Organic and Printed Electronics

Organic and Printed Electronics

Applications, Technologies and Suppliers

7th Edition

A working group within

VDMA

7th Edition OE-A Brochure

oe-a

Messe München
Connecting Global Competence

See you at LOPEC 2018

Save the date

March 13–15, 2018

Exhibition: March 14–15, Conference: March 13–15

Messe München, Germany

www.lopec.com

International Exhibition
and Conference for the
Printed Electronics Industry

LOPEC

Interactive Cover Page

Organic and printed electronics is thin, lightweight, flexible and can be produced at low cost, thus enabling new applications.

The interactive cover page of this OE-A Brochure includes intelligent paper with embedded NFC technology, making it possible to print connected objects using traditional methods of print.

This hybrid system combines a printed circuit and an embedded Si-NFC chip. For more information about this demonstrator, see the article on page 24 in this brochure.

Partner

arjowiggins

www.oe-a.org interactive-cover-page

This position held a sample
of printed electronics.

Organic and Printed Electronics

Applications, Technologies and Suppliers

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elcome to the 7th edition of the OE-A rochure.

Dr. eremy urroughes
Chairman OE-A Board,
CDT Ltd.

Dr. laus Hecker
Managing Director, OE-A

Once again, we have integrated a printed electronics device in the cover page; specifically an NFC tag that accesses a website on your smart phone or tablet when tapped. Connecting objects to the internet is another great example of what printed electronics can do for you.

Printed electronics enables the production of flexible and large-area components, and complements silicon electronics. Ultrathin, lightweight, robust, and economical to manufacture: these key features distinguish organic and printed electronics from traditional semiconductor technologies. However, these qualities do not just differentiate but create new markets and product categories, as well as contributing to the development of innovative concepts such as wearable electronics, Internet of Things (IoT) devices, and smart labels. This technology opens up new areas of application using a novel approach to manufacturing electronics.

The organic and printed electronics industry made significant progress over the last few years, and has established itself as a competitive growth industry. It has been proven that more and more products have matured onto the global market. OLED displays, for example, have become a truly mass-produced industrial product. But that is only the tip of the iceberg. This state-of-the-art technology is now being used in a variety of important industry sectors. Companies active in the areas of automotive, consumer electronics, household appliances, packaging, pharmaceutical, and healthcare have already launched products with integrated printed electronics. These current and anticipated developments are reflected upon in the latest OE-A Roadmap.

Triggered by new and improved materials, manufacturing equipment and processes as well as new device designs, experts in the OE-A expect the strong growth in the printed electronics industry to continue in the upcoming years. However, there are still areas in which fundamental technical barriers need to be overcome using new technological approaches. The large number of printed electronics application possibilities show just how complex the matter is. It is nonetheless certain that the number of applications will continue to advance dramatically. OE-A members share their expertise in this brochure.

One thing is crystal clear: The OE-A continues to go above and beyond to bring the organic and printed electronics industry to the next level. The OE-A's planned activities and goals for the near future contribute to the continuous process of building a bridge between science, technology, and applications in order to further advance an industry of emerging electronics. Strengthening the end-user involvement in the various industry sectors continues to be a key point on the agenda. In the future, the application of printed electronics is expected to keep growing, especially in consumer goods. It is nevertheless of great importance to improve the dialogue between end-users and the producers of organic and printed electronics in order to better understand their needs and requirements. Mutual information exchange encourages the development of advanced products using this novel technology.

The OE-A's activities and how the OE-A aims to accomplish its goals is described in this brochure. Together with its members and partners, the OE-A continues to further energize the printed electronics market and technology. We look forward to continuing working with you and bringing the organic and printed electronics industry to the next level!

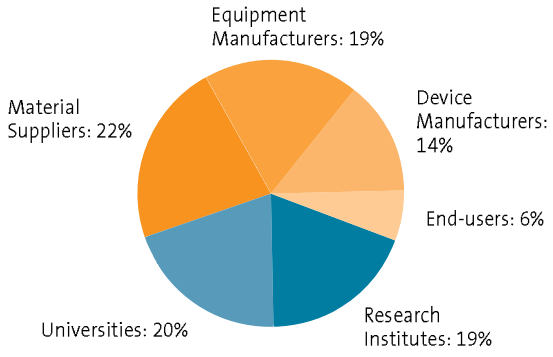
Dr. Jeremy Burroughes
Chairman OE-A Board, CDT Ltd.

Dr. Klaus Hecker
Managing Director, OE-A

OE-A – Connecting the Organic and Printed Electronics Industry

The OE-A (Organic and Printed Electronics Association) is the leading international industry association for the emerging technology of organic and printed electronics. Representing the entire value chain, the OE-A provides a unique platform for local and international cooperation between companies and research institutes.

Competencies of the OE-A Members



About the OE-A

Well over 200 members from Europe, Asia, North America, South America, Africa and Oceania are working together to promote the establishment of a competitive production infrastructure for organic and printed electronics. The vision of the OE-A is to build a bridge between science, technology and applications to grow an industry of electronics beyond the classic silicon approach. The OE-A enables and fosters collaboration by all participants along the value chain, from research to the integration into final end-products, by coordinating, harmonizing and facilitating their activities.

Our members are:

- Component & material suppliers
- Equipment & tool suppliers
- Producers & system integrators
- End-users
- Research institutes & universities

The OE-A is a working group within VDMA – the Mechanical Engineering Industry Association – located in Frankfurt, Germany.

Organic and printed electronics explained

Organic and printed electronics stands for a revolutionary new type of electronics – also called "emerging electronics" – which is thin, lightweight, flexible, robust, and produced at low cost. "Emerging electronics" means electronics beyond the classic sili con approach, including flexible, printed electronics from organic, polymeric or inorganic materials. The organic and printed electronics technology also enables a wide range of electrical components to be produced and directly integrated into low-cost reel-to-reel processes. This enables single-use, ubiquitous electronic devices and new applications. Many other terms exist for organic electronics: Printed, inorganic, plastic, polymer, flexible, thin-film, or large-area electronics. But in the end, they all mean the same thing.

OE-A's Key Activities

The OE-A offers many activities to further strengthen and develop the organic and printed electronics industry. Additionally, OE-A members are supported in meaningful ways and provided with numerous exclusive benefits.

- **International networking & communication platform** – Fostering collaboration and promoting information exchange among all international players along the entire value chain.
- **Market & technology information** – Projecting the industry's growth, providing a forecast for the main application areas and technologies, as well as identifying hurdles yet to be overcome.
- **Research & development** – Defining R&D funding programs, supporting and coordinating industrial R&D, and organizing projects that develop and demonstrate the various application possibilities.
- **Education & training** – Developing education and training programs that meet the industry's needs, relying heavily on the input of industry experts.
- **Standardization** – Supporting international standardization processes as well as developing dedicated guidelines for device characterization and testing methods.
- **Global visibility** – Promoting the innovations and developments in the industry through a multitude of media outlets and participation in events.
- **Advocacy & funding** – Representing the industry and its interests at national and regional governments, as well as within bodies of the European Commission.

Strenghtening synergies within the VDMA

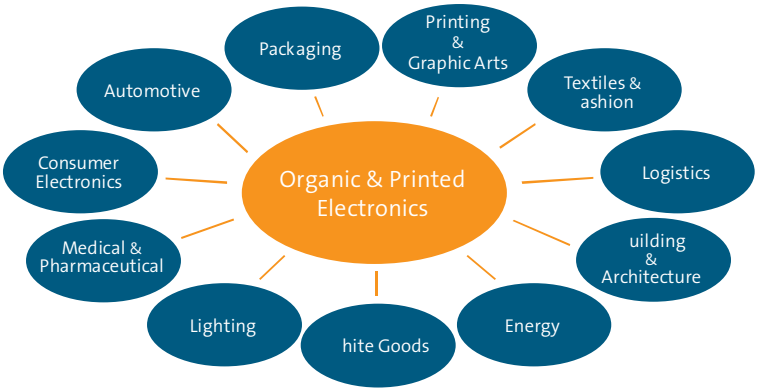
The OE-A is assigned to the VDMA sector association Electronics, Micro and Nano Technologies (EMINT), which leverages synergies between the sector's groups Productronic (electronics production) and Micro Technologies. Joint activities are launched in the sector association and groups, which cooperate closely with the VDMA's OE-A and Photovoltaic Equipment working groups as well as the Battery Production industry group. These partner associations provide sector-specific expertise to their member companies, many of which are business partners to the organic and printed electronics industry. The OE-A's internal network also provides us with excellent contacts to the printing and packaging, medical as well as plastics and paper equipment industries. More information can be found on pages 25-26.

The VDMA (Mechanical Engineering Industry Association) represents more than 3,100 mostly medium-sized companies in the capital goods industry, making it the largest industry association in Europe. VDMA is divided into 15 cross-sector departments, with branch offices in Berlin and Brussels, liaison offices in Brazil, China, India, Japan and Russia, 38 trade associations and working groups, international committees and forums, six state associations and numerous service organizations.

www.vdma.org

Competitive Growth Industry – Printed Electronics Everywhere

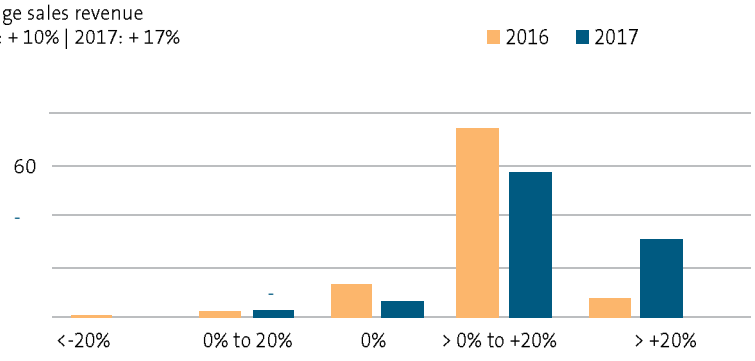
Organic and printed electronics has been established as a competitive growth industry, and o ers new applications and opportunities for numerous industries. Industry sectors such as automotive, consumer electronics, household appliances, packaging, and pharmaceuticals already offer products based on organic and printed technologies.



Organic and printed electronics enables new applications in numerous industries

Expected Sales Revenue for 2016 and 2017

Average sales revenue
2016: + 10% | 2017: + 17%



Responses weighted by number of employees, figures rounded

OE-A Business Climate Survey, 2nd half of 2016.
The organic and printed electronic industry expects an increase of 17% in sales revenue in 2017.
Respondents to the OE-A Business Climate Survey anticipated an increase of 10% in 2016.

Examples of application areas are: OLED lighting, OPV, flexible and OLED displays, electronics and components, and integrated smart systems. In the near future, the application of printed electronics will be additionally strengthened, especially in fields such as smart packaging, buildings, and textiles as well as automotive displays.

More information on this can be found on pages 14–18 as well as 20–22.

OE-A Roadmap

The current and expected developments and applications as well as challenges in the area of organic and printed electronics are extensively described in the OE-A Roadmap.

More information about the OE-A Roadmap can be found on pages 14-18 and at:
www.oe-a.org/roadmap

OE-A Business Climate Survey

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

International Events – Building Bridges Between Sectors and Continents

Creating the right partnerships is essential to both companies and research institutes. OE-A's strength lies in its global reach and international presence. By organizing working group meetings, workshops, and networking events around the world, the OE-A and its members seize opportunities in an emerging industry. Besides that, the OE-A also organizes seminars, presents and exhibits at various renowned international trade fairs and conferences, and hosts its flagship annual LOPEC event.

OE-A working group meetings

Through frequent working group meetings in Europe, North America and Asia, the OE-A supports its members with an effective networking and communication platform. The OE-A thereby fosters international collaboration as well as promoting information exchange among all players along the value chain.

More information about the OE-A working group meetings can be found at:
www.oe-a.org/oe-a-working-group-meetings

LOPEC

The OE-A and Messe München together host LOPEC, the world's leading International Exhibition and Conference for the Printed Electronics Industry. It is the business-oriented platform for end-users, engineers, scientists, manufacturers, and investors.

More information can be found on page 12 and at:
www.lopec.com

Trade shows & conferences

The OE-A organizes numerous seminars and sessions as well as presenting at international events and congresses at which speaking opportunities are also offered to its members. Moreover, the OE-A exhibits at world-leading end-user trade fairs, introducing various applications and new technologies to a broader audience. The OE-A additionally offers its members the opportunity to exhibit in joint pavilions worldwide.

More information about the OE-A's participation at international events can be found at:
www.oe-a.org/trade-shows-conferences

OE-A Working Groups – Fostering Collaboration Along the Entire Value Chain

In order to build a stronger organic and printed electronics ecosystem, the OE-A covers several important and current topics and issues. Through a number of working groups, OE-A enables and fosters collaboration among all members along the value chain – from research and development to production and integration into final end-products.
By means of discussion and cooperation in the individual working groups, OE-A members are able to gather valuable information, publish research, share best practices, initiate new and innovative developments, further improve existing products and processes, and find solutions to specific challenges.

Roadmap

The OE-A Working Group Roadmap develops the OE-A Roadmap for Organic and Printed Electronics. Based on the work of more than 250 experts, this key publication represents the common perspectives of all OE-A members. The roadmap has become widely recognized by industry, government agencies, and scientists as an important framework and tool for defining what is "state of the art" in organic and printed electronics.

Whereas increasing numbers of printed electronics products are available, and some are already in full production, many applications are still in lab-scale development, prototyping or early production. It is therefore important to provide up-to-date market and technology information, develop a common opinion about what kind of products, processes and materials will be available and when, and identify the key issues that need to be addressed. These are the primary functions of the OE-A Roadmap. Because printed electronics is a rapidly changing field, the OE-A Roadmap is published regularly.

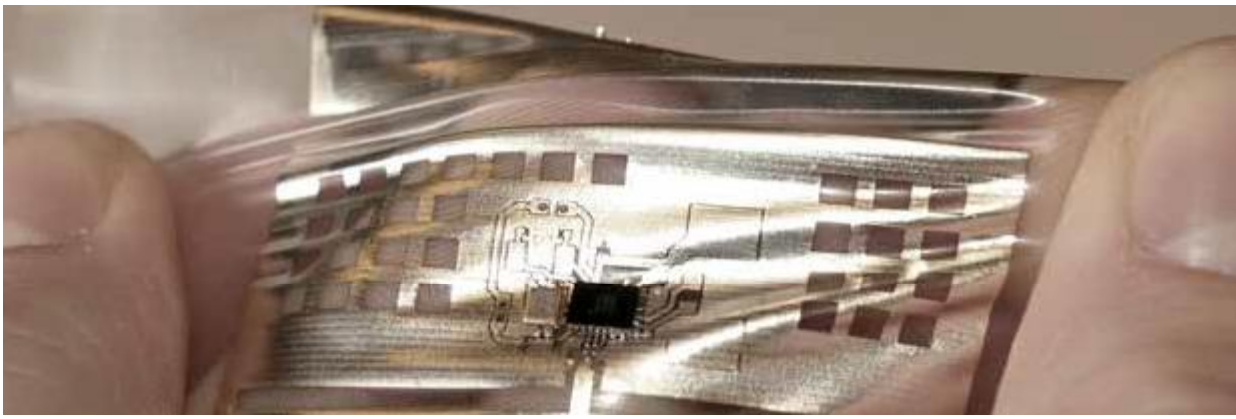
More information about the OE-A Roadmap can be found on pages 14-18 and at:
www.oe-a.org/roadmap

Demonstrator

The OE-A Working Group Demonstrator illustrates the potential of the organic and printed electronics technology as well as fostering cooperation among its members. Apart from the fact that a number of project teams have already worked together on a variety of demonstrators over the years, this working group organizes the annual OE-A Competition to support companies, designers, scientists, and engineers in developing a vision of future applications in organic and printed electronics. OE-A members can participate by submitting their new products and prototypes, thereby promoting their latest innovations. The resulting demonstrators and design concepts will be exhibited at LOPEC, where the best concept as well as the best demonstrator in each category will be honored.

The OE-A furthermore encourages student groups to develop their vision by taking part in the OE-A Competition.

More information about the OE-A Working Group Demonstrator can be found at:
www.oe-a.org/demonstrator



Hybrid Systems

The OE-A Working Group Hybrid Systems aims to bring together companies, research centers and universities that deal with hybrid systems. This group furthermore works on identifying best practices and competencies, as well as future concepts.

Hybrid systems combine printed and silicon-based components. This is where the best of both worlds is achieved: The high processing power of silicon electronics with the flexible, thin, and lightweight characteristics of organic and printed electronics, enabling a broad range of new applications.

More information about the OE-A Working Group Hybrid Systems can be found at:
www.oe-a.org/hybrid-systems

Encapsulation

Barrier materials and films, e.g. for encapsulation of OLEDs and OPV, remain a challenge, and further standardization efforts are required to qualify encapsulation. The OE-A Working Group Encapsulation addresses several topics relating to the encapsulation of organic electronics. The focus lies on „Lead Applications and Communication in the Value Chain", „State-of-the-Art and Roadmap", as well as „Standardization of Encapsulation Metrology".

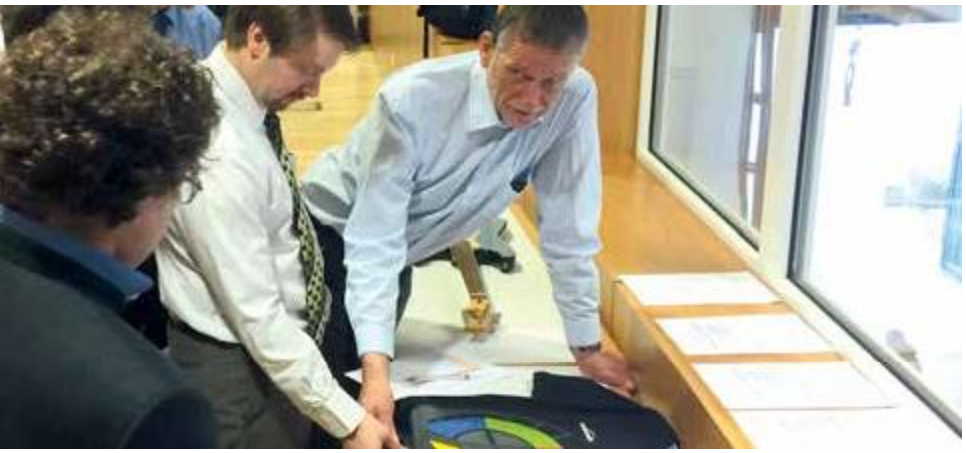
The goal of the OE-A Working Group Encapsulation is to trigger the standards development process. Therefore the group started round-robin tests to clarify permeation testing, qualify sealant materials and barrier-on-foil materials with optical and electrical, as well as calcium-tests.

More information about the OE-A Working Group Encapsulation can be found at:
www.oe-a.org/encapsulation

Sustainability

The OE-A Working Group Sustainability aims to identify and understand the sustainability benefits of organic and printed electronics technology, emphasizing its contribution to a sustainable future in an open dialogue with key stakeholders, markets, regulators, and wider society.

