionals.

Image sources: OET

A new generation of transport technologies

Researchers at CeNTI describe the development of smart RFID printed tags for humidity and temperature sensing, with embedded wireless energy charging, and communication capabilities

As a partner of the Portuguese project Vi-Tag, CeNTI (Centre for Nanotechnology and Smart Materials), together with Portuguese company Viatel, is developing a smart RFID label integrating systems with wireless energy charging and with greater autonomy, sensing and communication, directly on the outside of transaction box goods.

Viatel, part of Visabeira Global SGPS Group, is a leading company within the telecommunications network engineering sector in Portugal. Provided with a high capacity of technical and human resources, Viatel develops activities that include planning, projects, construction, installation, and maintenance, which makes them an integrated company offering global solutions. With a permanent logistic presence in all regions of Portugal, Viatel owns a wide knowledge in fixed – NGN (next generation networks) included – and mobile networks, as well as all types of technological infrastructures. CeNTI, a private non-profit Portuguese R&D centre, is an institute of new technologies with multi-sectoral orientation, equipped with cutting-edge technology that promotes, in a B2B approach, activities of research, technological development, innovation and engineering in the fields of smart & functional materials and systems.

Vi-TAG project

The Vi-TAG project aims to satisfy the needs of Viatel regarding the control and management of stocks during their transport. The logistics area, in general, has situations that need improvements and cost reduction, which also extends to the management of goods stock, which, when poorly managed, can seriously compromise a company's finances. For these reasons, CeNTI intends to develop a SMART TAG-RFID, or SMART TAG, that allows monitoring, in real time, the containers surrounding the goods, not only when they are inside the distribution van, but also when they are out (space between the van and the delivery place). The great advantage of RFID is the ability to collect hundreds of data sets instantly, without manual interaction, thus saving time, money and reducing the possibility of human error, which can happen in traditional methods such as barcode capture.

In addition, automation from RFID technology and wireless communication enables companies to create their own internet of things (IoT), making their logistics an intelligent and scalable asset for the future. Such stock control will facilitate the transaction of certain goods / products, while also increasing Viatel's scope of action, particularly in new markets.

When thinking about transporting a certain product in a van and subsequently transporting it between the van and the delivery point, it is necessary to consider the presence of external factors that can impair the quality of the product, for instance temperature, humidity, vibration, light intensity, violation of the correct packaging and sealing of the order, among others. These are the factors that cause a partial, or even complete, degradation of the merchandise. Therefore, it is part of the VI-TAG objectives to develop a TAG-RFID with sensing to analyse and report values of different physical parameters in the same SMART TAG (temperature, humidity, light intensity, vibration, among others) associating them to a mobile application, allowing the quality management of its content in real time and in an easy way for users.

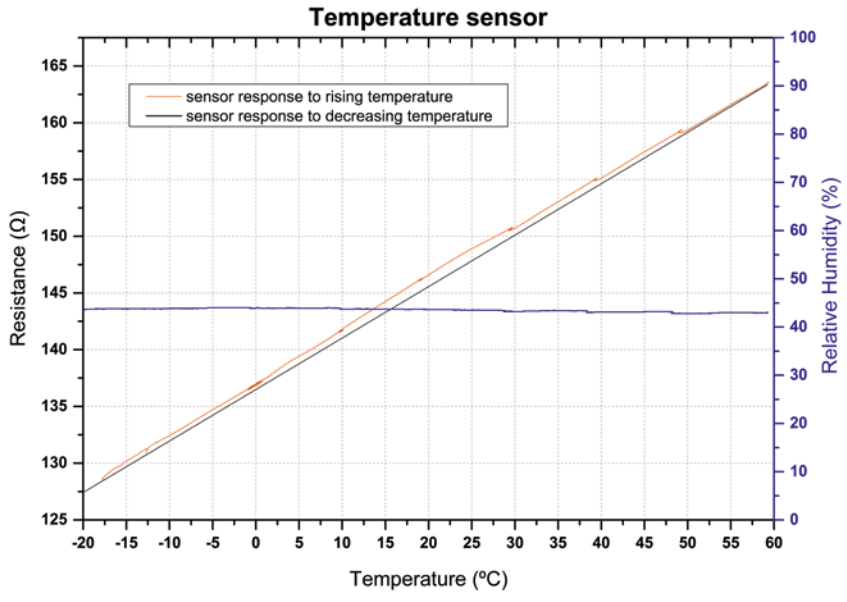


Figure 1: A graph of a printed temperature sensor

Printed sensors

"In temperature sensors, the larger the area and the greater the number of tracks, the greater the sensitivity of the sensor. However, considering the objective of the project, the sensor cannot have big dimensions," explains researcher Sílvia Reis. During this project, the temperature sensors were printed by a screen-printing process using kapton as substrate. Different inks were tested to understand which would have the greatest resistance variation, least hysteresis when subjected to different temperature values. Currently, the team is in the encapsulation phase of the sensor and in the graph of Figure 1 we can observe the linear behaviour of the sensor encapsulated in a climatic chamber. In this equipment

the researchers variate the temperature and stabilise the relative humidity. "As future steps, we intend to print these sensors directly on the PCB and evaluate their behaviour, but we believe we are on a good path," adds Reis.
In the case of humidity sensors, it is essential to have a fast response time, high sensitivity and be stable with temperature variation. To produce these sensors, it is necessary to define the electrode geometry considering a number of parameters, such as available area, distance and configuration, as the selection of the sensitive layer is equally important. "In this project, we made an intensive study of geometries, as well as inks for the electrodes and the sensitive layer. These sensors, shown in Figure 2, were tested in the climatic chamber with variation of relative humidity at a constant temperature. As future steps, we need study the encapsulation, which is a very delicate part, because on one hand, the sensitive layer needs to be in contact with the atmosphere to detect the relative humidity, and on the other hand, it has to be protected from atmospheric conditions. Finally, as part of the integration process we intent to directly print the humidity sensors on a flexible PCB. So there is a special need of complying and adapting all materials and structures in order to make the SMART TAG work properly," says Reis.

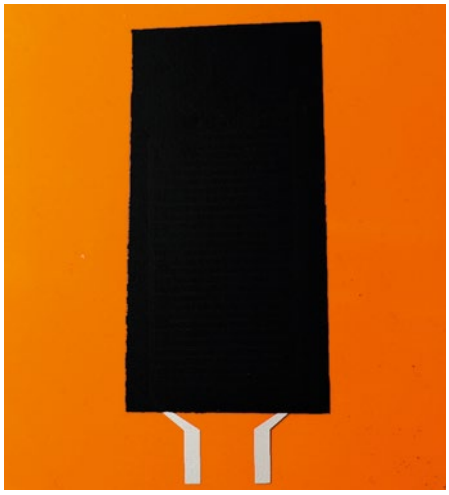


Figure 2: A printed humidity sensor

Printed communication

To obtain the information acquired from the sensors described above, an RFID communication solution was developed. A printed antenna was produced using electrically conductive inks with a screen-printing process in a PET substrate or directly on PCB, as

Figure 3: A printed antenna on PCB

shown in Figure 3. This antenna was then connected to the same PCB as the sensors to communicate the information gathered. "The main challenge that we face with printed RFID communication is, with the small area we have to work with, generating a signal detected some metres away and possibly with obstacles between our antenna and the reader," said researcher Rui Mesquita.
This printed solution proved to guarantee the communication with the chosen reader, but the reading distance was not ideal. From the aspects compromising this communication, the connection between the printed antenna and the controlling electronics is a challenge that needs to be solved. "In order to avoid this problem, we are currently developing an all printed solution to increase the reading distance of our antenna and also to simplify the production process," explains researcher João Silva.

Printed charging

All the developed solutions need a power supply to work and to achieve a true wireless solution. Wireless charging is a must, using RF UHF communication and a supercapacitor to store energy. Such a system will allow the SMART TAG to behave like a hybrid tag, since it will function both as a passive and an active tag. As a passive tag, the tag developed in the project, when inside the van, uses only the energy it acquires from wireless signals (through the RFID reader); however, as soon as the package with the SMART TAG leaves the van, the tag will behave actively, as it continues to collect and store sensor data even away from the RFID reader. "Here the challenge is the same: to guarantee an efficient charging with the distance and obstacles between the power source and our solution, but at the same time to rely on the energy provided by the supercapacitor," adds Silva.
The printed antenna was developed with the same process mentioned above only with a different design. The reading distance here is an even bigger challenge, because with longer distances the efficiency drops. "We are testing different designs of this printed antenna to increase the reading distance and the efficiency of the charging," underlines Mesquita.

Final remarks

It is expected that, with the result of this project, a new generation of freight transport will begin. That will be reflected in the efficiency increase in terms of management and stock control by Viatel and their customers. As a result of this goods monitoring, the company expects to have economic growth, since they will be able to guarantee that no product losses will occur due to damage or even losses during the warehouse-buyer journey and vice versa. Also, Viatel hopes to have a new line of products and services that support its current activity, to consolidate its business strategy and connection with current and new customers. This will be possible by guaranteeing a faster and more efficient application of its services supported by products, which due to a better storage during transport, will be more reliable. "From CeNTI's perspective, it is important to mention that the Vi-TAG project allows the application of our knowledge and skills in the field of printed and hybrid electronics, providing the development of a product that has tremendous potential in several areas, with a current focus on logistics and security," explains André Pinto.
This work was developed in the scope of Vi-TAG project (n. 33959), which was co-financed by Portugal 2020, under the Operational Program for Competitiveness and Internationalization (COMPETE 2020) through the European Regional Development Fund (ERDF).

Authors: CeNTI researchers Sílvia Reis, Joana Pimenta, João Silva, José Miguel Matos, and Rui Mesquita; André Pinto, CeNTI, project manager; Jorge Sousa, VIATEL project manager, Paulo Soeiro, VIATEL head of engineering and innovation, and Gonçalo Silva, VIATEL researcher.

Image sources: CeNTI

Nano inks with novel functionalities

GenesInk highlights its new transparent conductive inks and hole transport layer inks for transparent electrodes and photovoltaics applications

GenesInk is an SME specialised in metallic and semi-metallic nanomaterials and nanoinks manufacturing for consumer electronics applications. The company was created in 2010 in France and is nowadays employing more than 20 talented persons (80% in R&D&I) and has sales offices and distributors in Taiwan, Japan, and USA. GenesInk has more than 12 patent families with more than 60 patents worldwide. The manufacturer's actual range of products comprises more than 40 different nanoinks available on the market.

Focus on innovation

Nowadays, GenesInk enables consumer electronics that previously were not thought to be possible:

- Flexible and foldable active packaging, smartphones, and screens.
- Connected wearables such as eyeglasses and biosensors.
- Transparent and flexible layers for photovoltaics applications.

The French company is facilitating end to end processes: not only do they develop nanomaterials and formulate inks; they also help customers to set up printing processes and implement new printed components into their end-devices. By doing this, they are not selling the inks, but rather new functionalities. Genesink designs nano inks with novel functionalities at their core from particle synthesis to the printed end product. In doing so, electronics are freed up to enable a new generation of consumer electronics, claims the company.