As the organic and printed electronics industry moves into commercialization, the OE-A believes that sustainability is an increasingly important topic. It is critical that we examine our products and processes to identify how efficiently they are produced, how well we use the materials with



which they are constructed, and how well they use power and other consumables when in operation. Finally, when these devices come to the end of their lifetime, we need to identify how they can be recycled or dealt with in a responsible, sustainable manner. Additionally, the OE-A aims to understand the key changes in regulations that will affect the industry in the short, medium and long term, and how they will harmonize with the benefits of organic and printed electronics. Moreover, the OE-A would like to provide the organic and printed electronics community with information, guidelines and methodologies that will allow members to understand the sustainability of their own products and processes.

More information about the OE-A Working Group Sustainability can be found at: www.oe-a.org/sustainability

Education

The OE-A Working Group Education promotes training and education activities in the field of organic and printed electronics in order to support the OE-A's mission to build a bridge between academia, science and industry. Its key objective is to encourage international education and training activities in Europe, North America and Asia. By addressing individuals who are already active in or will (soon) be entering the field of organic and printed electronics at the various educational institutions, the community aims to create a pool of highly-qualified students and employees trained in disciplines relevant to these emerging markets who can be recruited in the future. These activities are conducted in close cooperation with several EC-funded projects.

More information about the OE-A Working Group Education can be found at: www.oe-a.org/education

Global Visibility – Getting the Word out About (Your) Organic and Printed Electronics

Promoting and ultimately marketing the innovations and developments in the industry is key to the future establishment of this emerging technology. The OE-A can help advocate the latest innovations and products through different channels, as well as offering its members various exclusive opportunities to increase their visibility.

OE-A Brochure

The OE-A Brochure, "Organic and Printed Electronics – Applications, Technologies and Suppliers", is distributed globally at international events. It includes, for example, member profiles, a market overview, and the OE-A Products & Services Directory.

You can download the OE-A Brochure at:
www.oe-a.org/downloads

OE-A Products & Services Directory

The OE-A Product & Services Directory provides information on the competences as well as the products and services of the OE-A members. It can be found on our website as well as in the OE-A Brochure.

The OE-A Products & Services Directory can be found on pages 90–101 and at:
www.oe-a.org/products

OE-A Roadmap

The OE-A Roadmap represents the common perspectives of the OE-A members, and serves as an important framework and tool for defining what is "state of the art" in organic and printed electronics.

More information about the OE-A Roadmap can be found on pages 6 and 14–18 and at:
www.oe-a.org/roadmap

OE-A Competition

OE-A members can participate in the OE-A Competition by submitting their printed electronics product, demonstrator or concept. All participants enjoy international publicity through various media outlets, their submissions will be showcased at LOPEC, and, finally, the winners will be honored and their ideas will continue to be promoted by the OE-A.

More information about the OE-A Competition can be found at:
www.oe-a.org/demonstrator

Digital & Print Media

The OE-A utilizes various channels of communication to inform, promote, exchange, advise, and influence industry, the media, (potential) members and government bodies. Information about organic and printed electronics is shared via OE-A's newsletters, website, social media channels, videos as well as in the globally distributed OPE Journal. Additionally, the OE-A can arrange contact with the international press for its members.

LOPEC – The Entire Industry in One Spot

What is next for printed electronics? What products are already available on the market? What applications will be feasible in the future?

Each spring, LOPEC provides the answers to these questions. As the leading global industry platform for printed and organic electronics, it brings together the entire value chain in Munich, Germany. This includes not only users of the promising future technology, but also developers, material manufacturers, and researchers from around the world, who attend in order to interact with this constantly growing industry, learn about innovations, and spot future trends.

The close strategic partnership between OE-A and Messe München ensures that LOPEC always has its finger on the pulse of the industry and ties together technology and business. As an exclusive business platform, it is geared towards a **wide range of application industries.** These include automotive, lighting, printing and graphic arts, energy, building and architecture, logistics, medicine and pharmaceuticals, textiles, consumer electronics, wearables, packaging, and white goods.

From think tank to product showcase

By the time it premiered, in 2009, LOPEC had already established itself as the leading industry event. Wolfgang Mildner, General Chair of LOPEC, remembers: "In its early days, LOPEC was primarily a think tank that aimed to promote printed electronics to the world. Today it showcases specific products and applications that are increasingly entering the mass market." The event now attracts **150 exhibitors and more than 2,000 attendees** from all around the world each year.

In addition to strong international attendance, the diversity of the attendees is another key feature of LOPEC, as Stephan Berlitz, Head of Development, Lighting Functions and Innovations at Audi, emphasizes: "The great thing about LOPEC is the bandwidth of businesses and research institutes. As an applications business, we can make use of this breadth of activity, and hold discussions with the specialists."

Exhibition and conference in one

The LOPEC concept perfectly reflects the dynamic nature of this emerging industry. Attendees can meet leading industry players at the exhibition and admire their new products, while also hearing around 200 talks on the latest trends by top industry experts.

The LOPEC Conference is divided into three modules to best represent all areas of printed electronics: The **Technical Conference** is geared towards industry and practical applications. The latest results in various research disciplines are discussed at the **Scientific Conference**. The main topics covered by the **usiness Conference** are business opportunities and market analyses. LOPEC also supports young entrepreneurs with its **Start-up Forum.**

In addition to the exhibition and conference, LOPEC offers several additional events, where ideas are exchanged, information is collected and networking plays a major role.

LOPEC will be celebrating its 10th anniversary next year (March 13-15, 2018). The LOPEC team is looking forward to seeing you!

LOPEC

www.lopec.com

OE-A Roadmap
for Organic and Printed Electronics – Executive Summary

OE-A Roadmap for Organic and Printed Electronics

Organic and printed electronics is based on the combination of new materials and cost-effective, large-area production processes to enable new applications not possible with conventional electronics. A key advantage of organic and printed electronics is the ability to make thin, lightweight, flexible, robust and environmentally friendly electronic products. One of the key activities of the OE-A since its inception has been the regular updating of the roadmap for this young but growing industry. This article summarizes the major findings of the OE-A's seventh edition of the Organic and Printed Electronics Roadmap based on work done since the sixth edition of the OE-A roadmap was completed in 2015.

Back in 2015, we already found that organic and printed electronics (OPE) had established itself as a growth industry. This growth has continued, and there are applications (organic LED i.e. OLED – organic light-emitting diode – displays, for example) where it is already a strong player, with signs pointing to further growth, as well as others, such as organic photovoltaics (OPV) or OLED lighting, in which niche products have been marketed but in which the market is still quite young. Sales of products including OPE were more than USD 25 billion in 2016 with future annual growth rates of approx. 14% predicted globally [Smithers Pira (2015), IDTechEx (2015)]. As in the last Roadmap, OLED displays accounted for the largest share of the market. Some areas, such as NFC (near field communication) enabled smart packaging, are just getting started, with sales of USD 322 million in 2016 expected to grow to more than USD 800 million by 2021 [Smithers Pira (2013), IDTechEx (2014)]. Sales of printed primary batteries and electroluminescent (EL) displays remain stable.

Printed transparent conductive films and touch sensors are entering interactive display products, e.g. in automobiles and home appliances. Some other O E applications are still looking for the best path to large markets.

A major development of the last two years has been the growing interest in and the establishment of OPE in important industrial sectors, such as automotive, consumer electronics, healthcare / ellbeing, smart buildings, printing and packaging, and the Internet of Things. These industry sectors implement solutions from a wide range of technology applications, for e ample, products based on curved displays, OLEDs, OPV, touchscreens and sensors can be found in the automotive sector. The progress of OPE into these sectors is an indicator of the growing maturity of the industry, and is discussed in some detail for the first time in the upcoming white paper, which will be available in the second quarter of 2017. Figure 1 summarizes a number of organic and printed electronics solutions finding their way into major industry sectors. Some of the solutions are already commercial on a significant scale, while others are still concept prototypes.

As might be expected with the increasing adoption of OPE in important industry sectors, there is

About the OE-A Roadmap

The OE-A Roadmap is one of the key activities of the OE-A. It represents the common perspective of OE-A members on the current state of printed electronics, based on the work of more than 250 experts. The OE-A Roadmap also gives short-, medium-, and long-term forecasts on where the industry is headed. Roadmapping is an ongoing process within the OE-A. First published almost a decade ago, the OE-A Roadmap is now published in its seventh edition. It is organized into five major application clusters and three technology areas, each lead by a renowned expert in his field. The OE-A Roadmap aims to provide information on technology and application, to support the industry, government agencies and scientists in identifying strategies regarding R&D activities and product plans.

Elaborating on major findings of the Roadmap on Organic and Printed Electronics, the OE-A publishes a white paper with more in-depth insight on the respective applications and technologies. For the first time, the white paper will also look more closely at key industry sectors and how printed electronics will be of benefit. The OE-A Roadmap White Paper will be published in Q2/2017 and is complimentary for OE-A members. Non OE-A members may find information on obtaining the OE-A Roadmap White Paper via www.oe-a.org/roadmap

OE-A oadmap for Organic and Printed Electronics Applications 2 17

Automotive	OLED lighting for exterior & interior style elements; curved displays; touch sensors; energy harvesting using OPV; 3D & flexible surface integrated sensor applications for smart user interfaces & HMI	
Consumer Electronics	Foldable & flexible displays for phones / tablets / wearables; EPD as second display; displays as decorative applications; OLED luminaires; sensing & signage for white goods; touch & functional surfaces; wearable tech	
Healthcare	Displays for use in wearables, smart watches; ECD for one-way diagnostics; bio sensors; OLEDs for light therapy; bio-compatibility of materials & substrates; monitoring & diagnostics: in clinics, self-monitoring for preventive care, for wellness purposes	
Internet of Things	Integration & embedding of displays in everyday objects; OPV-power sources for autonomous devices; smart labels, including e.g. temperature logging; printed / hybrid NFC & RFID	
Printing & Packaging	Low-cost & low-power displays for price labels (supermarket) & enhanced packaging; smart labels & tickets; smart packaging combining sensor systems, energy harvesting & storage, HMI; e.g. input devices and displays; printed / hybrid NFC & RFID	
Smart uildings	EPD for signage & decoration; ECD wallpaper and information labels; BIOPV everywhere (facades, windows, roofs); OPV for energy autonomous sensors; OLED lighting as decorative / architectural / functional lighting; sensor systems for use during and after construction (e.g. temperature, humidity, structural integrity) and for energy management (e.g. smart windows)	

Figure 1. Organic and printed electronics solutions in important industry sectors

a move from "technology push" to "market pull" defined by the needs of end users.
The OPE industry is not trying to put organic and printed electronics "everywhere," but is effectively implementing this technology in products. Various use cases show that OPE offers specific advanta ges in performance, cost or form factor over conventional solutions. Consensus appears to be growing that many OPE applications will involve hybrid system integration in the short to medium term, with a "brain" based on silicon electronics and other parts of the system enabled by printing.

This Roadmap continues the work started in previous versions, and reports on the growth in the OPE market in a wide range of applications. It also reports on the technical progress that has been made in the field since the sixth edition. In addition to our new analysis of OPE in important industry sectors, we continue to look at the deve lopment of the market in five key application clusters. These will be examined in more detail in the white paper, including a discussion of the technology readiness levels (TRLs) of different applications, a few highlights of which are as follows.

OLED lighting is moving from an expensive "design" option into more mainstream architectural lighting as prices are beginning to come down. Non-planar and bendable lighting has appeared in initial products, such as automotive taillights and bendable OLED lighting panels. In addition to established players in Europe, Japan and Korea, interest is growing in China and Taiwan, indicating hotter competition in the future.

OPV has seen both technical innovation and market growth in the past two years. There have been significant breakthroughs in efficiency and in semi-transparent modules, detailed environmental impact studies are available, and lifetimes up to 20 years have been reported. Production capacity has increased, flexible OPV modules can be bought online for a low price, and more building integration installations have been built.

While OLED displays are the biggest success story in OPE for the moment as rigid, glass-based displays, flexible or conformable displays are starting to become more widespread as well. Curved OLED displays are already being used in products such as TVs, mobile phones and watches, and conformable, glass-free LCDs are being integrated onto support pillars in cars as prototypes. In most cases, the electronics and components cluster delivers parts that are used in other applications rather than separate products. Active OPE devices are not established in the market yet, even though organic semiconductors are already compatible with inorganic materials like amorphous silicon. Progress has been made in performance and in analog circuitry, which has been a challenge in the past. Active matrix display backplanes are ready for products. Touchscreens based on metal nanowires or fine metal meshes have been integrated into interactive displays and controls. In addition to printed batteries, printed supercapacitors are emerging as interim storage in energy harvesting systems for distributed sensors.

Integrated smart systems refers to products and prototypes that integrate multiple functionality and multiple technologies to create added value. An important development in the last few years has been the increasing importance of the Internet of Things (IoT), in which everyday objects have functionality. The hybrid system integration of printed electronics, e.g. for sensing, interconnects, antennas and energy harvesting / storage, with the computing power of small silicon chips is becoming recognized as an area where OPE can be a true enabler. Wearable health and wellbeing applications, for hich the form factor of OPE is a strong advantage, are also emerging, including applications such as cardiovascular or medication compliance monitoring and enhanced bandages.

Our working groups have also monitored and analyzed the progress and predictions in the core technology fields that are necessary for the success of applications. unctional materials have continued to improve in charge carrier mobility, with today's values starting to be feasible for OLED display driving rather than only liquid crystal or electrophoretic displays. The ability to compete with polysilicon is expected in the coming years. Solution processible inorganic materials are also becoming more viable as processing temperatures come down significantly. Many of the same substrates are being used for OPE, with a focus on low-cost materials, but there are new trends as well. In particular, interest in substrates that are stretchable as well as bendable has grown significantly, especially with regard to wearables. There is also renewed interest in paper as a low-cost, environmentally friendly substrate for electronics. In the field of printing, coating and patterning, many of the same methods that are common in graphics printing and the coatings

OE-A oadmap for Organic and Printed Electronics Applications 2 17

	Existing 2 17	Short Term 2 1 -2 2	Medium Term 2 21-2 23	Long Term 2 2	
	Rigid white OLED modules; rigid red OLEDs for automotive applications	Flexible OLEDs (color); flexible OLEDs (white)	Transparent OLEDs; flexible red OLED for automotive applications	3D OLEDs; dynamic OLED signage (segmented); long stripes; OLED in general lighting	OLED Lighting
OPV	Portable OPV chargers; personal electronics power supply	Large area OPV foil; OPV objects; opaque OPV for building integration	OPV integrated in building products	OPV in packaging; energy harvesting combined with storage	
	Curved OLED displays, EPD shelf-edge labels, EPD secondary displays on phones; displays for wearables	EPD wrist band; transparent displays; conformable OLCD; enhanced display integration in wearables	Curved displays for autmotive interior; integration into clothing; white goods displays	Wallpaper displays; displays in everyday objects; foldable displays	lexible & OLED Displays
Electronics & Components	Printed devices: memory, RFID antenna, primary battery, active backplane; sensors: glucose, touch, temperature, humidity	Printed mobile communication devices based on antennas, light sensor; stretchable conductors / resistors; 3D touch sensors	Printed lithium ion battery; printed super caps; active touch & gesture sensors	Printed complex logic; 3D & large area flexible electronics	
	Glucose in-body sensing; pressure sensor arrays; NFC labels; hybrid RFID; HMIs (sensors)	Smart labels (discrete); HMI (embedded electronics & displays)	Human monitoring patches (single parameter, point of care, on-skin); disposable & quantitative sensors for food safety; biomedical sensors	Fully printed RFID / NFC label; ambient intelligence (connected); sensors for security (explosives)	Integrated Smart Systems

Figure 2: The OE-A Roadmap for organic and printed electronics applications,
with a forecast for the market entry in large volumes (general availability) for the different applications

industry continue to be used for OPE. However, due to the increased requirements for resolution and registration, improvements have been made to the printing forms and machines, including modifications to inkjet printing that can deliver 1 fl droplets, as well as high-resolution screens and gravure cylinders. Due to these and other advances, such as roll-to-roll nano-imprint lithography (NIL), throughput is starting to improve without loss of resolution.

In contrast to earlier editions of the Roadmap, we have not separated the **key parameters** determining the competitiveness of products into application and technology parameters. This reflects how OPE has become a customer-driven industry. The key parameters identified by the working group clusters reflect this move to market orientation. While the key parameters for each cluster reflect the diversity of the applications of OPE, the following were especially common across different fields:

- **Reliability**
- **Capital expenditure** for new equipment
- **Cost** (coming more and more to the forefront in discussions)
- **Environmental impact** / end of life / recycling
- Compatibility with **standards**

Individual roadmaps were developed for each application field and will be presented in the white paper. In addition, an overall roadmap for organic and printed electronics was developed, a summary version of which is graphically represented in figure 2 on the previous page.

As with each edition, we have looked at the **key trends** in the OPE industry since the last edition of the Roadmap. Some of the most important include:

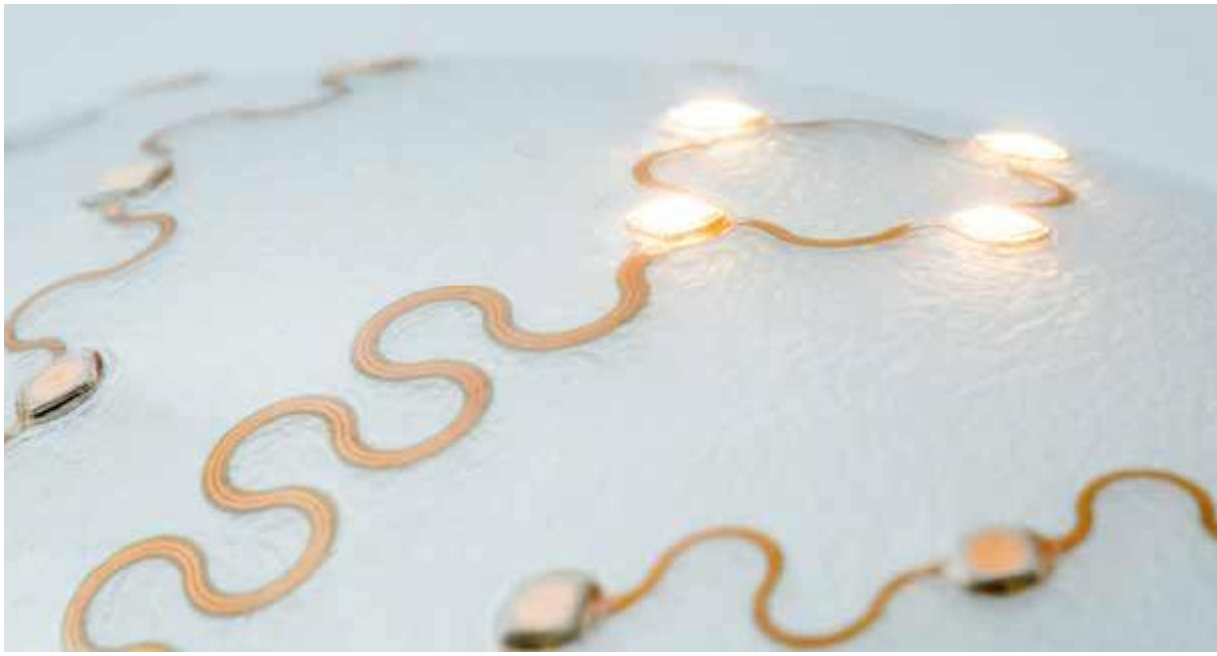
- **OLED displays** continue to be the biggest success story of OPE and dominate the OPE market, and are not only available in smart phones but also as large-screen TVs
- **Major industry sectors** are embracing OPE more than ever, and the number of OPE-enabled products in these sectors is increasing
- Patterning processes are scaling to **smaller dimensions** and **improved registration**
- There is a trend from flexible / bendable to **stretchable** products
- Integration of printed and silicon-based components to make **hybrid systems** has become a key paradigm for the development and manufacture of OPE products
- **NFC-enabled smart labels** based on OPE are now on the market in the area of smart packaging and brand enhancement
- The industry is becoming **more mature. Realistic growth** continues, and **significant revenues** and products are appearing in more and more application areas.