Solutions to the consumer electronics market

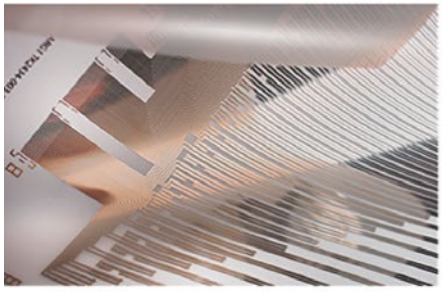
GenesInk is offering nanoparticle-based inks to the market. With nanoparticles, low temperature processed flexible substrates such as polymers, cellulose, and papers, can be considered for electronic applications. These nano inks can be produced at industrial scale and are designed with combined mechanical and optical functionalities at the core – flexibility, stretchability, thinness, high resolution, and transparency. The (conductive) nano inks are designed with ultra-high power efficiency. According to the manufacturer, they are up to five times more conductive than market leaders with seven to eight times less materials used. GenesInk also highlights that its nano inks are designed and produced in a way that is respectful to humans and the environment.

Know-how

Three types of nanomaterials are offered to the market by GenesInk:

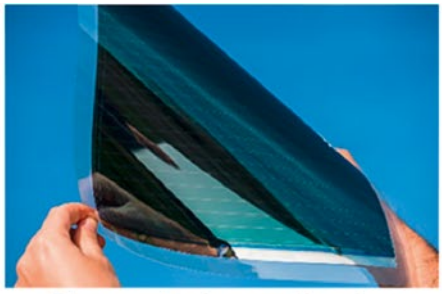
- The SmartInk silver-based nano inks are designed for printing highly conductive and flexible electronics. SmartInk products are cured at low temperatures, enabling the use of flexible substrates, and resulting in faster drying and lower sheet resistances than comparable silver products. SmartInk products are specifically designed for conductive interconnects, busbars, and antenna functionalities.
- The Tranductive nano ink based on Ag nanowires (Ag NW) is one of the most promising alternatives to ITO (Indium Tin Oxide). With the emergence of new technologies such as flexible PV and displays, ITO films are outperformed as they are difficult to process, brittle and delaminate frequently. Tranductive nanoinks are designed to be applicated by standard coating processes and compatible with plastic substrates thanks to their low drying temperature.
- Based on metal oxides (zinc oxide (ZnO), aluminium doped zinc oxide (AZO), and tungsten oxide (WO_3)), HeliosInk products are semi-conductive inks and can be used as charge transport layer in photovoltaic cells (solar energy), and lighting (OLED) applications.

In the further course of this article, we will focus on Tranductive and HeliosInk. Ag NW-based inks for transparent conductive electrodes (TCE) and WO_3 nanoparticle (NPs) based inks for hole transport layer (HTL) applications, respectively.



Highly conductive flexible circuits -SmartInk range

Smart screen applications – Tranductive range



Photovoltaics applications (solar cells) – HeliosInk range

GenesInk's nanoinks ranges and their targeted applications.

Ag NW based nano inks for TCE applications

Transparent conductive electrodes (TCE) for optoelectronic devices lack of flexibility due to the use of non-flexible, expensive, and short supply materials such as ITO., However, the current market is eager to achieve better flexibility to create more flexible devices. GenesInk provides nano inks based on Ag NW that are typically used to produce flexible, transparent, and conductive films. Their solution based on Ag NW (Figure 1) exhibits low resistivity keeping the viscosity adapted for various deposition processes. GenesInk aims to enhance (i) Ag NW adhesion to cellulosic and polymer substrates (5B ASTM D3359), (ii) up to 90% the transmittance, and (iii) reach sheet resistances lower than 10Ω/sq resistivity. Their performances are up to 10% higher than ITO standard, and fit applications for conductive papers and conductive electrodes. So far, GenesInk has reached 5B adhesion with Ag NW inks without altering the conductivity (7 – 30 Ohm/sq) and the transparency (80 – 89%) by adding specific additives to basic formulations.

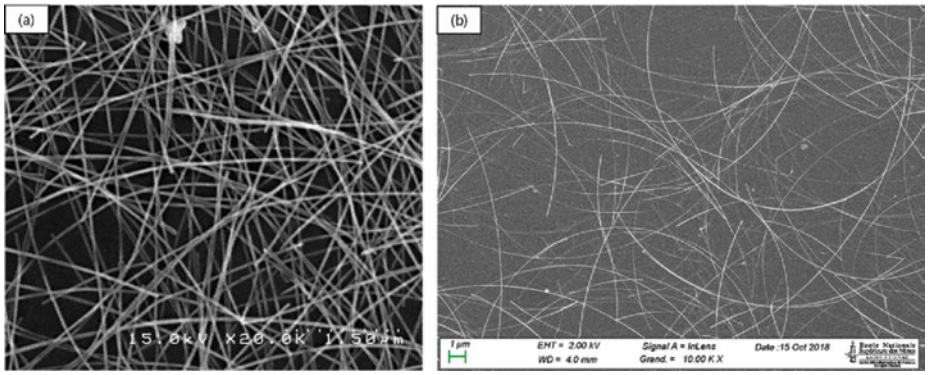


Figure 1: Scanning Electron Microscopy Ag NW based inks by GenesInk: (a) Tranductive N based on Ag NWs; (b) Tranductive E based on Ag NW and ZnO

WO_3 based nano inks – HTL

Compared to the state-of-the-art, GenesInk also offers also WO_3 based nano inks (Figure 2) for HTL applications with the following advantages:

- WO_3 is a safe metal oxide (MOx) causing no harm to operators and environment compared to NiO, MoO_3 and V_2O_5, which are classified or suspected as carcinogenic, mutagenic, or toxic to reproduction.
- WO_3 nano ink is solution processable, which means it can be deposited by eco-friendly printing techniques while MOx are commonly deposited by heavy methods such as chemical vapour deposition (CVD), anodising, etc.
- WO_3 nano ink is based on nanoparticles smaller than 10nm. Nanoparticles have higher specific surface areas than microparticles and thus a higher efficiency than larger particles.

OPV devices developed with GenesInk's WO_3 nano ink as HTL were performed, tested and compared to organic PEDOT:PSS in standard OPV and evaporated molybdenum oxide (MoOx) in inverted OPV (Table 1). On one hand, GenesInk's nano inks exhibit equivalent properties compared to evaporated metal oxides and solution processable PEDOT:PSS. On the other hand, WO_3 nano inks are deposited by additive techniques compared to MoOx and exhibit better UV stability and chemical compatibility compared to PEDOT:PSS. Therefore, devices using GenesInk's nano inks exhibit a stability of 1000 hours when exposed to 85°C/85% RH (Relative Humidity) during aging tests while PEDOT:PSS containing devices degrade almost completely after 336 hours of exposure to high temperature and humidity (aging tests). Indeed, organic HTL-based devices are unstable and degrade in harsh atmospheric conditions .

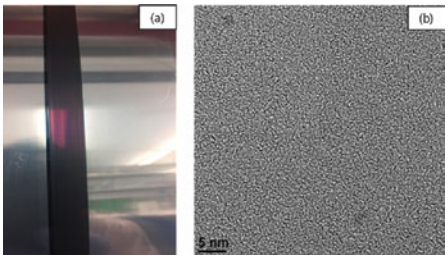


Figure 2: (a) Homogeneous WO3 nanoinks printed on active layer (b) Transmission Electron Microscopy of WO3 films

In the framework of the MADRAS project, GenesInk will enable new functionalities to their materials and address new markets such as geo-tracking tags and fingerprint sensors.

Image sources: GenesInk and partners

Acknowledgment: CNR - ISOF; AUTH – LTFN; MADRAS H2020 project partners

HTL material	OPV structure	TCE	Active layer	PCE%	Jsc (mA/cm²)	Voc (V)
HeliosInk SW41011 GenesInk	Inverted	ITO	HBG1:PC61BM	5.6	11.3	0.80
MoOx (evaporated)	Inverted	ITO	HBG1:PC61BM	6.0	13.8	0.76
HeliosInk SW41014 GenesInk	Standard	ITO	Bulk heterojunction	3.7	7.9	0.72
PEDOT:PSS	Standard	ITO	Bulk heterojunction	3.5	7.4	0.74

Table 1: GenesInk's WO_3 nano inks tested in OPV devices and compared to evaporated MoOx and printed PEDOT:PSS

Virtual meeting place

Due to ongoing travel restrictions and other uncertainties during the corona pandemic, the organisers of LOPEC have announced that the leading tradeshow for organic and printed electronics will be an online event in 2021

LOPEC 2021 will take place online due to the expected continuing worldwide travel restrictions. The central element will be the LOPEC Conference supplemented by a virtual marketplace for exhibitors. With LOPEC Online, Messe München and its partner OE-A (Organic and Printed Electronics Association), are able to ensure an international industry meeting in March 2021.

The event period for the online edition of LOPEC remains unchanged: From 23 to 25 March 2021, the printed electronics industry is now going to have a virtual get-together. Falk Senger, managing director of Messe München, explains why the decision was taken in favour of the online format: "LOPEC is an extremely international event with a high proportion of non-European conference speakers, exhibitors and visitors. As we are expecting considerable worldwide travel restrictions to still be in effect in March, we have now decided early on to hold LOPEC 2021 online." LOPEC Online will offer a concept that enables the entire industry to obtain information, to exchange views and to network in one single place, even during this difficult phase. Senger is convinced: "This way, even in its virtual format, LOPEC will be the central platform with a global reach for the entire industry. We are looking forward to now begin the detailed planning of the offerings."

A driving force in printed electronics

Klaus Hecker, managing director of OE-A, supports the online format and emphasises the importance of LOPEC as a driving force in printed electronics: "Despite all the challenges, we clearly see that the printed electronics industry is resilient and creative. In the medical and healthcare industry, in particular, we see numerous Corona-related new applications made possible by this innovative technology. This makes it all the more important for us to offer LOPEC 2021 Online as the central, international meeting point for the industry, even under the current conditions."

The central element of LOPEC Online will be the LOPEC Conference. In addition, there is going to be a virtual marketplace that accompanies and complements the conference programme to ensure the exchange of information within the industry.

Speakers from all over the world

Wolfgang Mildner, general chair of LOPEC, provides first insights into the virtual Conference programme: "With LOPEC Online we can guarantee the participation of speakers from all over the world. We have already received commitments from renowned companies like TCL from China or Google from the USA, who will talk about their experiences and applications with printed flexible electronics."

The presentations of the digital LOPEC Conference will be made available to all participants via live streaming service, no matter where they are.

Image source: Messe München

Impressions from LOPEC 2019

Innovative approaches for flexible electronics

On 30 September, a hybrid event (digital and physical attendees) was held at the premises of INOCON in Attnang-Puchheim, Austria. OPE journal talked exclusively to Paul Sparenborg from the LED technology pioneers at Lumitronix, who gave a lecture at the seminar

OPE journal: Mr Sparenborg, the event on "Selective plasma metallization of flexible printed circuit boards" took place at INOCON Technologie GmbH. What is your relationship with that company and why does it make sense for Lumitronix to collaborate with them?

Paul Sparenborg: INOCON is our most important technology partner. The company holds several key patents in the field of plasma technologies and produced the fully automated reel-to-reel plasma coating line. Selective plasma metallization, which is processed by INOCON according to our layout specifications, is the basic process for our reel-to-reel assembly of components using the reflow process.
We are the exclusive supplier worldwide for the flexible modules based on the patented technology of selective plasma metallization. In this context, I would like to highlight our other valued partner within our consortium: PLASMA INNOVATIONS, which is intensively engaged in the basic technologies of flexible base materials and plasma powder coating. Together, INOCON, PLASMA INNOVATIONS and Lumitronix research and develop innovative approaches for flexible electronics.

Paul Sparenborg, sales director at Lumitronix


Impressions from the INOCON event

OPE journal: Your company's main contribution to the seminar was the presentation on "Innovative LED modules and battery cell connectors on flexible boards". How does this presentation complement the other topics of the day?