Based on an analysis of the application and technology parameters, the recent progress in materials and process technology and the expected future technology development, key challenges (**"Red Brick Walls"**) were identified, for which **major breakthroughs** are needed. It is notable that the key challenges in this edition are more focused on production, use and cost than on basic technology, which reflects the growing market orientation of OPE:

- **Cost:** Capital expenditure for manufacturing equipment as well as materials
- **Processes:** Resolution, registration, uniformity and characterization
- **Encapsulation:** Not only lower cost but also stretchable encapsulation materials are needed
- **Scalability:** From lab to production and from small to large areas while keeping performance high
- **Inspection / yield:** Progress in both yield improvement and in-line inspection and recognition of defects is needed to improve competitiveness
- **Standards** and **regulations** for organic and printed electronics are under discussion, but not yet implemented

In previous editions, we asked whether there would be a Moore's Law for organic and printed electronics. With the growing diversity of the OPE industry, it is becoming more and more difficult to find a single scaling parameter (or even just a few) that can describe the whole industry. While there are indications of regular improvements in materials performance and patterning processes, the effects and importance of these vary widely from application to application. What can be seen in the progress since the sixth edition of this Roadmap is that OPE is maturing, and rather than a "killer app" (with the exception of OLED displays) we see growing use of organic and printed electronics in a wide range of industry sectors. OE-A will continue to follow this development and keep you informed.

Outlook on the Organic and Printed Electronics Market



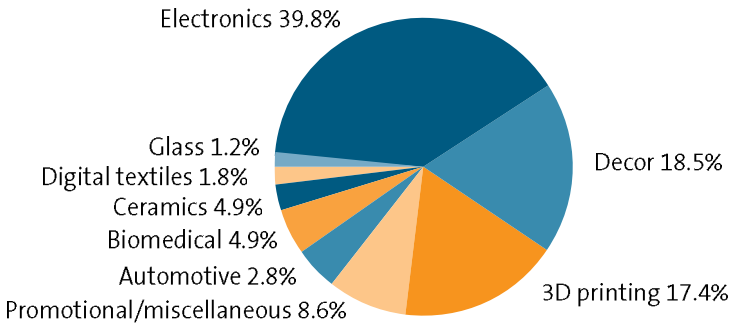
A Decade of Growth for Printed Electronics

By John Nelson, Commissioning Editor, Smithers Pira

Electronics is an increasingly important segment in non-traditional print markets. Data from the Smithers Pira report 'The Future of Functional and Industrial Print to 2020' shows how applications like antennas, displays, photovoltaics and circuitry have pushed a market valued at USD 5.6 billion in 2010 to USD 26.9 billion in 2016.

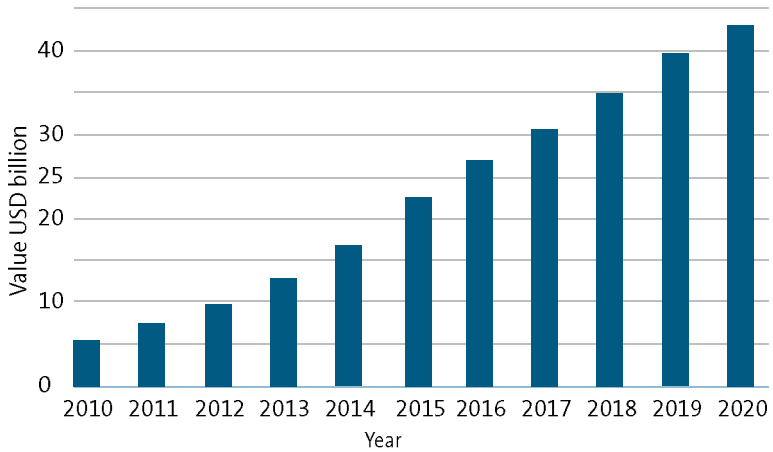
This has seen its share of global functional and industrial print demand rise from 17.4% at the beginning of the decade to 33% by its midpoint. By its close, further investment, new material sets, and the evolution of new applications will see this climb to a 39.8% share. By 2020, Smithers forecasts a year-on-year market value increase of 13.9% for printed electronics, as opposed to 9.9% for the functional print market as a whole.

Global Functional Industrial Print Market by A lication



By 2020, electronics will be worth nearly 40% of the worldwide functional and industrial printing market (USD billion,constant values). Source: Smithers Pira

Global Market for Printed Electronic Products



By 2020, the market value of print is expected to be worth about USD 43 billion. Source: Smithers Pira

Electrics and electronics

The growth for the past six years has been due in large part to proliferation of printing as a low-cost solution for producing basic components – like membrane switches, RFID antennas, and connective circuitry – that might most accurately be described as printed electrics.

Progress has also been rapid in developing genuine printed electronics – devices that incorporate a semiconductor element – with organic LED (OLED) technology. Commercial penetration has been limited, however – principally due to low yield from production lines and resulting high prices. The major area of success has been in smart-device screens, a segment where technology leader Samsung is now being joined by a number of Chinese, Taiwanese, and rejuvenated Japanese competitors.

For Korea to maintain its lead, the R&D focus is increasingly on evolving the flexible potential of OLED stacks to realise bendable or foldable smartphone screens. Samsung is rumoured to be planning to launch a handset with a partially flexible screen in 2017.

Large-area prospects

In large-area displays, despite good reviews, price has kept OLED technology out of mass consumption. Despite progress by LG Display in cutting the costs of large panels, the enhancement of LCD screens with quantum dots (QDs) has undercut OLED's advantages in picture performance while maintaining relative price competitiveness. The situation is complicated by the fact that many of the companies that hold the purse strings for investment in this area are involved with both technologies. Samsung, for example, spent a reported USD 1.2 billion on R&D for printed, flexible and organic electronics in 2014, but has chosen to focus on enhanced QD-enhanced LCD televisions rather than OLED.

The location of both OLED's commercial innovators (Japan and Korea) and the potential for new low-cost production (China, Taiwan and Vietnam) helps make Asia the largest regional market for

printed electronics. Smithers' analysis shows that Asia was worth 20% more than the next two most valuable regions – Western Europe and North America – combined in 2015. This is driving business decisions among material suppliers, like Merck's 2015 decision to open its OLED Application Center (OAC) in Pyeongtaek, South Korea.

Smart packaging

In other application segments for printed electronics, Asia's dominance is less pronounced. This will see European and American companies gain ground in terms of global market share for printed electronics over the next five years.

One segment which highlights this is smart packaging. In 2015, Norway's Thinfilm Electronics began work on mass commercialising its printed electronics technology with US print giant Xerox. With a production line at Xerox's base in Webster, New York state with a reported annual output potential of 1.3 billion labels, this could place electronic connectivity via packaging within the budget of the consumer mass goods market. The partners are believed to be targeting a unit price of USD 0.10 to make this viable.

This could serve to convert a segment that has previously focussed on printed electric solutions – like RFID antennas – into a printed electronics one. The next generation of smarter solutions could serve a number of functions simultaneously, including:

- Anti-counterfeiting/brand protection;
- Consumer engagement;
- Logistics track-and-trace;
- Monitoring a pack's contents for spoilage.

The technology infrastructure for enabling this is being established by the increasing prevalence of consumer smartphones and new communication methods, like the Near-Field Communication (NFC) protocol. In verifying goods, a shop owner or law enforcement officer can use NFC to scan a tag or other circuit on an item's packaging to be directed to a secure website to confirm it is genuine and where it should be, without the need for specialized scanning equipment or training. Printed electronics and smartphones can also democratize the battle against fake or grey-market products, by placing the verification tool directly in the hands of the consumer. The prevalence of domestic counterfeiting makes China a focus for such applications. This has been explored by Thinfilm Electronics in a trial with Ferngrove Wine, an Australian vineyard selling predominantly to China. Once a connection has been made via a smartphone, it gives brands the option to maintain a conversation with the buyer– forging a two-way relationship via tailored discounts and individual feedback if the consumer is amenable.

Smithers estimates that world demand for packaging that enables smart electronic communication with the customer or user will be worth USD 322 million in 2016. This will climb to in excess of USD 800 million by 2021, though the majority of value will remain in RFID circuitry.

Printed sensors

Another active area of research is developing cheap printed sensors that monitor temperature or even the emission of gases associated with the spoilage of food. Both formats can show whether perishable goods remain fit for consumption. Similar components could be used in monitoring for dangerous gases like carbon monoxide in domestic or industrial facilities. Another applica tion being actively pursued is the use of a web of printed gas and stress sensors applied across and even inside a building or structure like a bridge, giving live feedback of its condition.

Opportunities for cheap, flexible skin-mounted sensors also exist in healthcare. This is based on the emergence of telemedicine – the remote monitoring of largely aging populations with chronic health conditions – though the expensive and time-consuming compliance procedure for medical devices will slow this deployment.

Mass production of Thinfilm's printed electronic smart labels has begun in the US.

3D printing

One other functional print application that is forecast to witness strong expansion for 2015-2020 is additive manufacturing, or 3D printing. Smithers' data shows this segment, valued at USD 8.3 billion in 2015, growing to USD 16.8 billion by the end of the decade. The total 3D printing market was valued at USD 5.85 billion in 2015. This will grow year-on-year at over 20% to reach USD 49.1 billion in 2025.
Greater use of such systems – and especially high-speed industrial 3D printers – can help printed electronics penetrate new segments, such as automotive moulded interconnect devices for aerospace or automotive vehicles.

OLED lighting

The same OLED technology that has gained share for printed electronics in screen applications also has potential in illumination. Despite several advantages – panel thinness, flexibility, and emission quality – over existing technologies, none of these is significant enough to overcome the cost premium of OLED illumination. Consequently, its use has been limited to niche applications and demonstration installations, a position that looks set to continue in the near future. One small segment where penetration is likely to happen first is automotive where weight reduction and the luxury effect are key considerations. Implementation has already begun in concept models from German car makers, though how long this will take to filter down to production models remains to be seen.

Photovoltaics

Solar-energy harvesting – photovoltaics – systems are another printed electronic platform that has received substantial R&D funding, but is yet to see mass-market sales. Despite lower electricity yields than conventional solar, concepts like Heliatek's organic building integrated photovoltaics (BIPV) films have been developed to counter this with much larger surface areas at low cost.
This segment, like much renewable energy technology, is suffering from low conventional energy prices linked to oil prices and the arrival of shale gas, as well as cutbacks in government development and installation subsidies.

Print technology

Smithers' analysis shows that screen printing remains the most popular process for the printing of electronics and is worth half the global market by value in 2016. Gravure is the second most widely used – 21% in 2016 – and with the exception of inkjet the only process forecast to expand its market share over the next five years. This is largely attributable to gravure's suitability for quality-sensitive layers like organic semiconductors and semiconductor/dielectric interfaces in transistors.
Inkjet printing is increasingly finding its niche in printing electronics, and its contactless nature makes it a natural fit with other developments, like 3D printers. Its value will experience a year-on-year increase of more than 18% through to the end of the decade.

High prices mean OLED lighting will be confined to niche applications like luxury vehicles in the short term.

Smithers Pira

Smithers Pira is the worldwide authority on the packaging, paper, and print industry supply chains. It was originally established in 1930 as the Printing Industry Research Association. It provides market reports, consultancy, books, publications, events, membership, and testing. More details are described in the new Smithers Pira report 'The Future of Functional and Industrial Print to 2020.' OE-A members receive an exclusive 15% discount on this and its other market and technology scoping reports.
www.smitherspira.com

OE-A rochure
Interactive Cover Page

www.oe-a.org interactive-cover-page

The Future of Printed Products is in Your Hands – Interactive Cover Page

The integration of thin and flexible electronics opens up new possibilities for classically printed products. Light, sound, displays, power or sensors can be integrated into traditional print products like journals, brochures or packaging, thereby enhancing their functionality. Interactive print products provide additional functionality and new opportunities for entire industries, such as advertising.

Interactive cover page of the 7th OE-A Brochure

In order to illustrate new possibilities, the OE-A brochure features an interactive cover page that lets you experience the next generation of electronics: Enabling new applications that are thin, lightweight, flexible, and produced at low cost.

10,000 NFC tags have been produced, and one is integrated into each OE-A Brochure – a clear example of printed electronics already being produced en masse. The demonstrator illustrates the versatility that organic and printed electronics can offer in terms of scalability, miniaturization, adaptability, manufacturability, integration, complexity, and high technical yield.

Tapping the NFC tag with your smart device automatically takes you to www.oe-a. dma-verlag.com, where you will find a number of OE-A members and partners that have embraced this technology and are using it as a marketing tool. However this page illustrates only one possibility. Imagine all that this NFC tag could be integrated into! Serving as an information indicator or smart label on medicine packaging, sharing your curriculum vitae with your business card, or unlocking and starting your car with a digital key saved on your smart device are just a few application examples.

Technology and Process

The card itself is printed on Powercoat® Alive paper, developed and manufactured by OE-A member Arjowiggins. This "intelligent" paper with embedded NFC technology makes it possible to print connected objects using traditional printing methods. This material combines the multiple award-winning specialty paper – adapted for printing electronics by using a patented technology – with printed circuits and an embedded, unpackaged silicon chip on which data is stored. The printed circuits are produced via screen printing process, dried and rendered conductive via a high-temperature sintering process. The paper is then laminated with an aqueous glue between two sheets of fine paper, making for a seamlessly integrated chip. This NFC tag is therefore a perfect example of a hybrid system.

Placing an NFC-enabled device in close proximity (within a few centimeters) of the printed RFID circuit containing the chip enables small amounts of data to be transferred between the devices. Passive RFID tags are powered by the electromagnetic energy transmitted from the NFC-enabled device/reader. Consequently, it needs to be held close to the substrate to ensure that the radio waves are strong enough to power the tags. The card itself can be recycled because it contains no plastics. The ink and tiny silicon chip can easily be extracted before recycling. Furthermore, these Powercoat® paper inlays provide the perfect way to integrate printed electronic functions into plastics and other laminates, opening up a world of opportunities for new intelligent objects.

EMINT – VDMA Sector Association Electronics, Micro and Nano Technologies

Chip production starts with wafers made of single-crystalline silicon in clean rooms.

The sector association EMINT creates the framework for the effective use of technological innovations in the areas of electronics production as well as micro- and nanotechnologies. Furthermore, VDMA EMINT supports its member companies with the development of new business applications and new international markets.

Micro cameras in cell phones, magnetic fields and location sensors in game consoles, micro-pumps for insulin, and touch-sensitive surfaces are already available today. The "Internet of Things," video contact lenses, nanorobots, lab-on-a-chip, mentally operable prostheses, autonomous driving, and self-organizing production ("Industry 4.0") are demonstrated product developments with a high future market potential.

Fitting of the inner rotor for a micro annular gear pump

They all combine sensors, actuators, and wireless connections with data processing, power supplies, display systems and storage devices, and appear in two high-tech sectors: micro- and nanoelectronics as well as technologies. In the past, those two sectors developed side by side. In the present, however, they have increasingly merged. The magic word here is "system": It enables more miniaturization and creates increased product diversity.

VDMA EMINT – the organization

To take the merging of these two high-tech sectors into account, the VDMA (Mechanical Engineering Industry Association) founded the sector association Electronics, Micro and Nano Technologies in 2014 to gain synergies from the sector groups Productronics (electronics production) and Micro Technologies.

VDMA EMINT's members include more than 100 companies, most of which are located in Germany.

A broad range of applications

In the sector group Micro Technologies, member companies operate in the various markets for micro-products, test and measurement technology, specialized markets for micro-production equipment and machines as well as process technologies and systems. The birth of new disciplines in the microtechnology sphere made possible many new solutions to optimize processes that are responsible for increasingly precise production.

The sector group Productronics managed to unify equipment manufacturers for the entire electronics production process chain. Besides semiconductor chips and highly integrated electronic assemblies, this also includes photovoltaics, displays, data storage as well as batteries. The electronics industry offers a broad range of applications with varying requirements.

While microchips feature sizes in the nanometer range, power-plant generators require man-sized electronic components. Alternatively, automotive electronics require a much higher level of reliability and durability than consumer electronics with their extremely short product life cycles.

Micro component made from synthetic material

Networking – a component of success

To stay competitive and innovative, it is essential for companies to be well connected to their customer industries and research institutes. "Meet the end-user industry" and "Science meets reality" are the slogans of the member events organized annually in spring and the fall. Through these events, VDMA EMINT supports its members with a networking platform as well as fostering collaboration and the exchange of information between customer industries, research institutes and member companies.

Trends and market information

The "Internet of Things," bioelectronics or intelligent factories open new markets. Ongoing miniaturization not only opens almost immeasurable opportunities, but also involves new requirements of the manufacturing process. VDMA EMINT provides its members with the latest information about upcoming trends, emerging markets as well as new technologies for electronics production and microtechnologies.

Meeting production requirements

In order to meet manufacturers' production requirements in the future, it is necessary to constantly advance new technological developments. Therefore, working groups for Organic and Printed Electronics, Photovoltaic Equipment and Battery Production have been founded within VDMA over the last 12 years. Both sector groups and the sector associations are in close contact with the working groups OE-A and VDMA Photovoltaics Equipment as well as with the industry group VDMA Battery Production. Synergies and cross-sectoral issues are addressed in working groups – such as the OE-A Working Group Hybrid Systems – and at various events, like the annual spring and fall meetings of VDMA EMINT. Members of all of these organizations benefit from those joint activities.

VDMA contact

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Internet www.emint.vdma.org

Soldering machines finalize the assembly of components on printed circuit boards.

OE-A Member Profiles

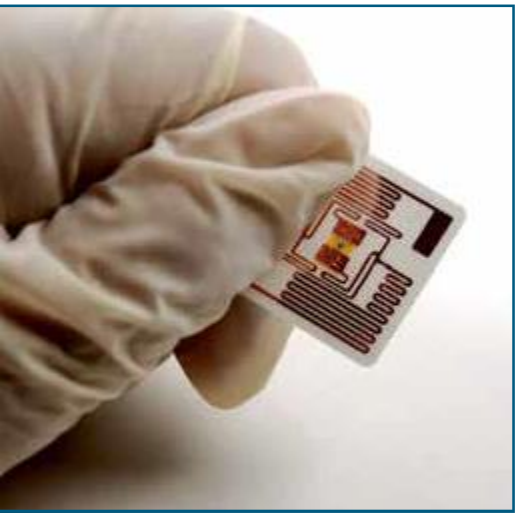
epresented OE-A Members

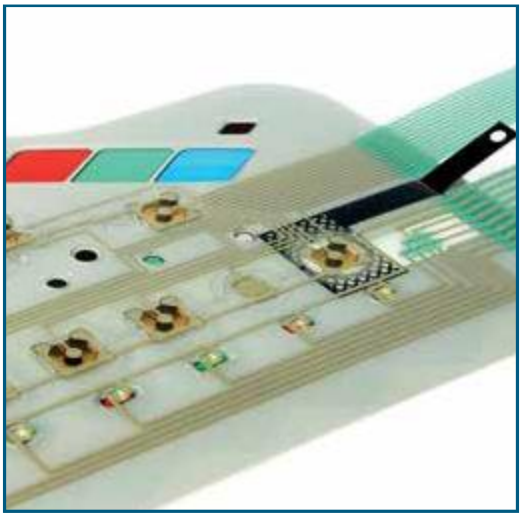
Companies

29 Alpha Assembly Solutions
3 Arjowiggins Creative Papers
31 BASF New Business
32 Bosch Rexroth
3 Brewer Science
33 BST Eltromat International
3 Carestream Contract Manufacturing
37 CDT - Cambridge Display Technology
3 Ceradrop
39 Coatema Coating Machinery
Cynora
1 Dowa HD Europe
2 DuPont Advanced Materials
3 DuPont Teijin Films
Elantas Europe
5 Erhardt+Leimer
Exakt Advanced Technologies
7 Fujifilm Dimatix
Genes'Ink / Kelenn Technology
9 Heraeus Deutschland
5 Kelenn Technology
51 Kroenert
52 Liquid X® Printed Metals
53 Merck
5 NovaCentrix
55 nsm Norbert Schläfli
5 PolyIC
57 Printed Electronics
5 Pütz Folien
59 Reisewitz Beschichtungsgesellschaft
SAES Getters
1 Saueressig
2 SmartKem
3 Sumitomo Chemical
SunaTech
5 Teknek
Thin Film Electronics
7 TSE Troller
Xenon Corporation

esearch Institutes & niversities

9 Aristotle University of Thessaloniki – LTFN
7 CEA LITEN
71 COPT Centre
9 CPI – Centre for Process Innovation
72 CSEM
72 CSEM Brasil
73 ENEA
73 Fontys University of Applied Sciences
7 Fraunhofer ENAS
7 Fraunhofer FEP
75 Fraunhofer IAP
75 Fraunhofer IFAM
7 Fraunhofer ILT
7 Fraunhofer ISE
77 Georgia Tech – Center for Organic Photonics and Electronics
77 Hahn-Schickard – Institut für Mikroaufbautechnik
7 Holst Centre
7 IK4-Cidetec
79 INM – Leibniz Institute for New Materials – Optical Materials
79 INM – Leibniz Institute for New Materials – Structure Formation
InnovationLab
IPC – Technical Centre of Plastics Engineering
1 Joanneum Research
1 Johannes Kepler Universität Linz – LIOS
2 MINES Saint-Étienne – Microelectronics Center of Provence
2 Munich University of Applied Sciences
3 pmTUC – Institute for Print and Media Technology
3 RISE Acreo
Tampere University of Technology
Technische Universität Chemnitz
5 Technische Universität Darmstadt
5 Technische Universität Dresden
University of Bordeaux – ELORPrintTec
University of Cambridge – EPSRC Centre for
Innovative Manufacturing in Large-Area Electronics
7 University of Novi Sad
7 University of West Bohemia – RICE
VTT – Technical Research Centre of Finland





Materials Innovation for Printed, Flexible and Formable Electronics

ALPHA is a leading global supplier of innovative electronic assembly materials. For over a century, electronics manufacturers have relied on Alpha for tailor-made materials and solutions.

Alpha is serving the flexible, formable & printed electronics segment through two broad market categories:

- Printed electronics / circuits on flexible polymer films where flexible circuits (conductors) and other circuit elements are additively printed on polymer films.

- Flexible PCBs for assembly of conventional devices and packages such as ICs, processors, MEMS, passives, etc. on circuited flexible substrates.

Printed electronics

- Conductive inks – Highly conductive silver (Ag) and lower-cost Copper (Cu) inks for printing fine circuit lines and features.
  Applications: membrane switches, RFID tags, smart packaging, heaters, sensors, etc.
- Graphene-based inks and pastes for environmentally benign applications.
  Applications: Antennas and Sensors.
- Stretchable conductive inks – Silver (Ag) based stretchable conductive, screen printable ink for interconnects.
  Applications: flex membrane switches, 3D molded interconnect devices, control panels, 3D-LED luminaires.
- Conductive adhesives – Low-temperature, screen printable and dispensable electronic adhesives.
  Applications: device/component attachment and reinforcement.
- Dielectrics & encapsulants – Low-temperature, UV and photonic curable, screen printable and dispensable dielectrics & encapsulants.

Flexible PCB's

- Solder pastes - Standard (SAC), low-temperature (SnBi) and very low temperature, fine-pitch, low-residue, stencil printable solder pastes.
  Applications: flexible PCB assembly.
- Reinforcing adhesives – Low-temperature & UV curable, fine-pitch stencil printable and dispensable adhesives for flexible substrates.
- Low-temperature sintering materials – Silver, nano silver, nano copper and other metals.

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A MacDermid Performance Solutions Business

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Phone + 1 908-791-3000 • E-Mail printedelectronics@alphaassembly.com
Internet www.alphaassembly.com

Powercoat® paper, the multi-award winning innovation from Arjowiggins, provides a smart way to integrate intelligent functionality into products we come into contact with every day. This includes paper objects such as packaging, event tickets, cards and magazines as well as more sophisticated applications and components including pressure sensitive materials, lighting, displays or secure and authenticated objects to name a few.
Powercoat® is a 100 % paper substrate with a microscopically smooth coating that creates the ideal surface for printing electronic circuits. It is recyclable, biodegradable and FSC certified, and thanks to its inherent paper qualities, it is lightweight and flexible and can withstand high temperatures without change in its physical properties making it easy to integrate into even non-paper end products. Discover the range:

POWERCOAT®

Powerful Paper for Intelligent Solutions

Conductive circuits printed on Powercoat® HD

Intelligent packaging made using Powercoat® ALIVE

Powercoat® HD paper has an ultra-smooth surface ideal for printing the most complex conductive circuits. It has been engineered to yield impressively high-precision patterning. It can withstand high temperatures in sintering – a key process for printing electronics, allowing a dramatic reduction in the amount of expensive conductive inks required for printing circuitry.

Powercoat® XD paper is designed for printing flexible circuitry in high volumes and is made to stand up to demanding production processes. It is the perfect solution if the surface smoothness of Powercoat® HD is not required.

Powercoat® Alive is an intelligent paper with embedded NFC technology. Powercoat® Alive comprises Powercoat® XD paper with pre-printed circuits and an embedded and unpackaged silicon chip on which data is stored. This sheet is then laminated using an aqueous glue between two sheets of our fine papers making for a seamlessly integrated chip. The result? An intelligent sheet of paper for printing connected objects using traditional graphic printing methods. ALIVE products are available on-demand for customized products or via a selected network of distributors for our ready-to-print standard graphic printing products.

Powercoat® Alive Adhesives is our Powercoat® Alive paper in adhesive form – either available on-demand or in a standard format measuring 37mm in diameter.

Powercoat® Smartcore is the latest addition to the Powercoat® family. This is our on-demand offer for incorporating intelligence into non-paper objects by embedding Powercoat® ALIVE paper inlays into plastics and other laminates opening up a world of opportunity for new intelligent objects for the automobile, medical or building and construction industries among many others.

arjowiggins

Arjowiggins Creative Papers
32, avenue Pierre Grenier • 92517 Boulogne-Billancourt • France
E-Mail info@powercoatpaper.com
Internet http://powercoatpaper.com

Bringing New Features to Electronics

BASF's portfolio of Printed Organic Electronics inks enables the fabrication of organic thin film transistors (OTFT) for backplanes of truly flexible displays as well as for paper-thin circuitry applicable in smart packaging, labels, sensors or other innovative products.

Employing our experience in material design, ink formulation and process development, we offer a variety of ready-to-use inks based on organic semiconductors, dielectrics and auxiliary materials (e.g. for passivation or planarization layers, interlayer dielectrics, SAM) as well as predefined ink packages for OTFT production.

We support you in the optimization of your devices and printing processes. Our technical experts tailor ink packages to meet customer-specific process and application requirements.

Versatile inks for a variety of applications
With BASF's high performance Printed Organic Electronics inks, OTFTs can be produced by using well-established processes such as spin or slot-die coating, and gravure, off-set or ink jet printing. Our materials do not require high temperature steps like annealing or sintering – as needed for inorganic materials – allowing much more freedom of choice for substrates and materials for surrounding layers. Our inks can be applied on flexible and super-thin substrates. Shapes, sizes and forms can be freely selected.

Our semiconductors show mobilities of 0.5 – 2 cm /Vs combined with a large on/off ratio and therefore already meet the technical requirements of backplanes for EPD (electrophoretic display) and LCD applications. We are developing solutions for OLED display backplanes as well. Our unique product range includes matching p-type and n-type semiconductors for CMOS applications. BASF`s inks can be used in top or bottom gate configurations and on various substrates.

BASF New Business GmbH leads BASF's activities in Printed Organic Electronics
BASF New Business GmbH is a wholly-owned subsidiary of BASF SE, the world's leading chemical company. Operating globally, the company aims to create forward-looking business with above average growth rates that goes beyond BASF`s current activities.

BASF
We create chemistry

BASF New Business GmbH • Benckiserplatz 1 • 67059 Ludwigshafen • Germany
Phone +49 621 60-76811 • E-Mail printedelectronics@basf.com
Internet www.basf-new-business.com

Bosch Rexroth is one of the world's leading providers of drive and control technologies. Regardless of the automation or motion task that customers face anywhere in the world, they will always find a Bosch Rexroth team with the local experience and the know-how from more than 30 industries.

Bosch Rexroth AG – Your Automation Partner for Flexible and Printed Electronics

Our associates take on their customers' challenges with passion until the right solution is found. This is what makes us a strong, reliable partner in the market segments of mobile applications, machinery applications and engineering, and factory automation to develop innovative components as well as tailored system solutions and services.

Bosch Rexroth has always been quick to discover and promote future technologies and developments. Accomplishing the new tasks in the areas of organic and flexible electronics requires solid know-how in two sectors of industry: printing and electronics manufacturing. Bosch Rexroth has acquired many years of valuable experience in both application areas and is therefore familiar with the processes in the electronics manufacturing industry and the traditional production processes used by the printing industry.

For many years, our flexible linear motion technologies are being applied for moving substrates during deposition processes of solar cells and flat panel displays. The substrates are moved smoothly and accurately under particle-free vacuum conditions.

Our roll-to-roll technologies and know-how have been applied in many ambitious projects at several research institutes where accuracy in web handling control is challenging.

Specialized technologies for rapid and accurate placement processes from electronics manufacturing are being applied for flexible and hybrid electronic applications.

As the drive & control company, the company develops, produces, and distributes its components and systems in over 80 countries. With a product portfolio that includes all technologies as well as a comprehensive offering in service and support, Bosch Rexroth sees itself as an expert partner for the complete machine life cycle. In 2015, Bosch Rexroth achieved sales of close to 5.4 billion Euros with its nearly 31,100 associates.

Rexroth
Bosch Group

Bosch Rexroth AG • Bgm.-Dr.-Nebel-Str. 2 • 97816 Lohr • Germany
Phone +49 9352 18-0 • E-Mail info@boschrexroth.de
Internet www.boschrexroth.com/plastic-electronics

CompactGuide with WideArray Sensor


Web Guiding with CompactGuide


Line and Contrast Sensor CLS Pro 600 for Web Guiding

Web Guiding Systems for Maximum Precision

Functional printing, printed electronics or advanced films – those are just a few examples of products that are manufactured by roll-to-roll processes and impose particularly high demands on the precision of web guiding. In this field, innovative solutions from BST eltromat International are capable of coping with any task.

The range of web guiding products is likewise based on this practical experience, giving customers a choice between eco versions, basic systems and high-end solutions – all of which can be adapted to specific tasks by the company's specialists, should the need arise.

Tried-and-tested web guiding systems, particularly for narrow-web processes
CompactGuide, the modular, upgradeable compact web guiding system, is an ideal solution for narrow material webs, such as are customary in the production of flexible packaging, printed electronics or advanced films, for example.
Six sizes, with web widths of up to 750 mm and for web tensions of up to 600 N, mean flexibility for all your production requirements.

Which sensor or which camera, and when?
From ultrasonic sensors and optical sensors, line and reflection sensors, and also line scan cameras, all the way to wide-array sensors with particularly wide coverage – the BST eltromat product range includes sensors for virtually any demand on web guiding. Which sensors are used in a particular instance depends on the materials used, the fields of application, and the environmental conditions.

BST eltromat International
has been developing innovative solutions for web guiding since 1979. It was as long ago as then that the company committed itself to professional competence in matters of quality assurance in connection with moving webs. In the course of the decades, this has given rise to a comprehensive portfolio of efficient, productive solutions for dealing with widely differing demands on web guiding, offering customers a choice between eco versions, basic systems and high-end solutions – that are adapted to specific tasks by the company's specialists, should the need arise. Web widths ranging from 10 mm all the way to 5 m are covered by BST eltromat.

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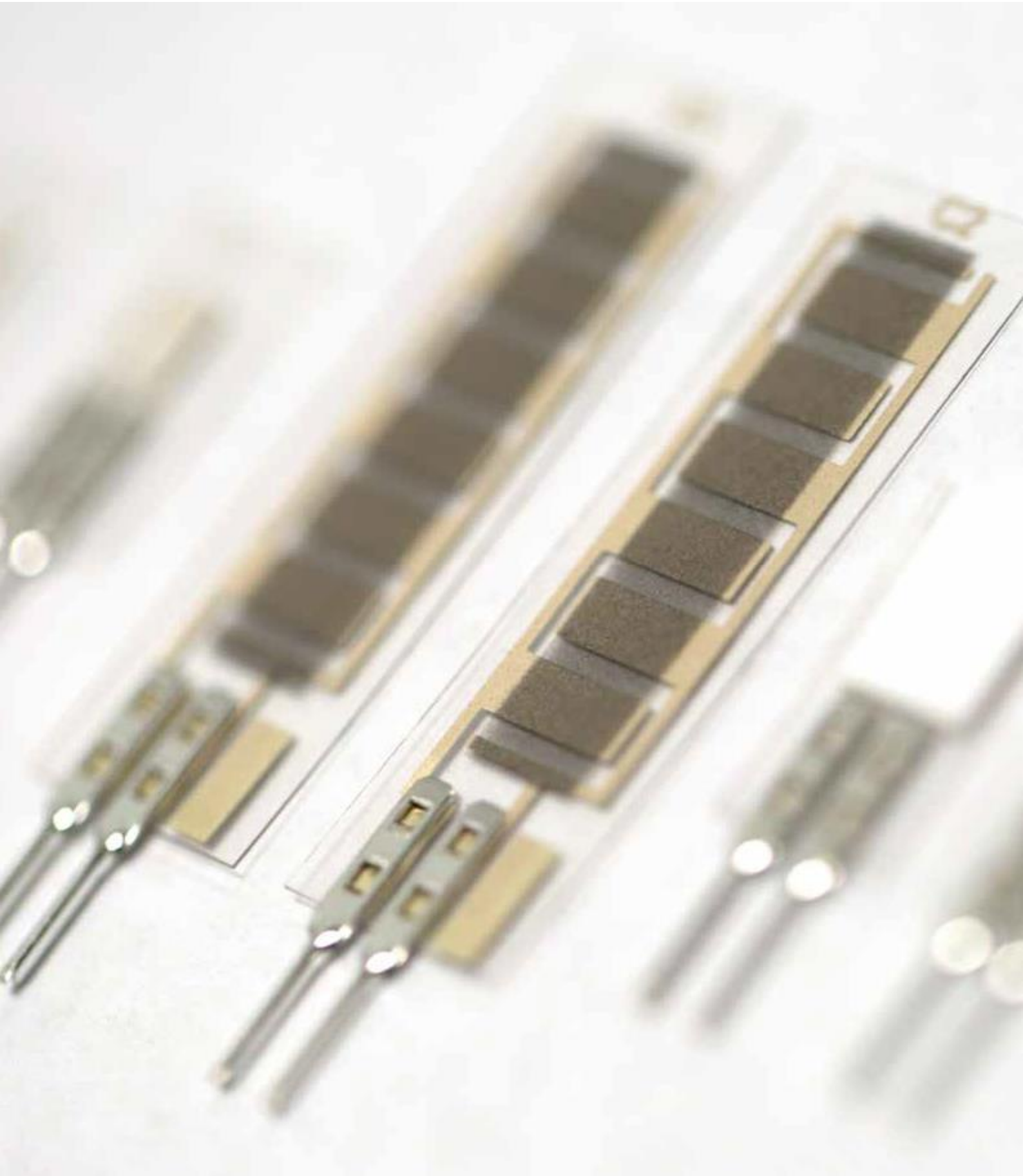
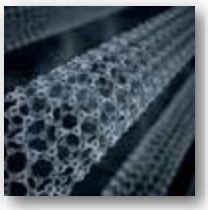
Brewer Science is Your Partner for the Future



Founded in 1981, Brewer Science is known as an innovator and manufacturer of leading-edge materials and processes used in the semiconductor and microelectronics industry. Under the leadership of Dr. Terry Brewer, founder and president, Brewer Science is recognized as the inventor of anti-reflective coatings (ARC® materials), which resulted in a revolution in the global microelectronics industry and ushered in today's high-speed, lightweight electronic devices.

Today, Brewer Science creates, develops, and manufactures specialty materials and process solutions for applications in semiconductors, advanced packaging/3-D ICs, MEMS, sensors, displays, LEDs, and printed electronics.

Devices with unique materials and design that enable viable resource monitoring for enhanced quality of life.

Brewer Science is pleased to unveil a new realm of sensor performance technology utilizing our revolutionary carbon-based nanotechnology. This sensor technology is so advanced that it enables the delivery of highly sensitive and real-time response to small changes in the environment. The InFlect™ sensor solutions can be the pivotal point allowing users to know the exact instant a change happens, which can mean the difference in operating at full capacity or having to change processes to accommodate mishaps.

In addition to their real-time response, Brewer Science's sensors have a flexible form factor, which sets the stage for easy integration with existing sensing technology. You can take monitoring to the next level with Brewer Science InFlect™ sensors.