P. Sparenborg: Our aim was to show flexible products that are already being produced in series in our facility for the mass market. We have highlighted the advantages of selective plasma metallization for further processing in reflow soldering on our reel-to-reel production line.

The participating experts also gave an outlook on future trends. We learned that there are many exciting fields on the market that are currently in a very early stage of development. For us it was good to hear that our development work is fertilising the needs of the industry.

Just to name a few of the approaches for the future: Today we are working intensively on transparent modules, flexible infrared applications, various sensor solutions and hybrid circuit boards. Our entire development work is based on the process of plasma metallization, and the end products will be offered on reels on a large scale.

OPE journal: Let's get into the details: Lumitronix is considered to be an LED specialist of the first hour, with soft- and hardware development and production at its site in Hechingen, Germany. What can your company offer to its customers in general – and to the attendees of the INOCON event in particular?

P. Sparenborg: In addition to our standard products, which, historically, are mainly equipped with LEDs and are aimed at the classic lighting market, we see ourselves as a supplier for the entire industry. We do not shy away from any challenge in the field of flexible electronics and today we handle numerous customer-specific requirements within the framework of development projects and contract manufacturing. The assembly of electronic components on flexible materials can reduce the complexity of the end product and enable new functions. We consider our technologies to be a unique added value for the entire business. Our goal is to bring challenging and at times futuristic requirements of our customers quickly and reliably to the mass market.

OPE journal: Can you point out a few applications of your LED technologies?

P. Sparenborg: One application we are increasingly serving these days is large linear luminaires for public areas and offices. This is where our flexible technology scores and enables a slim design of the virtually limitless LED board with good efficiency at lower costs. Furthermore, we are supporting a growing number of projects for large area lighting, such as illuminated ceilings and light panels. Simple installation and weight savings are good arguments to rely on our flexible boards. In general, it can be said that all applications that require flexible PCBs, because they have to be specially shaped or are in motion, can get good solutions with our technical approach.

Last but not least, we are in contact with many lighting designers because they can realise innovative lighting concepts with our flexible base materials. In order to serve the movement towards sustainability, solutions made entirely from sustainable materials are highly in demand. Our in-house development project to create a luminous lampshade has met with great interest and is currently being pursued by various lighting manufacturers.

Fig 1a: A flexible LED board made of paper combined with a décor layer results in an innovative approach for a lampshade

Fig 1b: Décor options on flexible base materials open up new design possibilities

OPE journal: Large lengths, few single parts and continuous layouts – these are the main advantages of your LED modules which you pointed out in your presentation. Can you provide some more technical data on these modules?

P. Sparenborg: Our flexible Z-Flex LED module with dimensions of 280x20mm, for instance, promise a significantly easier installation than the usual rigid LED modules. The flexible LED strips are based on the popular Zhaga standard of modules with a length of one foot and are therefore compatible with many existing linear luminaire types. Unlike rigid modules, which must be fixed in large numbers with screws, the Z-Flex LED strips can be glued into the housing in one piece. Another advantage over modules based on rigid boards is the wiring. The Z-Flex modules can be operated up to a maximum length of 1.4 metres with one feed. Moreover, the production lengths of up to 56m result in considerable savings for companies in the lighting industry, especially in cost centres such as warehousing and transport.

The square-shaped version of Z-Flex with dimensions 280x280mm is suitable for large-scale applications. Also here we offer considerable advantages in terms of processing and cost management since the production in roll form minimises storage and transport as well as installation effort. Furthermore, both Z-Flex versions can be powered with a low voltage of 24V and are therefore safe to touch.

OPE journal: What are the core elements of your flexible printed circuit boards?

P. Sparenborg: A flexible circuit board basically consists of a carrier and an electrical conductor. As carrier we can use different base materials such as polyimide, PET and paper. We also process many customer-specific flexible materials after a feasibility test.

Depending on the application, we use copper, aluminium or conductive "silver paint" as the electrical conductor. Aluminium and silver tracks can be cost-effectively applied to the flexible base material and are made solderable with our process of selective plasma metallization.

Optionally, we supplement our flexible PCBs with insulation materials and décor layer which is printed or made of a specific textile.

OPE journal: Can you take us through the production process for your flexible boards?

P. Sparenborg: Our production line serially equips basic material that is present in the form of reels. We work with substrate widths of 150mm – 500mm and virtually endless lengths. However, the lengths must be logistically processable, our current unwinding unit can handle a roll weight of up to 150kg. Presently processed thicknesses of the material are between 10µm – 150µm.

These reels are chucked at the beginning of the lines and tightened along the entire length by clamp supports – also referred to as hitch feeders – so that the further processes of coating with solder paste and equipping with LEDs and other components may be performed smoothly.

We do process a wide range of different components; at present we are limited in size: 27x27mm with a maximum component height of 8.5mm. The placement speed currently reaches 52 500 components per hour.

Upon the step of equipping, the flexible printed circuit boards are soldered in an infrared oven and then checked electronically and

Fig 2: A lightweight – this segment (50x350mm) contains seven LEDs and weighs about 2 grammes

optically by a machine. Afterwards, the flexible printed circuit boards may be cut to individual lengths and different patterns, respectively, by oscillating blades.

Our line is designed for large-scale production. For smaller quantities we can also offer sheet-to-sheet assembly in the initial development phase. However, from the very beginning we design all processes and material combinations in a way for them to be reproduced in reels as well.

OPE journal: Finally, one of your most well-known products is the Paper-Flex LED wallpaper. What can you tell us about this?

P. Sparenborg: Our Paper-Flex is a future-oriented product that uses paper as a sustainable and environmentally friendly basis. This makes the paper module a novelty in the industry, enabling it to be used in a wide range of applications. We have a standard version of Paper-Flex in our portfolio and do offer numerous customer-specific paper solutions for different kind of purposes.