- InFlect™ moisture sensor
- InFlect™ thermistor
- InFlect™ flex sensor

The unique carbon nanotechnology design allows Brewer Science sensors to detect a change within milliseconds, at or less than 250 milliseconds to be exact. Brewer Science has developed the InFlect™ sensor platform to equip customers with the ability to fit all their needs in a variety of applications.

- Agriculture
- Environment
- Laboratory
- Process industries
- Safety & security
- Wearables

Brewer Science's in-depth knowledge and expertise in materials science, chemistry, physics, optics, modeling, nanotechnology, and process integration distinguish Brewer Science from all other material suppliers worldwide, which enables customers to succeed. Brewer Science provides technology and product solutions to complex technical problems.

For more information about Brewer Science devices with unique materials and design that enable viable resource monitoring for enhanced quality of life, email us at sensors@brewerscience.com or visit Brewer Science's website at www.brewerscience.com.

brewer science

Brewer Science, Inc. • 2401 Brewer Drive • Rolla, Missouri 65401 • USA
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Internet www.brewerscience.com

Carestream Contract Manufacturing – Custom Coating Services

Carestream Contract Manufacturing offers roll-to-roll contract coating services for a wide range of organic and printed electronics products. We deliver multi-layer coating expertise, combined with exceptional rapid prototyping capabilities, to help customers take products to market quickly and efficiently.

Cost-Effective, Precision Roll-to-Roll Coating
High-precision, roll-to-roll solution coating is a cost-effective approach for incorporating advanced material formulations into many organic and printed electronics products. We develop optimal solutions to our customers' coating challenges, and deliver top quality and process economics for demanding electronics applications.

Carestream provides product design, technology integration and manufacturing support to produce a variety of functional films, including polyurethane, silicone, acrylics, adhesives, OCA's and more. We can create structures of up to 20 precision-coated layers in a single pass, with options for two-sided coating, radiation cure, on-line inspection and lamination.

Clear hardcoat film example
Carestream's crystal-clear, super-hard polymer film coating imparts a durable, scratch-resistant surface that looks and wears like glass when adhered to any product surface. The clear hardcoat is available as a coated PET, PMMA or PC film in 5 mil. (125µm) and 7 mil. (175µm) thicknesses. Typical applications include touch screens, consumer product glass replacement, among others.

We can cost-effectively move your complex electronics products from concept to full production. Visit us at: **www.tollcoating.com**




Carestream
Contract Manufacturing
Precision Custom Coating Services

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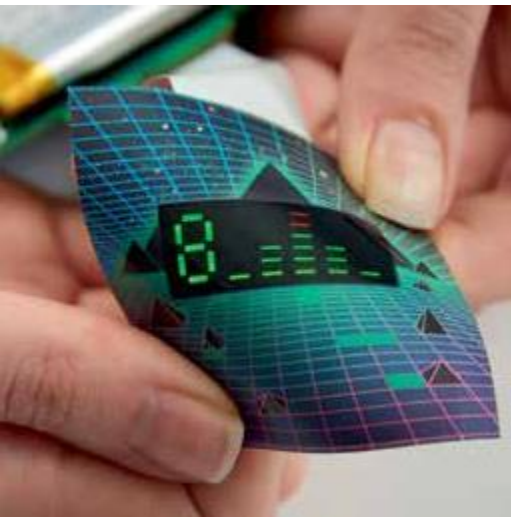

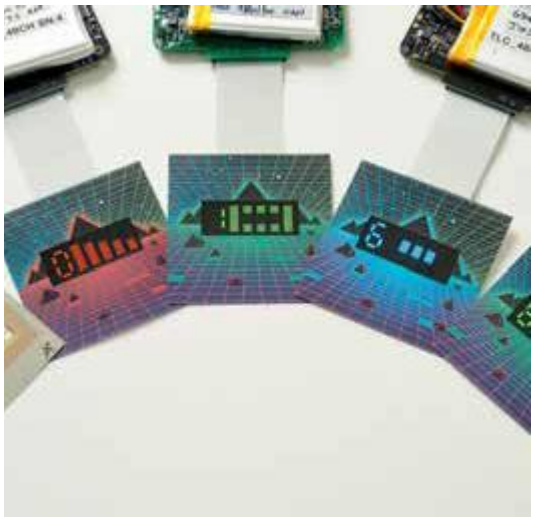

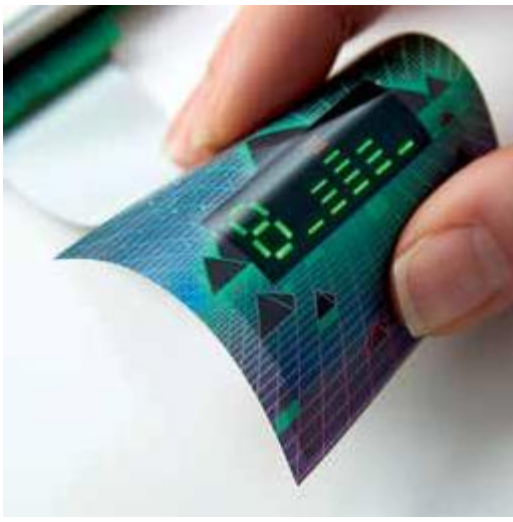

Leading Printed Electronics Materials and Device Technology Company

CDT Ltd is part of the Sumitomo Chemical Company Group (SCC) and is SCC's European Research Centre, actively engaged in developing materials and device technology in the field of Printed Electronics. The research and development carried out at CDT is application focused and often conducted in partnership with other companies, including SCC and research institutes. Commercialisation of technology developed by CDT is carried out by SCC & other SCC group companies. We are currently developing the following technologies: OLED lighting; low-cost flexible displays (FlexOLED); organic photodiodes (OPD); Near-infra-red OLED; biosensors for point of care and agriculture applications; flexible hybrid supercapacitor/batteries and organic thermoelectric generators for energy harvesting.

We have developed an air-processable electron injection material that can be used with Al or Ag cathodes, resulting in simple displays that are < 0.3 mm thick, flexible, with operating voltages of < 5 V and efficiencies similar to standard OLED devices (see images). Shelf and operating lifetimes are sufficient for a number of applications such as games, wearables and small appliances and we are working on further improvements for large appliances (white goods). Monochrome and multi-colour displays can be fabricated using a variety of printing technologies and the simple fabrication process lends itself well to roll-to-roll manufacturing. This technology, coupled with organic photodiode technology, can also be used for a variety of further applications such as pulse-oximetry and bio-sensors.

In partnership with our parent company, SCC, we have developed a range of light absorbing materials that can be used to produce high efficiency (EQE) organic photodiodes (OPDs). The EQEs realised are similar to silicon photodiodes with the advantage that they can be printed to any size or shape required. We have been developing materials and devices with specific markets in mind. For X-ray imaging, a very low dark current is required. SPV001, which has a cut off absorption at 900 nm, we can meet X-ray specifications. We have also demonstrated that this technology, coupled with our red and infra-red emitters, can be used in applications such as pulse-oximetry.

C|D|T

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CeraPrinter F-Serie
All-in-one State-of-the-art digital materials deposition platform

Industrial platform
Flexible inkjet printing solutions from R&D pilot line to high-throughput 24/7 manufacturing

Flexible Digital Printing Solutions for PE and Smart 3D Printing

CERADROP, a MGI Group company, designs and markets advanced materials deposition digital printers exclusively for printed electronics industry and smart 3D printing. The CeraPrinter Series models are high-accuracy digital multi-material deposition systems combining Inkjet and Aerosol Jet® technologies, with in-line curing technologies, in-situ characterization facilities, driven by an exclusive software suite. This enables the users to go quickly from design to functional components printing together with wide range of services: strong partnership, maintenance, upgrade, and process development assistance worldwide.

Major products

CeraPrinter X-Serie is a turnkey materials deposition inkjet tool for process development. Thanks to its patented rotative head holder "plug and play", full curing area, in-situ characterization devices and exclusive software suite, the CeraPrinter X-Serie is a perfect "all-inclusive" tool for advanced inkjet process development.

CeraPrinter F-Serie is all-in-one state-of-the-art digital materials deposition platform for process development. In addition to all the CeraPrinter advantages, the F-Serie is a hybrid materials deposition platform combining Inkjet and Aerosol Jet® technologies. Its single user-friendly software opens the way to study hybrid processes inaccessible by Inkjet or Aerosol Jet® separately, enabling its users to achieve the highest goals.

Industrial platform

Flexible inkjet printing solutions from R&D pilot line to high-throughput 24/7 manufacturing. All CERADROP features on industrial scale: large format, single pass, high throughput (several m²/min), multi-substrate (rigid, flexible), multi-material, multi-curing technologies (IR, NIR, UV, photonic).

Advantages

- State-of-the-art digital materials deposition platform
- Hybrid process development with Inkjet and Aerosol Jet®
- Turnkey digital solutions for dedicated applications
- From R&D to 24/7 manufacturing equipment
- Worldwide support

Market served

CERADROP considers among its customers: public or private R&D laboratories, centers for technology transfer, 1st industry adopters and high-volume 24/7 manufacturers from all over the world.

CERADROP • 32 rue de Soyouz • Parc d'ESTER • 87068 Limoges • France
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Coatema offers mechanical engineering and R&D for coating, printing and laminating plants for R2R and S2S applications. For almost 40 years Coatema has been delivering solutions to a wide range of markets. Coatema offers lab units, pilot plants and entire turn-key production solutions for coating, printing and laminating of flexible or rigid substrates.

Coatema Offers Lab and Production Plants for Organic and Printed Electronics

Since more than a decade plants for the development and production of organic and printed electronics belong to Coatema's product portfolio. The combination of conventional coating technologies and the targeted use of electronic functions are made possible by units from Coatema. The competence of covering the entire spectrum is made obvious by 2 plants: the Smartcoater and the PrintoCent Production Line, which was inaugurated in Finland in 2012.

The Smartcoater is a compact and multifunctional small-scale coating unit with various application systems. Complex products can be produced with a working width starting at 100 mm, a wide range of coating applications and production speed with a minimum use of substrate and chemistry. The base unit offers a 5-in-1 coating module with slot die, knife, dipping (foulard), micro-roller and engraved roller. In addition other modules are being added rapidly including: screen printing; flexo printing; UV spraying and others.

In comparison, the PrintoCent Production Line appears enormous: it includes as inline process on two floors all needed printing, coating and other steps to manufacture large area printed electronic devices. This allows a R2R mass production from lab to fab. Built by Coatema in close cooperation with VTT who established PrintoCent the line is equipped with interchangeable printing and coating units: gravure and reverse gravure, rotary screen, flexography and slot die. Additional processes such as hot embossing, plasma treatment, lamination, rotary die cut, hot air drying and UV crosslinking as well as an automatic registration are included. The line with a working width of 300 mm and running with an operation speed of up to 30m/min.

A wide variety of Coatema equipment offers the following processes for Large Area Printed Electronics: Web Treatment, Etching, Printing, Coating, Laminating, Nano Imprinting, Hot Embossing and Laser Patterning.

Coatema® Coating Machinery GmbH

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TADF materials for OLED

CYNORA GmbH is a leader in TADF (thermally activated delayed fluorescence) technology for OLED products. The company's focus is on highly efficient emitting materials which will enable a significant reduction in power consumption of OLED displays.

Emitting materials with TADF technology
CYNORA's efficient TADF emitting materials are developed to enhance today's top-of-the-line displays further:

- reduced power consumption
- higher display resolution
- Iridium-free materials
- designed for existing vacuum processes
- adaptable for future printing technology

Unique technology protected by IP
CYNORA has a broad IP portfolio covering the innovative TADF technology. The company has now filed more than 100 patent families and is aiming for over 600 patents.

Ensuring customer fit
CYNORA's material development includes simulation, synthesis, analytics and device fabrication. The internal material design is based on customer feedback and stack adaptations. This efficient approach ensures a fast progress towards the best material set for the customer.



CYNORA

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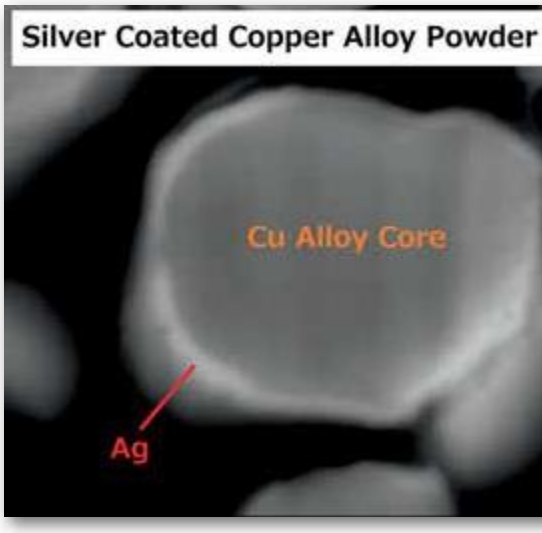
DOWA is a Japanese smelter and DOWA Electronics Materials is an established manufacturer of various materials such as silver/copper/zinc/iron powder for electronic device and semiconductor wafer/LED, with an annual revenue of about USD 4.1 billion. We focus on new functional materials, nano-size particles, silver-coated alloy powder (copper zinc/copper nickel zinc) for printed electronics.



DOWA Can Provide the Functional Materials You Need!

What is DOWA
DOWA HD Europe GmbH is the member of DOWA Holdings Co., Ltd. (Japan). Our main activity is to promote the products of DOWA HD and to expand the business region in Europe. DOWA HD supplies materials and services in a broad range of businesses, including nonferrous metals, environmental management & recycling, electronic materials, metal processing and heat treatment which enhance the quality of life.

DOWA was founded in 1884 as a smelting company. Since its foundation, the enterprise has made a transition to higher technologies. Especially, DOWA Electronics Materials Co., Ltd. supplies semiconductors, conductive materials and magnetic materials which are all based on nonferrous metals.

Functional powder materials technologies
Functional powder materials technology is one of our competencies. To design the particles and manufacture at lower cost are our competitive goals. For particle design, we can control not only size (nm / µm), shape (sphere, flake and agglomeration) but also surface treatment (hydrophilic or hydrophobic). And we can provide silver, copper, zinc and alloy powders.

In addition, in terms of manufacturing methods, we apply both wet and dry systems to manufacture powders in mass production. We are trying to realize printed electronics more competitive and developed worldwide in the near future.

Technology scouting
For the printed and organic electronics industry, it is necessary to integrate some elemental technologies. For example functional conductive ink, the elements of materials, formulations and printing methods are necessary to be merged, while the properties of conductive ink strongly depend on processing and applications.

From this point of view, we recognize that we should find potential partners to make technological collaboration with or even offer financial support as well.

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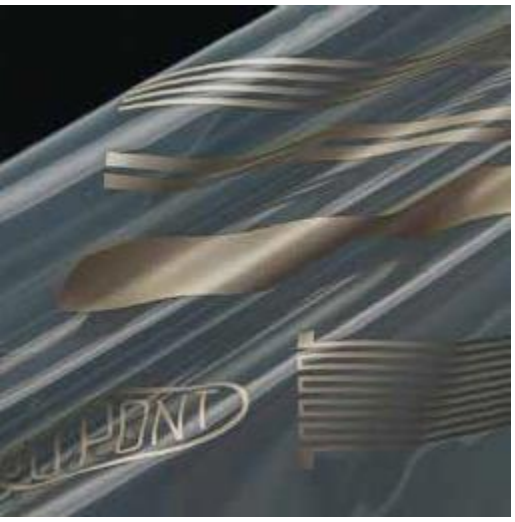

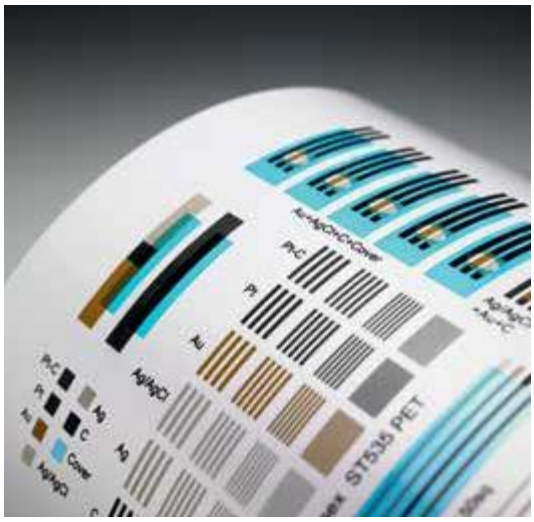

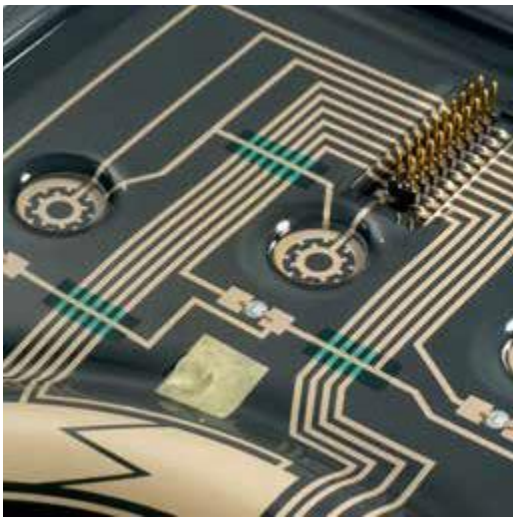

Innovative Functional Inks for Printed Electronics

DuPont has been a major supplier to the printed electronics industry for more than 50 years, becoming a global leader in low-temperature curing inks for flexible substrates. A science-based company with a broad technology base and global presence, DuPont enables advanced printed electronics applications with an expanding range of new, innovative products.

- **IN-MOULD ELECTRONICS** – A new range of conductive and dielectric inks that are designed to survive the intense stretching and heat of the thermoforming and injection moulding processes. These can be used to construct true 3D circuits with capacitive switches and LED lighting for applications such as controls in automobiles and domestic appliances.
- **SMART PACKAGING** – Low-temperature curing inks for printing functionality on packaging materials with lower temperature tolerances such as PVC and polyolefins.
- **RFID** – High-conductivity silver compositions for printing HF and UHF antennae. New copper and alloy compositions have been introduced ensuring a cost-effective solution.
- **LIGHTING** – New highly conductive nano-Ag inks suitable for OLED lighting bus and grid lines. Also a range of inks for fabricating LED circuits, including an interconnect silver, a solderable conductor and a flexible white solder mask.
- **WEARABLES** – A complete suite of electronic ink materials enabling a manufacturing-ready approach to deliver superior comfort and functionality for smart clothing and other wearable electronics. These inks are designed for exceptional stretch performance and endurance through multiple wash cycles.
- **PHOTOVOLTAICS** – Silver grid and bus bar materials for current collection in flexible thin film, organic and perovskite photovoltaic cells.
- **BIOMEDICAL SENSORS** – Silver/silver chloride, gold, platinum and carbon screen formulations for highly stable electrode systems for applications such as blood glucose sensors, ECG patches and other point of care devices.
- **TOUCH PANELS** – Fine line screen and ink jet silver compositions for grid lines and bus bars with good adhesion to ITO.
- **FLEXIBLE HEATERS** – New DuPont™ Kapton™ inks for high-temperature heater applications, PTC carbon for self-limiting heater applications.