The paper modules to be adhered can be installed in a time-saving manner and are also touch-proof due to the low voltage of 24V. In addition, the extremely low weight and the roll shape ensure that storage and transport costs are significantly minimised. Moreover, the paper substrate is ultra-flat (approx. 0.8mm after assembly) and thus more than suitable for large-area applications where a low installation height is required.

The diffusion openness of Paper-Flex is a decisive factor in ensuring that the paper modules can be used as wallpaper. Due to the breathability of the paper there is no danger of moisture accumulation. Currently our paper module is being presented as an LED wallpaper to various DIY stores in Europe and we are confident that our product will soon find its way into many living rooms!

Image sources: Lumitronix

Design is the key to smart products – printed electronics enables new designs

Wolfgang Mildner

Success in using printed electronics is often sought in the various technical advantages: The resulting products are thinner or lighter, they could be even flexible. Success factors such as attractive pricing due to cost savings can in some cases be achieved by reducing the number of parts or by using new production processes that are more effective in the use of materials. A successful solution often results from the integration of different components of a different nature, so-called hybrid products and systems.

Sometimes, however, there is an argument for a product success that technologists do not hear that often. The product is considered beautiful and attractive. Now the assessment of beauty is often in the eye of the beholder and is therefore subjective. Criteria for beauty are factors such as good, self-evident usability or aesthetic appearance. But often the uniqueness of the product also plays a major role.

Ease of integration

Why are these arguments used in connection with the use of printed electronics? Here, a technical argument that was already mentioned above plays a role: the ease of integration. One could also say that technology steps back in favour of the requirements for form and function.

Be it the sensor integrated in the curved surface, which allows operation by touching a surface that is illuminated or functionalised by an integrated display. This seamless integrated human interface is intuitive, self-explanatory, and convenient.

Operator guidance only appears when it is needed (sometimes called "Deadfront") (image source: PolyIC)

Or the rear lights of a vehicle, which allow new features, personalised effects combined with functions to increase safety.

The new Audi Q5 with intelligent rear light technology based on OLED (image source: Audi Media-DB)

Beautiful products sell much better: this fact has long been recognised by not only market researchers. Here too, beauty is a question of feasibility, a question of talented and motivated designers and their collaboration with adequate technologists. A study by McKinsey & Company, "The Business Value of Design" (Oct. 2018) shows that design-oriented companies are significantly more successful than their competitors. However, the study also shows that success is not only due to an increase in beauty, but also and especially due to a user-centred design – the user experience.

New degrees of freedom in design

Design therefore plays an important role in the selection of the technological solution. Printed electronics creates new degrees of freedom for the design of a product.

An important factor for smart product design is its sustainability. This product attribute is getting more and more significant and is part of a successful product design.

Although it is a more "invisible" value of a solution, it is also part of the beauty and attractiveness of a product. Ease of use of a product includes all phases of the product life cycle, including easy recycling at the end of the product's life.

LOPEC 2021 will provide talks about the topic and exhibits to show the state of the art.

Turning billboards into disinfectant terminals for mobile phones

In OPE journal we often write about touchscreens and displays, but barely in the context of germs and viruses that can survive on these screens. According to recent research coronavirus can survive four weeks on a smartphone screen. Now the Nordic health company Terveystalo turns billboards into disinfectant terminals that can clean a phone in only 15 seconds with UVC light

Disinfecting and washing hands has become a common routine. However few are aware of the vast amount of bacteria and viruses dwelling on the surfaces of our smartphones – devices we constantly touch and hold against our faces. This is why Terveystalo brings disinfecting terminals to public places where they can be accessed by anyone.

"We at Terveystalo see health in a wider context. Not only do we cure diseases but concentrate on preventing them. In the midst of a global pandemic, having a strong immune system and practicing proper hand hygiene is highly important. This project is also a reminder for people to take care of all aspects of their health and billboards are a great way to spread this important message," says Veera Siivonen, marketing and communications director at Terveystalo.

15 seconds are enough to rid your phone from viruses and bacteria thanks to a new solution from Terveystalo

From 15 minutes to 15 seconds

There are disinfection solutions for smartphones available to consumers but they can take up to 15 minutes of UVC exposure. The new solution introduced by Terveystalo, however, does the job in 15 seconds thanks to hospital-grade technology.

According to Terveystalo's research a 10 second exposure to UVC light disinfects smartphone surfaces nearly perfectly. The effectiveness of UVC light in disinfecting surfaces has also been proven by previous researches. The solution has been developed together with Sterlights, a Finland-based company that imports and distributes hospital-grade UVC lights.

"The cheap consumer products usually have low-output lamps that require longer exposure time. The lamps that are used in the disinfecting stations make use of UVC light with a 254nm wavelength that destroys all pathogens such as viruses and bacteria. These high-output UVC lamps take only 15 seconds to properly disinfect smartphone surfaces," says Dr Udy Ben Yosef, chief scientific officer at Sterlights Oy.

Safe disinfection

The billboards are located in Helsinki and Turku in southern Finland. There is a small hatch in the billboard where anyone can place their smartphone for cleaning. Exposure to UVC light can cause skin irritation and in extreme cases loss of sight. Safety of the user is secured by the fact that the UVC light in the billboards turns on only when the hatch is closed. It is physically impossible for anyone to harm themselves.

Turning billboards into disinfectant terminals is only the first phase of the project. The solution is currently developed further to work as a standalone disinfectant unit for example in public places.

Image sources: Terveystalo

Stan Farnsworth
Chairman OE-A Board, NovaCentrix

Dr. Klaus Hecker
Managing Director OE-A

Dear Reader,

This is the last OPE Journal edition of 2020. And what a year it has been. We switched from conferences and trade shows around the globe to web seminars; from international meetings to digital calls; and from office buildings to working from home. Even though the world is upside down, we tried to make the best of it and continued representing the flexible, organic and printed electronics industry. And not without success!

In total we had nearly 1,000 participants during the OE-A Web Seminars. The Executive Summary of the newly launched OE-A Roadmap White Paper was downloaded numerous times. The digital OE-A meeting encouraged many discussions and thought-exchanges. Entries for the OE-A Competition 2021 are flooding in. All of this and more gave us energy in these challenging times.

"Energy" is the key word, as it relates to so many meanings for the OE-A. For many of our members, the harnessing and utilization of energy forms the basis of our businesses and research, in the forms of electricity, light, or heat. Electricity from OPV's, light from OLEDs, data from sensors, information from displays, and the stored potential of printed batteries are all the results of energy collection, conversion, or storage and form the basis for many products. Our initiatives on Sustainability also are based on the utilization of energy, and in identifying and implementing improvements in efficiencies and value. Innovations in energy utilization are a driving force in our community.

Here at the OE-A, we are also interested in the energy of our membership, in the forms of enthusiasm, participation, and feedback. Our community exists because of the initiative of each of our members in participating to build and realize a shared vision, that "Flexible, organic and printed electronics are widely implemented for the benefit and value of society and industry. "

So as each of us reflects on the year thus far, anticipates year-end, and plans for the start of the new year, we at the OE-A would like to wish everyone a nice, relaxing holiday season. Let 2021 be a year that brings us closer to our shared vision, and hopefully to a time when we can meet in person, face to face in live format again!

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

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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 22, 2021 (day before LOPEC)	**Munich (DE)**
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 Meetings Europe	
October 19-20, 2021 (preliminary)	**Tampere (FI)** Hosted by Tampere University
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	
electronica **November 10-13, 2020, virtual**	OE-A and LOPEC will be represented with a virtual exhibition booth and will host free online seminars on November 11, 15:00 - 16:00 h (CET) on flexible, organic and printed electronics.
LOPEC DRIVING THE FUTURE OF PRINTED ELECTRONICS **March 23-25, 2021**	**Messe München, Germany** Messe München and OE-A jointly host the leading international trade fair and conference. The event offers a high-quality platform to all manufacturers, industrial customers and research institutions engaged in the field of organic and printed electronics. **www.lopec.com**
Drupa 2021 **April 20-28, 2021**	**Düsseldorf (DE)** OE-A will have an exhibition booth (at VDMA Printing and Paper machines) and will host free seminars on organic, flexible and printed electronics
ICFPE 2021 **28. Sept. - 1. Oct 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	
Healthcare **November 05, 2020, 16.30 – 17.45 (CEST)**	OE-A members will discuss recent technology advancements and use-cases of Printed Electronics for healthcare applications

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

OE-A Fellow 2020 appointed

Bertrand Fillon, CEA-Liten is honored with the title of OE-A Fellow.

Since 2017 the OE-A honors persons who have made special contributions to the further development of the flexible, organic and printed electronics industry and the OE-A (Organic and Printed Electronics Association) - a working group of the VDMA. With the appointment as 'OE-A Fellow' a personal OE-A membership for life is connected.

This year, the OE-A Board has chosen Dr. Bertrand Fillon, Program Director of the CEA-Liten of France. The fellow certificate was digitally handed over by Stan Farnsworth, Chair of the OE-A Board and Chief Marketing Officer of NovaCentrix, d uring the online OE-A meeting.

"Dr Fillon has made great contributions to both the OE-A and LOPEC, the international exhibition and conference for the printed electronics industry," said Farnsworth. "For more than fifteen years, Bertrand Fillon has been an important ambassador for the

OE-A and has contributed significantly to fostering the very good and ever-increasing cooperation with French companies and networks", Farnsworth added.

Bertrand Fillon has also supported and promoted the flexible, organic and printed electronics industry at European and international level. Bertrand Fillon is also a member of the

Dr. Betrand Fillon CEA-Liten honored with the title of OE-A Fellow

Scientific Board of the LOPEC conference. He is also involved in various European platforms and associations as well as in various expert groups at international and national level.

"The OE-A would like to thank Dr Fillon for his services to the printed electronics industry, his support of the OE-A, and his work in establishing networked communities of both research and business in France and throughout Europe ," continued Farnsworth. "We look forward to continuing our collaboration". \\

Printed electronics: Significant decline in sales due to Corona pandemic

OE-A Business Climate Survey: Sales decline of 20 percent predicted for 2020 and partial recovery expected for 2021

The organic and printed electronics industry is also severely affected by the Covid19 pandemic, according to the latest business climate survey by the OE-A (Organic and Printed Electronics Association). While the figures at the beginning of the year were still very positive with a forecast sales increase of 8 percent, the survey participants now expect a sales loss of 20 percent this year. Main reasons: Cancellations of orders and a significantly reduced order intake due to the Corona pandemic.

"This is the first negative sales forecast since the first OE-A Business Climate Survey in 2014," says Dr Klaus Hecker, OE-A Managing Director. "Although the order situation has recovered significantly after a strong decline in the 2nd and 3rd quarters, companies will not be able to fully compensate for the sales losses already suffered this year," adds Dr Hecker.

The semi-annual OE-A Business Climate Survey sheds light on the anticipated growth of the organic and printed electronics industry. During each survey, OE-A members – from material suppliers to end users – are asked to provide qualitative data on the state of the industry and their expected sales development.

OE-A expects 7 percent sales growth for 2021

But there is also positive news: A partial recovery is expected for 2021 with a sales forecast of plus 7 percent. This growth is expected along the entire value chain. In addition, two-thirds of the companies plan to increase their investments in production within the next six months. There are also positive signs for employees: The employment situation is stable at almost 90 percent of the companies and 9 percent of the firms are even increasing their workforce. Currently, the most important user industries are still consumer electronics, automotive and, increasingly, the medical and pharmaceutical sectors.

The OE-A business climate survey forecasts a decline of 20% in sales for the industry this year. For 2021 a plus of 7% is expected.