DuPont Advanced Materials •
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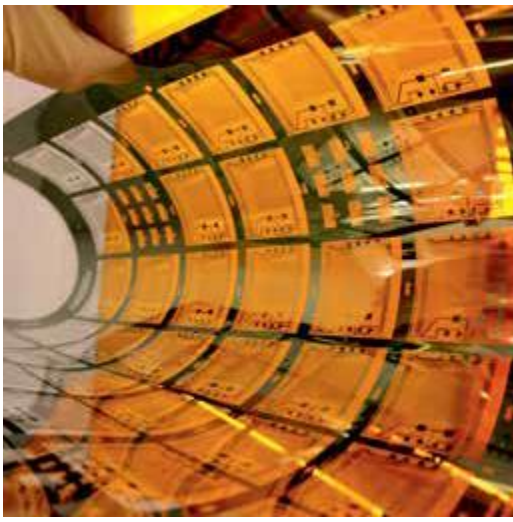

Innovative Film Solutions for Flexible Electronics Applications

DuPont Teijin Films is a world-leading manufacturer of high-performance PET and PEN polyester films for flexible and printed electronic applications.

The trusted brand

Melinex®, Mylar® and Teonex® brands are the substrates of choice for precise registration and dimensional control. Our wide range of stabilised films are strong and flexible with excellent resistance to heat, abrasion, chemicals and moisture.

Continuous innovation

DuPont Teijin Films has supported the emerging flexible electronics market since its inception, and has listened to technology developers to understand the characteristics required for flexible, polymeric substrates.

A range of new innovative films are available to support this growing market area and Melinex® PCS is the latest of these developments, designed to offer a near defect-free surface for the deposition of organic and inorganic barrier materials.

The Melinex® TCH series of polyester films combine low bloom properties and index-matched coatings to achieve superior optical clarity, for use in touch sensor applications utilizing indium tin oxide (ITO) and alternate transparent conductor materials.

Teonex® PEN films are a high performance extension to the existing range of Melinex® and Mylar® PET film products and bridge the gap between price and performance for polyester and other polymeric substrates. PEN films give excellent dimensional control and improved hydrolytic stability for applications requiring exposure to extreme heat or harsh chemicals.

DuPont Teijin Films is at the forefront of innovation and future developments.
Our films are already key components in devices used in our daily lives.
We are now inventing new films for the products and markets of tomorrow.

DuPont Teijin Films

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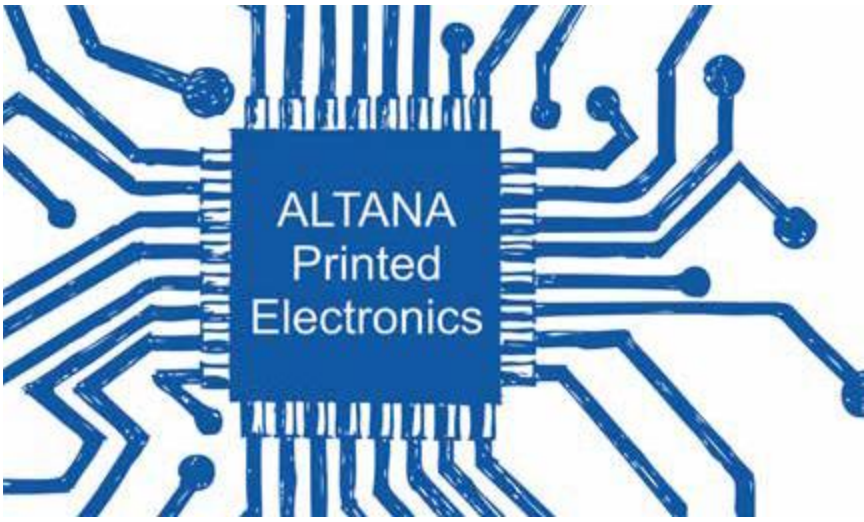
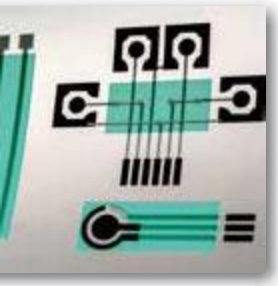
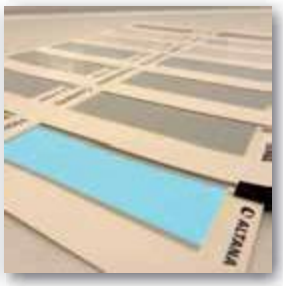
ALTANA Printed Electronics is a business line of ELANTAS Europe and offers excellent products for printed electronics combined with personal service to push forward your printing capabilities. Our product portfolio includes conductive, insulating and functional screen printing inks for applications such as membrane switches, functional surfaces, hybrid electronics, sensors, antennas and electroluminescent lighting.



One Solution – Functional Inks and Service





Your added value
We provide support for your tests and carry out printing and characterization services in our laboratory according to your specifications. Our technical service would be pleased to accompany you on site.

Competencies
At our site in Hamburg, Germany, we have comprehensive equipped R&D, printing and testing laboratories. We develop and formulate inks and coatings by using various stirring and mixing methods. Printing and curing (UV or heat treatment) of inks and coatings can be made under clean room conditions. We have the capability to manufacture conductive and insulating test sheets as well as electroluminescent devices. We can provide comprehensive characterization of substrates, thin-film layers and devices, with e.g. surface analysis, electrical, optical and mechanical testing methods. Moreover, environmental stress tests, e.g. water and oxygen permeability determination, climate stressing, temperature cycling and salt spray test can be established.

About ALTANA
ALTANA is a global leader in true specialty chemicals, with its headquarters based in Wesel, Germany. The group offers innovative, environmentally compatible solutions for coating manufacturers, paint and plastics processors, the printing and packaging industries, the cosmetics sector and the electrical and electronics industry. The product range includes additives, special coatings and adhesives, effect pigments, sealants and compounds, impregnating resins and varnishes, and testing and measuring instruments.

ALTANA's four divisions, BYK Additives & Instruments, ECKART Effect Pigments, ELANTAS Electrical Insulation, and ACTEGA Coatings & Sealants all occupy a leading position in their target markets with respect to quality, product solution expertise, innovation and service.

ELANTAS
Electrical Insulation

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Phone +49 40 78946-0 • E-Mail AdvancedPrinting@altana.com
Internet www.altana.com • www.elantas.com

High-Precision Positioning Processes and Quality Assurance for the Production of Printed Circuits

Erhardt+Leimer is one of the world's leading suppliers of control and inspection systems for moving webs and belts. At the core of the company's broad portfolio of products are positioning systems, solutions for web tension control and measurement and inspection systems that can be individually adapted to the various applications of our customers.

ELGUIDER
Positioning systems with the highest precision
In conjunction with a huge selection of very different position sensors, the pivoting frames in the ELGUIDER series enable high-precision positioning of the substrates that are to be printed.

ELTENS
Web tension control
Accurate positioning of the substrates also requires precise control of the web tension. Erhardt+Leimer offers tailor-made solutions for this with the load cells and closed-loop controllers in the ELTENS product family.

ELSIS
Monitoring of surface quality
The ELSIS surface inspection system is used for quality control and process optimization during the production of printed circuits. The camera system comprises all data interfaces for optimal integration in production and IT systems

ELTIM
Ultrasonic measurement of layer thickness and coating weight per unit area
The ELTIM measuring system offers quality control via ultrasound. It allows a precise measurement of the individual layer thickness with a measuring accuracy of 0.5 % to 0.2 % – even in combination with other substrates. Precise substrate mixture specifications or repeated calibration will lead to even better values. As well as point-based, traversing measurements, it is also possible to perform a 100% measurement over the entire web width.

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Defined, consistent and reproducible: Fulfilling the functional requirements in pastes, coatings and inks used for organic and printed electronics is of utmost importance. EXAKT Three Roll Mills (TRM) guarantee best results in the dispersing process.

EXAKT Three Roll Mills – Dispersing and Analyzing in the Production Process of Functional Materials

The increasingly diverse applications of organic and printed electronics require ever new formulations of high quality pastes, coatings and inks. Regardless of the particular functional needs, a basic requirement of all matrixes is elimination of oversized particles of a defined size and a narrow particle size distribution. In particular, the measurement of the particle size is problematic and time consuming in daily practice. Controlling this parameter in the dispersing process is of utmost importance.

The process advantages of EXAKT TRM result in the ability to precisely control the shear rate in the deagglomeration process as well as the ability to accurately reproduce production settings. The shear rate is defined by the µ-precise setting of the roller gaps and the circumferential speed of the rollers. The principle of this dispersion process guarantees that 100 % of the product will be dispersed at exactly the same physical conditions. In addition, EXAKT TRM are able to process much higher concentrations than is possible with other common dispersion devices, e.g. dissolver or agitator bead mill.

A unique feature of our new generation of electronically controlled TRM systems is the possibility to analyze the dispersion process during production. Due to the continuous measurement and recording of the forces, different temperatures, gap settings, power and speed, a detailed analysis of the process is possible. Based on the realtime on-screen graphical analysis, the dispersing process can be optimized on the run and the production process itself can be perfectly documented and reproduced.

EXAKT TRM are commonly used in R&D and production to disperse coatings, inks or pastes used for batteries, capacitors, solar cells, fuel cell anode/cathode, flexible displays, sensors and many other electronic components.

EXAKT is engaged in various research projects and organisations. The continual participation in e.g. ZIM or BMBF supported research projects and our active participation in organizations, such as oe-a or NanoCarbon, are further reasons for our technological leadership.

EXAKT
precision matters

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Dimatix Materials Printer DMP-2850 Drop-on-Demand Inkjet Deposition and Fluid Development Platform

The DMP-2850 is a versatile system for inkjet deposition development. Building on the established DMP-2831, the DMP-2850 provides improved performance and functionality and features an integrated PC with Windows 8.1. Remote control, diagnostics and update of the system are among the new features available with a ReST API. Two cameras, gigabit Ethernet devices with improved resolution, permit inspection/pattern registration and a drop watcher facility. The system allows the deposition on substrates up to A4 size and utilizes a disposable piezoelectric cartridge featuring 16 nozzles. Print patterns can be created using the editor program provided or derived from images to create complex structures. Precise motion control (25um resolution) coupled with a fiducial camera and software alignment tools enable accurate registration to predefined structures.

In addition to printing, the drop watcher adds the capability to characterize and develop jettable materials. This permits examination of drop formation and progression from each of the printhead's nozzles. A graticule enables drop quality, trajectory and drop speeds to be calculated easily. Simultaneously, real-time control over the electronic drive signal supplied to the printhead allows users to explore fluid jetting properties, understand its suitability for inkjet deposition, and establish conditions for printing. The cartridge drive system allows each jet's drive to be adjusted to obtain drop firing consistency across the head for accurate placement.

To accompany the launch of the DMP-2850, FUJIFILM Dimatix SAMBA inkjet technology is now available in a new cartridge compatible with DMP systems. SAMBA brings the benefits of silicon MEMS to piezoelectric inkjet deposition technology: resistance to mechanical abrasion, robustness to chemical attack and high frequency response. This unique combination enables deposition of a wide range of materials, such as metallic conductive inks, organic light emitting materials and semiconductors, dielectrics and biological materials. In unifying the jet design of the DMP cartridge with that of the 2048 nozzle SAMBA printhead, FUJIFILM Dimatix provides a path from R&D to manufacturing for a wide range of applications.

FUJIFILM Value from Innovation

Dimatix

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Internet www.dimatix.com

Make Inkjet Printed Flexible Electronics an Industrial Reality

Clearsilver is an industrial solution made by KELENN Technology and Genes'Ink for the manufacture of flexible and transparent conductive film to replace ITO.

Indium Tin Oxide (ITO) is the main material used for transparent conductive films (TCF). These films have significant drawbacks such as fragility, indium depletion and high manufacturing cost.
Our flexible and transparent conductive film is an innovative solution based on conductive patterned grid using industrial inkjet printer and conductive inks.
Our TCF shows a unique combination of conductivity (< 10Ω/sq), transparency (> 90%), flexibility and low roughness (< 5nm).
Our TCF are used for the manufacturing of OPV, OLED lighting and touch screens.
Our industrial solution is also used for the manufacture of flexible printed circuits on plastic foils.

KELENN Technology
KELENN Technology creates innovative and scalable manufacturing technologies related with digital additive methods such as inkjet deposition and contactless dispensing to Large Area Electronics. First Industrial stand-alone machines, mastering inkjet printing of highly conductive silver nanoparticles with photonic sintering, have been introduced to the printed electronic market (see profile on page 50).

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Genes'Ink
Genes'Ink is a worldwide leader in advanced materials and formulations supplier for the printed & flexible electronics market. Our conductive and semi-conductive inks bring competitive advantages to industries looking for thin and flexible devices along with outstanding electrical performances.

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13790 Rousset, France
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E-Mail contact@genesink.com
Internet www.genesink.com

Heraeus Conductive Polymers Clevios™: Conductive, Transparent and Flexible Polymers

Delivering innovation
As the team that invented PEDOT:PSS, Heraeus Conductive Polymers stands in a unique position in the development, production and delivery of commercially available Clevios™ conductive polymer materials and formulations for electronics. Clevios™ PEDOT:PSS – poly(3,4-ethylenedioxythiophene) – poly(styrenesulfonate) products start with antistatic Clevios™ P and go through to highly conductive Clevios™ PH1000 (1000 S/cm or approx. 150 ohms/sq). The range also includes Clevios™ hole injection materials. Conductivity, flexibility, transparency and "ease of use" permit a broad range of applications in electronics.

Printable conductivity
All Clevios™ PEDOT:PSS products are printable. Formulations such as Clevios™ FE-T and SV4 can be printed to <100 µm line width and to <200 Ohm/sq. Printing methods include slot-die, gravure, screen, and ink jet, as well as spraying, dip and spin coating.

Flexible touch screens
Flexibility and durability are intrinsic properties of Clevios™ products, that can be coated onto substrates such as PET, polyimide, polycarbonate and paper. Clevios™ is an enabler of foldable, bendable, and rollable electronic devices and offers major opportunities in future touch technologies. Clevios™ is compatible with photolithographic processes, e.g. dry-film resist, or can be patterned simply by laser. Clevios™ etch technology has been developed to create patterned films that are invisible to the human eye. Clevios™ HY hybrid materials are the latest addition to the Clevios portfolio, bringing together the best of AgNW and conductive polymers to enhance performance and possibilities for new flexible electronics devices.

OLEDs and solar cells
Clevios™ water and solvent-based hole injection (HIL) and transparent electrode and planarization materials are offered for OLED display/lighting and organic solar cells. Clevios™ HIL-E, which combines HIL and electrode properties, has been developed for flexible OLED lighting. Optimized formulations for OPVs, such as Clevios™ HTL Solar, are also available.

Heraeus

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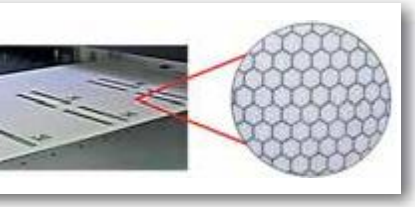
KELENN Technology creates innovative and scalable manufacturing technologies related with digital additive methods such as inkjet deposition and contactless dispensing dedicated to large-area electronics. First industrial stand-alone machine, mastering inkjet printing of highly conductive silver nanoparticles with photonic sintering has been announced in 2015 to the printed electronic market.

KELENN Technology – Leading Innovation – KSCAN PE



From lab to fab

KELENN Technology matches customer requirement with a turnkey solution.
Thanks to a scalable architecture, customers can start deposition of patterned functional fluids such as conductors, organic semiconductors and dielectrics from lab scale. Sliced high-speed inkjet print head subsystems, high-resolution vacuum flat beds, drop watcher and photonic annealing equipment are all in one enclosure for high efficiency, 2D and 3D digital deposition of multiple layers of a mix of functional fluids. Typical production are: interconnect systems, array of cathods, RFID antenna, flexible micro printed circuit boards, OPV, OLED...

Think digital

The digital factory concept developed by KELENN Technology unifies the process of layout design, production, camera inspection, tracking and production management to reduce time to market and cost of operation.
Furthermore, KELENN Technology's unique KEOS_PE^{tm} reliable ink jet deposition sliced systems have many benefits: high speed, high resolution, limited amount of raw material such as nano particle of silver ink, better productivity at single pass yield, lower setup time, less waste. KSCAN_PE^{tm} enables new innovative product opportunities and business models.

Think smart

For 10 years, KELENN Technology has been involved in the digital factory concept. Today, a number of software tools are being made available to our customers in a foundation environment:

- KReport^{tm}: production management
- Smart VDG^{tm}: layout and layer editor, variable data generator, interface with CAD, ...
- Smart KPM^{tm}: scripting, operator control, spooling, process automation...

Global servicing

KELENN Technology has developed a proven expertise in installation, training, commissioning, servicing and hotline services to key industrial players worldwide. With subsidiaries in the USA and ASIA, KELENN Technology has the capability to synchronize with different time zones for best efficiency and it provides all services and product customization with absolute confidentiality and partnership vision.

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KROENERT in Hamburg/Germany has been developing and building innovative, specialized coating, printing and laminating machinery since 1903, and is the oldest company in this field worldwide. More than a century of experience definitely pays off! We at KROENERT have laid down our values and norms in a corporate philosophy intended not only to keep the company functioning for decades, but to preserve its identity. The proposition of customer benefit remains in the foreground.

KROENERT – Experts in R2R Coating and Printing

All lines are the result of expertise, inventiveness and knowledge. We understand quality and reliability and guarantee the highest levels of efficiency and a long service life in production with minimal maintenance costs. Further education and training in technical and commercial professions ensure high quality for generations. The market of large area organic printed electronics is in rapid development to increase efficiency and quality as well as to further lower the costs. In order to make the final products more affordable and feasible pricewise, but at the same time highly accurate, roll-to-roll (R2R) production on flexible transparent polymer substrates is the way to move forward in the future.

KROENERT offers state-of-the-art-high-end printing and coating R2R machines, techniques and processes to the market, suitable for a laboratory scale of up to 500 mm working width. However, production scale machines with larger working widths are also available.

In the case of printed electronics, customized machine solutions and processes of the utmost precision and accuracy are required, which in their turn are based on standard machine components.

These comprise mainly:
- unwinding and rewinding units
- coating/printing heads
- dryers
- laminators as well as
- auxiliary equipment

The components themselves have to be precise and must be easily operable and maintainable to fulfil the demands of the printed electronics industry. One further aspect is the versatility and flexibility of the R2R equipment, regardless of whether the machine is used in R&D institutes, laboratories, start-ups or by industrial customers. The expert support KROENERT offers, both theo retical and practical training, also forms a major part of our success. Further, KROENERT offers a R&D technology center with various machines, like e.g. the LabCo, where the production of upscaling from lab-to-fab can also be demonstrated.