Photo: © OE-A

"For 2021 the outlook of the industry is optimistic. Numerous product launches are planned and the interest of important user industries remains," says Dr Hecker. "However, the companies expect it will take one to two years to fully compensate for the losses," adds Dr Hecker. "The pandemic has also boosted the development of and demand for specific applications such as smart patches for monitoring temperature or respiration in the medical sector, and sensor mats for distance control in the retail sector. Every crisis is also an opportunity. The companies have accepted this challenge in a very dynamic and flexible way". \\

Follow OE-A on Social Media

Easily connect with us and the Printed Electronics community

Follow OE-A on social media to make use of the fastest communication tools and to never miss any printed electronic news. Connect with the community, get inspired and receive industry news at first hand.

Photo: © Shutterstock

To gain more international visibility and traffic yourself we would like to encourage you to use social media. OE-A is happy to engage with your posts on Twitter and LinkedIn – Make sure to mention / tag us accordingly as well as to use the hashtags. \\

Social Media Channels

Twitter
@OEAonline /
www.twitter.com/OEAonline

LinkedIn
@OE-A (Organic and Printed Electronics Association) / www.linkedin.com/company/oe-a

Hashtags

\\ #OEAmember
\\ #PrintedElectronics
\\ #LOPEC2021

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New OE-A team member

A hi from my side, my name is Isabella Treser. I am happy to start working for the OE-A as Project Manager Press & Public Relations from January 2021 onwards, as the successor of Sophie Isabel Verstraelen.

Before joining the VDMA I coordinated international scientific meetings at a pharmaceutical association. Since 2013 I am working for the VDMA with great pleasure. The past seven years I was working for the valves manufacturers association in VDMA. There I was responsible for the topics public relations, market monitoring and sustainability.

**And now I am looking forward to supporting the OE-A members and their business in organic and printed electronics. **

A big shout-out to the printed electronics community

After 5.5 years working as project manager at OE-A it is time for the next step in my career.

I will therefore start a new job in my home country of the Netherlands at the beginning of next year.

During my time at OE-A I have learned and achieved a lot. From managing all international communication and PR activities, setting up an entire new website from scratch, and boosting our social media channels to increasing the number of OE-A Competition participants, relaunching the Working Group Sustainability, and initiating the Working Group Women in Printed Electronics. I have very much enjoyed working closely together with the OE-A board, managing director and team to optimize our strategy to strengthen the printed electronics industry. LOPEC has of course been our main annual event and it has been a great pleasure working with the Messe München team year-round to set up a strong and continuously growing international conference and exhibition.

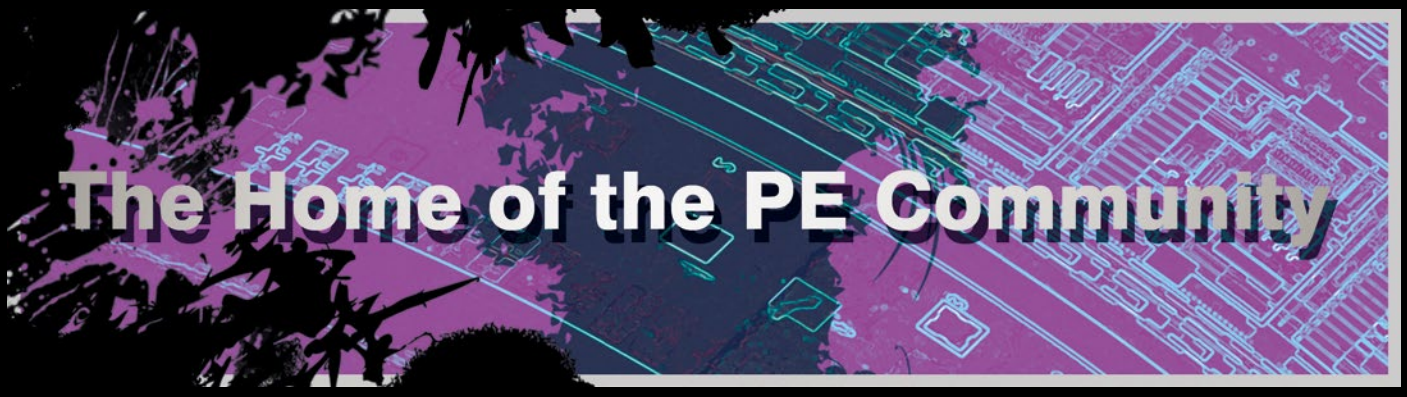
In the years that I have closely worked together with the OPE journal team, I have seen the OPE journal grow into a professional as well as the key magazine for the flexible, organic and printed electronics industry. Above all, I found teaming up with our international OE-A members from different parts of the value chain to be very inspiring. I truly believe we have a wonderful community that we can all be proud of.

I will close this chapter with many fond memories and would like to thank you all for all those wonderful experiences, support and fruitful cooperations. I wish you all the best for the future. And remember, #PrintedElectronics everywhere!

Take care, especially in these strange times and hopefully we will see each other again sometime. \\

Sophie Isabel Verstraelen

P.s. Let's stay in touch via LinkedIn (www.linkedin.com/in/siverstraelen).



OPE journal

Magazine for Organic & Printed Electronics

The OPE journal media pack 2021 is ready for download

Especially in these difficult times, you can rely on the OPE journal to reach a large number of experts in the printed electronics industry, users at home and abroad. This is guaranteed thanks to our extensive and personalised recipient database! Will the upcoming trade fairs take place? Is there a new lockdown? Whatever the future holds:

OPE journal will be reliably in readers' mailboxes and e-mail inboxes in 2021.

In the media pack you will not only get detailed information on our editorial topics, but you will also find the relevant data about circulation, attractive and effective advertisements and online features of OPE journal.

This offers you the perfect platform for your media presence and ad placements.

Please get in touch with us and bundle your individual media package with OPE journal!

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