KROENERT

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The Liquid X® Advantage

Liquid X Printed Metals® (Liquid X®), headquartered in Pittsburgh, Pennsylvania, is an advanced material manufacturer of particle-free, functional, metallic inks that takes an application from prototype to production.

Liquid X® inks are considered disruptive in that our technology is particle-free. This provides processing advantages and achieves better metal film properties than other metallic inks that feature nanoparticles and metal flakes. Our silver, gold, and alloy metallic inks can be printed via inkjet, slot die, flexography, gravure, and aerosol jet onto a wide variety of substrates including Gorilla Glass, display glass, quartz, fabrics, PET, Kapton, ITO and coatings. Upon applying energy (thermal, photonic, IR, etc.), the wet film converts to metal films/traces that have electrical conductivities close to that of the bulk metal – even at nanometer scale thickness.

Liquid X® inks are meticulously engineered to be sustainable, cost-effective, and adaptable to deposition techniques and emerging applications.

Sustainability is derived from the fact that Liquid X® inks enable additive manufacturing processes which is environmentally friendly and reduces waste of precious metal.
Cost effectiveness is attained with comparatively low silver loading coupled with cure techniques that lend themselves to roll-to-roll processings.
Processability on existing commercial printing platforms is achieved by Liquid X®'s proprietary particle-free formulations.

Liquid X® technology applies to a wide range of applications within the printed electronics and 3D printing markets including sensors, smart packaging, touch screen, transparent conductive films, photovoltaics, wearable devices, automotive, and in-mould applications.

Our goal is to take our innovative technology to the next level by partnering with companies who can utilize our breakthrough features and explore the possibilities, while pushing the boundaries in the functional ink market. Contact us for more information about our technology and the benefits of partnering with us.

LIQUIDX printed metals

Liquid X® Printed Metals, Inc. • 515 William Pitt Way • Pittsburgh, PA 15238 • USA
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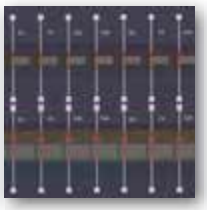
Merck is a leading industrial supplier of hybrid electronic (HE) materials and formulations. From our R&D centres in the UK and Asia, through to large-scale, stringently controlled manufacturing facilities in Germany, we have capability to provide stable, high-performance materials in easily processable formulations. They can be customized to target specific requirements and are compatible with mass production techniques, including photolithography, spin and slot-die coating, inkjet, gravure and flexographic printing.

Merck – Your Innovative Material Supplier

lisicon® – Making the future flexible
Merck's offerings for HE include the full stack of organic semiconductor and dielectric materials for organic thin film transistors which enable flexible displays as well as complex circuitry. We are commercializing organic photovoltaics (OPV's) by developing semiconducting polymers, interlayers and, in collaboration with our partner Nano-C, fullerenes, which we supply as formulations. Other applications include printable organic photodetectors and sensors.

Merck's materials are developed to enable high functionality enabling innovative electronic devices. OPVs are lightweight devices with customizable coloring. They can be manufactured using established printing techniques, producing cost-efficient rigid and flexible solar cells which provides a high degree of design freedom, such as integration into clothes, photovoltaic membranes for buildings and foldable mobile solar cells. HE provides opportunities to commercialize conformal and flexible displays on plastic substrates which are robust and light-weight for target sectors such as consumer goods and automotive applications.

Merck is your innovative material supplier with expertise derived from decades of experience in development, scale-up and production of advanced materials for high-tech applications. Our reputation in OPV and HE are founded on the capability to develop application-oriented formulations with a customer-focused approach. We believe that success in this emerging area can only be achieved through collaboration and partnerships, thereby enabling innovative applications across different industries.



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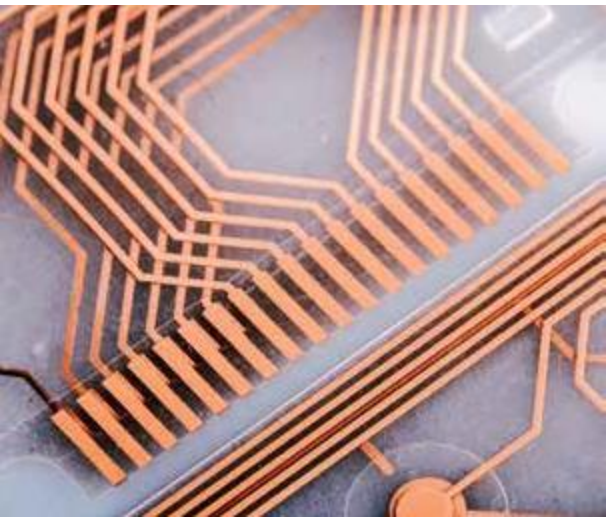

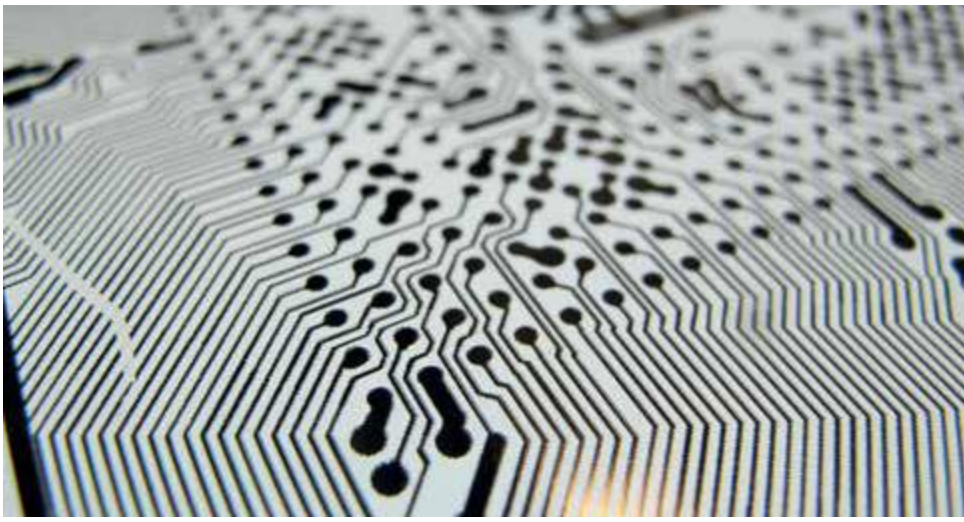

Enabling Printed Electronics Applications

NovaCentrix offers industry-leading photonic curing tools, material and expertise, enabling development and production of next generation printed electronic devices – some already on the market. PulseForge® tools utilize photonic curing which is a cutting edge technology that dries, sinters, and anneals functional inks in millisec-onds on low-temperature, flexible substrates such as paper and plastic. PulseForge® tools can save time and money, and enable new types of products in applications like solar, RFID, display, packaging, and circuit.

NovaCentrix partners with you to take ideas from inception to full production. Our PulseForge® tools continue to revolutionize the printed electronics industry through photonic curing, enabling product innovators and manufacturers the option of flexible, low-cost substrates and functionality not possible with conventional ovens and lasers.

The NovaCentrix team develops, patents and commercializes new technologies in printed electronics, nanoparticle manufacturing, pulsed power equipment and related fields. Our science and engineering team has decades of cumulative experience. We strive to create class-leading technologies, such as the PulseForge® tools and the Metalon® inks. We work to enable every customer to succeed in his efforts. If we can add products or capabilities or make improvements for our customers' benefit, we would like to hear about it.

NOVACENTRIX

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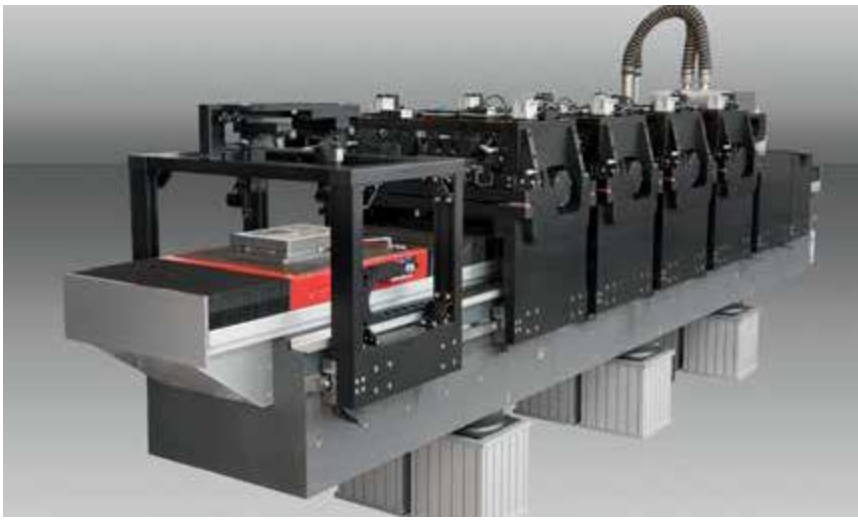
challenger 600 R2R printing and coating system



challenger 650 sheet-to-product printing and coating system (picture wihout housing)

Over 30 years experience in developing and manufacturing of high-precision printing and coating systems for R & D

nsm Norbert Schläfli AG, based in Zofingen, Switzerland, was founded in 1985. nsm is a family run company which specializes in developing and manufacturing of high-precision pilot printing and coating systems mainly in the area of printed electronics.

From the table top lab sheet-fed printing machine to a complex multi-functional printing and coating system, nsm is developing – based on over 30 years of expertise in printing/coating technology – innovative and customized solutions for laboratories worldwide. The product range also includes innovative, ultra-precise sheet-to-product and R2R printing and coating systems. You have an exceptional printing/coating task that is not covered by our standard products? Please contact us, because: customized special printing/coating systems with highest accuracies in the micrometer range are our specialty – and our passion.

nsm challenger 650 is an ultra-precision and multi-functional printing and coating system. The unique system is predestined for the development of printed elelctronics and printed functional devices. The challenger 650 is especially designed to meet and exceed the high technical demands of printed electronics. Its unique register precision allows printing of multilayers with highest accuracy **<10 µm** and allows for the design of complex structures.
challenger 650 can be equipped with the following modules: gravure, flexo, screen, slot die, gravure offset, inkjet, pick & place, laminator, UV dryer, comb-nozzle dryer, photonic curing, etc.

Features challenger 650:
- Printing and coating on **flexible and rigid substrates**
- Low ink consumption
- Integrated air bearing guide allows vibration-free movement of the substrate carriage
- Vacuum substrate chuck
- Individually programmable printing and coating speed at each station
- Individually programmable drying process at each drying/curing station
- Printing size up to 240 x 170 mm
- Printing speed up to 90 m/min.

nsm Norbert Schläfli AG

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PolyIC GmbH & Co. KG develops and commercializes touch sensor solutions for innovative user interfaces and smart surfaces for many industry sectors, for example automotive, home appliances and consumer electronics, worldwide. The sensors are based on high-resolution, printed, transparent, conductive structures (PolyTC® technology) which the company develops, manufactures and commercializes in collaboration with its parent company LEONHARD KURZ Stiftung & Co. KG.

PolyIC GmbH & Co. KG – Smart and Flexible Printed Solutions

PolyTC® technology for demanding sensor applications
PolyTC® consists of conductive, high-resolution metallic structures (metal mesh) with a high optical quality on a transparent PET substrate. These functional foils are produced in a fast, economical roll-to-roll process. PolyTC® can be used to produce very thin, flexible and transparent touch and gesture sensors that are easily integrated into a variety of applications and controlled by conventional electronic components. PolyTC® based sensors are especially versatile and offer a high level of design freedom and process efficiency. It is even possible to simultaneously decorate and integrate functionality into a part in a single combined process.

PolyTC® for the automotive sector
Touch and gesture control user interfaces are on the rise in automotive interiors. Their key advantages include their sophisticated appearance, closed surface, thinness, and low weight while also being economically priced. PolyTC® functional foils and KURZ decorative foils can be used to implement backlit touch panels with refined surface designs. Thanks to their flexibility, these foils are also suitable for use in 3D applications.

PolyTC® for white goods
The PolyTC® touch technology can be used to implement innovative user interfaces that significantly enhance the visual appearance of household appliances. When combined with non-conductive metallic decorative foils from KURZ, they can be used to create elegant, closed designer interfaces with no mechanical switches or buttons. It is also possible to implement dead front effects where the control panel only becomes visible when a backlit display is activated.

PolyTC® for consumer electronics
PolyTC® foils possess a high optical transparency, sensor sampling rate, signal quality, and electromagnetic immunity. This makes them exceptionally suitable for use in mobile and consumer electronics devices. PolyTC® sensor foils are made to order with their dimensions and properties tailored to the customer's individual requirements.

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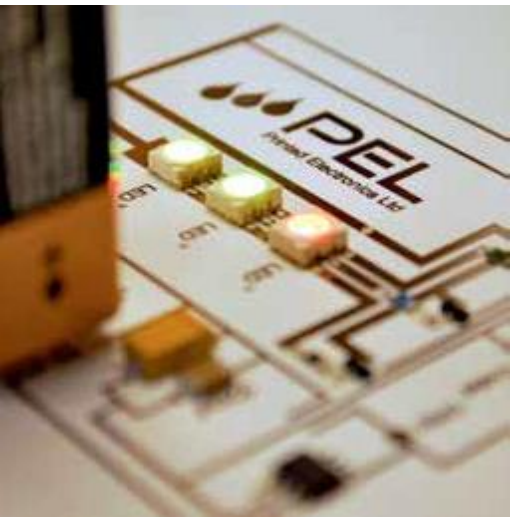

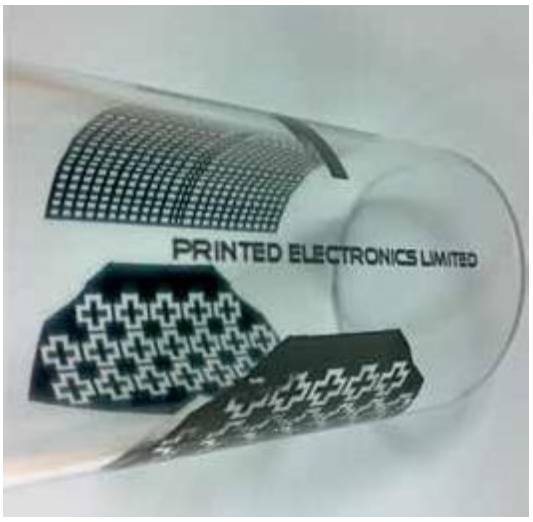

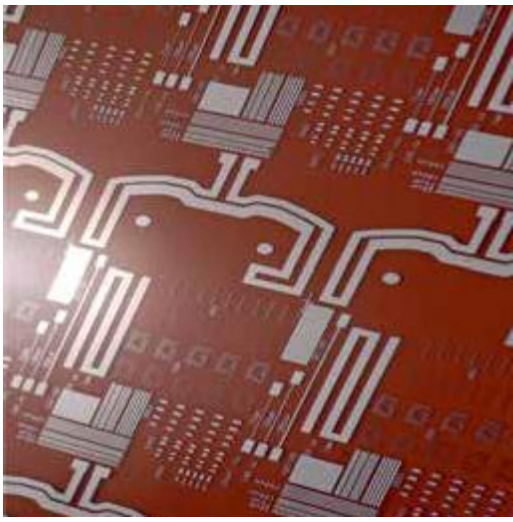

Printed Electronics and Process Development Expertise

PRINTED ELECTRONICS EXPERTISE

Over the past decade, PEL have built a strong reputation as experts in functional printing, material deposition, inkjet and digital 3D technologies. We focus on electronic applications, but our knowledge is often applied to support customers in conventional printing and general material deposition.

We supply and support a variety of systems, processes inks and substrates. We are uniquely skilled in providing solutions that will give you the best printing result through bespoke combinations and adaptations of machines, inks and substrates for specific applications.

From prototype smart labels through to development of large flexible systems, we are experts in embedding electronics – especially in areas where electronics are not conventionally used.

Our component range includes antennas, sensors, displays and printed batteries. We integrate these elements with paper, plastic film, fabric, ceramics, metals, and even large 3D physical objects with our 3D surface printer.

We design, manufacture and assemble on site and our core partner is Amphenol-Invotec, the leading European manufacturer of highly complex rigid, flex and flex-rigid PCBs. Using our joint skills, we can produce true printed hybrid products. PEL also supply wearable electronics through partnerships with technology developers and designers.

PEL are European distributors for SIJ Technology Inc. Superfine Inkjet is a true drop-on-demand platform capable of printing sub-micron scale patterns.

The SIJ (superfine ink jet) platform is an advanced micro-deposition system for digital printing of ultra-precise micron scale structures. SIJ systems use femto-litre drops that are 1/1,000 of the size of conventional inkjet drops.

SIJ can print a wide variety of materials, including conductors, dielectrics, semiconductors, UV curable materials and biomaterials.

PEL Printed Electronics Ltd

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Internet www.printedelectronics.com

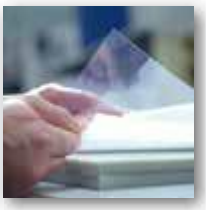
Precision Slitting of Substrates for Flexible Electronics Applications

For more than 55 years, Pütz GmbH + Co. Folien KG has built up an excellent reputation as a high-tech, family-owned film convertor on the market.

To meet the increased quality demands especially in organic electronics and pharmaceutical industries, it was already decided a few years ago to improve the existing, high cutting quality by providing clean room conditions and adequate machinery equipment.
Specially trained staff guarantees a high cutting accuracy and clean converting of films. Films which are also used for OLED, OPV, lighting amongst others.
To learn and understand the requests from the market, Pütz-Folien keeps a close contact to users, joins exhibitions and supports leading R&D partners.

High-performance Teonex® PEN films and PET
Clear films, available with planarized, smooth surfaces. Heat-stabilized films offer excellent thermal and flatness properties.
Long-term partnerships with leading film manufacturers around the world provide the best possible substrates, precisely converted by Pütz-Folien.
A high level of initiative, experience and responsibility distinguishes the team for this application.
The combination of customer requirement, experience of Pütz-Folien and close cooperation with the manufacturers permit continuous improvements for this increasing market segment.

Slitting rolls and sheets
Film thicknesses between 0.9 µm and up to approx. 800 µm can be slit in roll widths between 4.5 mm and 2,500 mm, depending on the material. Sheet lengths of approx. 35 mm up to 1,800 mm. Wider dimensions on request.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Internet www.puetz-folien.com

Reisewitz Beschichtungsgesellschaft mbh, an R2R coating company, specializing in aqueous, solvent and UV coatings and printing, has been manufacturing speciality products since 1992. Based in Penig, Germany, the company has decades of experience in contract coating high-quality substrates for technical applications. Substrates including paper, films and laminates in the range of 36-1,300 micron in reels are coated and printed for diverse industries providing high added value for our customers. Our philosophy is to develop coatings to enable solutions so that niche products can be successfully and profitably manufactured.

Reisewitz – Your Partner for Creative Roll-to-Roll Coating Solutions

Reisewitz coats and prints PET, polyolefin, ETFE, PVC and paper rolls for industries which include furniture/furnishings, interior decoration, electrical batteries manufacturing, architecture/roofing membranes, labels and tags, and displays. With many years of experience in handling transparent, white and colored films, Reisewitz can offer custom coatings for use in organic and printed electronics applications. An example of extremely durable printing solution (guaranteed for more than 5 years) is to be seen in the silver prints used in the ETFE filmic membranes to construct the roofing structure in the famous Allianz Football Arena in Munich. Expertise is available in R2R applications which include, but is not limited to:

- durable coatings and printing
- conductive coatings
- resistant coatings
- optical coatings
- barrier coatings

Surface effects, which include 3-D prints, supermatt and glossy effects, soft-touch and anti-fingerprint effects are all made possible through specialized equipment and knowledge available in the research and development department. A versatile pilot coater in the width of 320 mm assists in producing prototypes which can be later coated on the production machines with coating deckles of 1.2-1.6 meters.

Reisewitz is enriched by expertise and products coming from its sister companies within the MDV Group. MDV in Karlstein produces up to 2.2 meter wide water-based coatings, whereas Tech Folien in Liverpool, England, manufactures PE/PP blown films in up to 1.6 meter width. Although we are newcomers to OLED and OPV applications, we want to apply our competence in helping to produce conductive, resistant, and barrier-coated materials for use in areas like furnishing fronts, displays, flat batteries, OLEDs and labeling materials.

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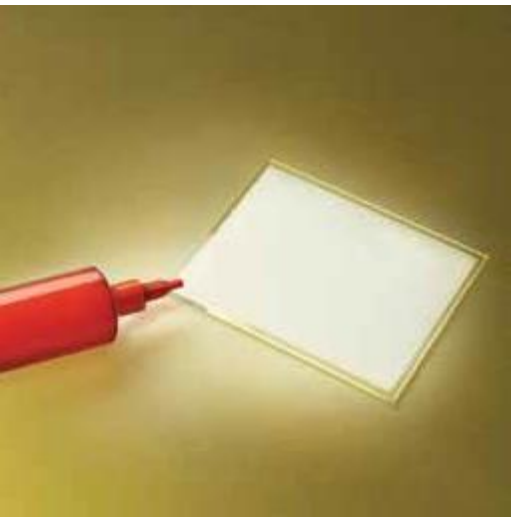

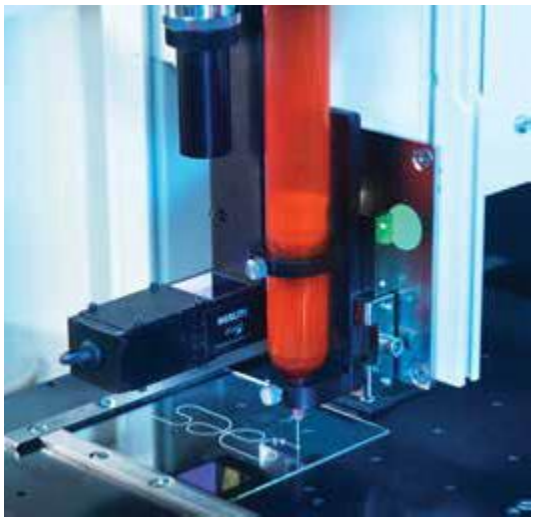

SAES Group Enabling Advanced Materials and Technologies for Organic Electronics

The SAES Group is an advanced materials company, world leader in the supply of functional metals and functional polymers for a wide range of applications, from consumer electronics to scientific and research systems, lighting, automotive, medical and telecommunications among others. SAES products and know-how are focused on gas handling and gettering, release of high-purity vapours, shape memory and superelastic materials and addition of specialized functionalities to polymer systems. In the organic and flexible electronics applications, efficient electron injection material sources and encapsulation materials and solutions are granting SAES Group a leading role in the key aspects of product performances and lifetime reliability. All the group factories are certified according to proper ISO/DIN standards related to their own business field.

As far as the organic electronics business area is concerned, we provide a very large portfolio of active edge sealants, active transparent fillers and dispensable getters. These products come as the result of our deep know-how in functional polymer composites, and they are specially tailored to address customers' specific OLED designs and processes. Leveraging on our functional polymer composite technology, we have been able to develop solventless formulations, with water sorption capacities exceeding 13 percent in weight and very high flexibility and adhesiveness for fully bendable devices. Our products can be applied via screen printing, blading, syringe, ink-jetting, ODF and even be employed in thin film encapsulation structures, to make them simpler and more reliable.

Together with the functional polymer composite based products, we also provide high-performance tape dryers, as thin as 110 microns, for R&D and small-scale bottom emission OLEDs. Another important class of products is related to AlkaMax: this technology offers an efficient and safe method of depositing ultrapure alkali metals. Our alkali metal dispensers and pills keep the alkali metal pure in the form of a stable salt, until it is thermally activated in the evaporation chamber.

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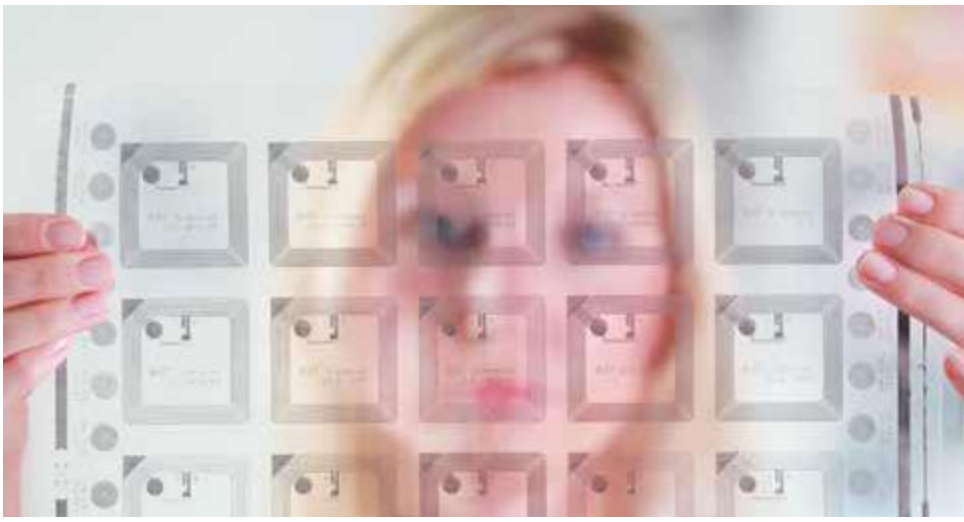

Full Service for Printed Electronics

SAUERESSIG is a leading brand deployment company that supports its customers along the complex prepress process, from design to print, thereby maximizing the workflow efficiency of its business partners. Based on more than 60 years of experience, SAUERESSIG evolved into a renowned expert in premium printing and embossing formes and special machinery solutions.

Extensive experiences and optimized processes
Having entered the printed electronics market at an early stage, SAUERESSIG refined its printing formes to conductive materials within the last years. Today, the company benefits from extensive experiences and optimized processes to meet the high requirements of printed electronics and offer a wide product range of individualized solutions adapted to costumers´ needs. Sophisticated technologies enable remarkable micron-precise high-resolution printing formes in a constant quality.

The SAUERESSIG pilot lab also offers cost-efficient test runs to define the perfect printing result before starting mass production. The own engineering department gained know-how in constructing special machines such as calenders for the battery industry over decades.

As an industry-leading company, SAUERESSIG is constantly working on research and development and thus expecting a further expansion of its product range, especially in the field of printed electronics. A constantly growing network of strong partners expands the company´s competencies.

High standards matter
Cooperating with SAUERESSIG guarantees

- high-quality rotogravure and flexographic printing cylinders and plates
  special machinery construction adapted to your needs
  a strong partnership with an experienced specialist in the printing industry

SAUERESSIG is part of the brand deployment group of SGK. SGK is a division of Matthews International Corporation. For more information, visit: www.saueressig.com

SAUERESSIG

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SmartKem is the leader in the supply of proprietary organic semiconductor materials and technology, enabling the manufacture of a new generation of flexible OLED displays.

Leaders in organic semiconductors

Smartkem is at the forefront of the development and commercialisation of materials, formulations and support technology for the manufacture of thin film transistors for the production of flexible OLED displays. SmartKem, along with its strategic partners in Asia and throughout the world, is reshaping the display industry with the commercialisation of exciting new form factor wearable, mobile, embedded and large area OLED display based products.

Molecule To Market Support

From an 8,000 sq ft technology facility in the UK, SmartKem's team of 40 industry respected scientists and engineers provide the materials and support that offer the OLED display industry a route to the manufacture of the most flexible and lowest power thin film transistor platform on the market today. From molecular design, material synthesis and formulation to coating protocols and thin film transistor device design and test manufacture, SmartKem offers complete turn-key 'molecule to market' support to its strategic partners in adoption.

Flexible Thinking

SmartKem's award-winning truFLEX® semiconductor platform is founded on a broad portfolio of over 150 patents. It is the only semiconductor platform that allows immediate adoption via highly uniform solution processing onto glass or plastic at low temperatures using existing slit coating equipment and standard substrate materials.

Founded in 2009, SmartKem's scientific and management teams have decades of experience in the scale-up and production of innovative materials for the display industry. They are highly focused on responding to the industry demand for a lightweight, ultra-flexible and low power thin film transistor solution, enabling a new generation of OLED displays.

SmartKem

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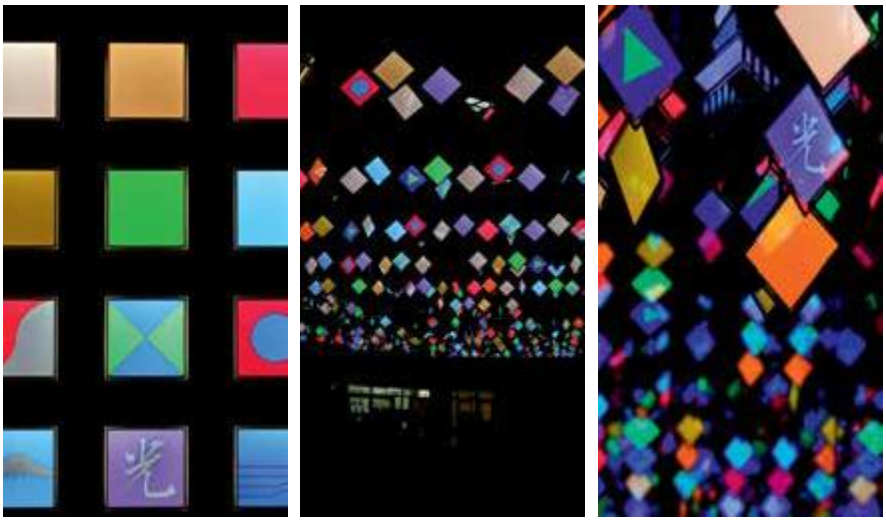
The development of printed electronics in Sumitomo Chemical originates with the development of conductive polymers which started in 1981. Depositing polymer films on plastic substrates only became possible by improving the solubility and film-forming processes. This improvement enabled us to develop applications for conducting and semiconducting polymers, and development of polymer OLED started at the end of the 1980ies. Development of organic transistors and organic photovoltaics followed from polymer OLED and extended the available range of printed electronics applications.



Sumitomo Chemical printed electronics history

OLED Display and Lighting Devices:
Our company has extensive expertise in materials chemistry and device physics to realize high performance materials for high end display and lighting applications. We focus on the optimisation of ink formulations and print processes to enable fabrication of high performance OLED displays and lighting. Recently we have developed anisotropic phosphorescent emitters (green) that can achieve 112 cd/A efficiency, this technology can be employed for both displays and lighting to further enhance performance. High-efficiency OLEDs are expected to be the next-generation lighting solution, that is thin, light-weight and flexible. Sumitomo Chemical is developing materials & manufacturing technologies for low-cost, high-efficiency and large area OLED lighting. OLED lighting panels from Sumitomo Chemical are on sale in Japan and Europe. Our OLED lighting panels feature a wide variety of colors and also a dual color panel that is customizable in color and design.

Organic semiconductor and insulator materials for TFTs
Organic semiconductors from Sumitomo Chemical can be supplied as an ink in eco-friendly non-halogenated solvents. Organic semiconductor films can be formed on plastic substrates by printing processes at low temperature in air. Light-weight and flexible electric devices can be realized. Insulator materials can be printed over large-area yielding a layer with highly insulating properties and with strong adhesion to various substrates and electrodes. Several insulator materials for thermal or photo curing are available depending on customer processing requirements.
These materials enable wider printed electronics applications to be envisaged such as sensors, circuits, displays and wearable devices.

Organic PV and PD materials
Organic photovoltaics provide key differentiating features, e.g. thin/light-weight form factor, flexible and conformable devices in a range of shapes, compared with traditional photovoltaic technology. Our OPV material absorbs light up to 900 nm, which helps to enhance the device efficiency. Organic photodiodes enable new devices and applications that cannot be made with conventional semiconductors. The absorption spectrum of our OPD materials can be tuned throughout the visible and near-infra-red, allowing application tailoring. They also have similar efficiency to Si photodiodes.

SUMITOMO CHEMICAL

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Internet www.sumitomo-chem.co.jp/english/

From Chemicals to Materials

With a broad arsenal of chemical building blocks for organic electronic materials to choose from, SunaTech is now ready for supplying OPV polymers useful for the development of large-area printing processes. From spin coating to R2R, SunaTech helps making the transition.

Incorporated in 2008 and located in the Suzhou Industrial Park, one of the most dynamic areas in China, SunaTech Inc. is committed to providing support to the R&D in a number of advanced technological sectors, such as organic photovoltaics, organic light-emitting diodes, OTFT, bioanalytics and medical diagnostics. Since its incorporation, SunaTech has established an international customer basis and has become a member of OE-A.

SunaTech supplies high quality chemicals/materials and offers problem-solving solutions to the rapidly developing field of organic electronics. SunaTech's products include luminescent metal complexes, organic conductors and monomers/intermediates for low bandgap OPV conjugating polymers.

The company also provides custom synthesis and contract research for both academia and industry under confidential agreements. Operated by experienced chemists, SunaTech understands its customers' desires in confidentiality and has established policies to protect its customers' interest in the way it protects its own interest.

While serving its customers, ranging from academia to industry and from organic electronics to bioanalytics, SunaTech is also building its expertise and developing technologies in collaboration with its partners in multiple sectors. SunaTech is looking for investors and strategic partners to expand its R&D and business areas.

SunaTech Inc.

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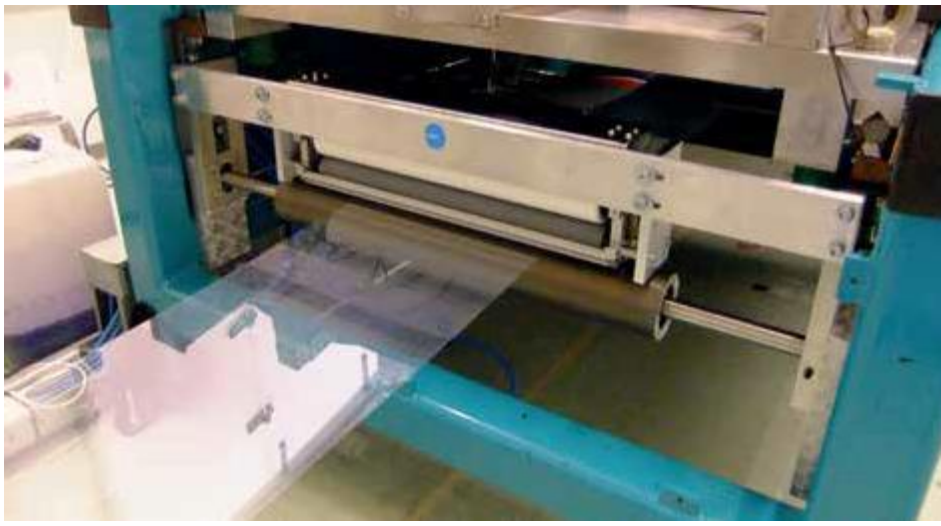
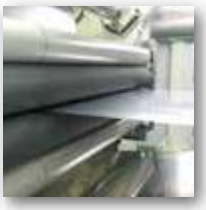


Teknek – Zero Defects – Research Provides Solutions



Teknek are the world's leading manufacturer of contact cleaning systems. They have been the market leader for over 30 years, pioneering and developing the process.

Teknek capability:

- Remove particles down to 20nm
- Clean up to 4 meters wide at 600 m/m
- Clean sheets as small as 15 mm x 10 mm and big as 2 m x 4 m
- Clean substrates as thin as 9 micron.
- Provide systems certified for use inside high vacuum chambers

Since July 2011, Teknek has been a wholly-owned subsidiary of Illinois Tool Works Inc.

Research provides solutions

Teknek use a unique elastomer roller to lift dry, unattached particles from the substrate. The contamination is then transferred to a reverse-wound roll of adhesive. Teknek manufacture the elastomer and adhesive systems in-house. This ensures the quality, the traceability and the suitability for use in contact cleaning.

Innovation for the future

Auto adhesive system: Teknek has developed a new technology that measures the effectiveness of the adhesive and then displays when it needs to be changed. It takes into account different speeds and levels of contamination to adapt to all applications. Users can set levels to ensure the best cleaning and cost-effective use.

Nanocleen 20.20 static dissipating elastomer rollers: Nanocleen is a silicone-free polymer formulation which does not use carbon or metallic particles to control conductivity. Nanocleen 20.20 has surface resistivity of <2x108 ohms (ESD STM11.13-2004), making it suitable for use in all PCB assembly applications. (Independently verified)

Global reach

Teknek has direct sales and service teams worldwide. A network of trained and qualified distributors provides local support in the local language. With fulfilment centers in Hong Kong, USA and Europe, Teknek provides a flexible supply chain solution to meet with customer demands and short lead times.

Teknek – world leader in contact cleaning.

WORLD LEADER IN CONTACT CLEANING teknek An ITW company

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Thinfilm is the leader in development and commercialization of printed electronics and smart systems. Thinfilm's printed logic, display, memory and NFC capabilities are helping bring low-cost intelligence to products we use everyday.

Using printed electronics for affordable, item-level intelligence

NFC Solutions
Thinfilm's NFC solutions combine the instant interactivity of Near Field Communication (NFC) with the advantages of printed electronics technology.

NFC SpeedTap™ allows smartphones to communicate with everyday objects containing a SpeedTap tag – giving physical products a digital identity. SpeedTap enables innovative mobile marketing campaigns with analytics at the item level.

NFC OpenSense™ creates a connected "smart package" using printed sensor tags and a smartphone's NFC capabilities. The smart tags know when a container or bottle is sealed or opened – helping fight product diversion, counterfeiting, and unauthorized refills.

Cloud-based Marketing Platform
Thinfilm's NFC tags and cloud-based marketing platform helps brands connect to their customers. Analytics provide information about tapping events such as location, date, device and what product was tapped. Consumers can receive product information, authentication alerts or unique promotional offers.

Extended Portfolio
- NFC SpeedTap
- NFC OpenSense
- Smart Label Platform
- Electronic Article Surveillance (EAS) tags
- Thinfilm Memory™

THINFILM

Thin Film Electronics
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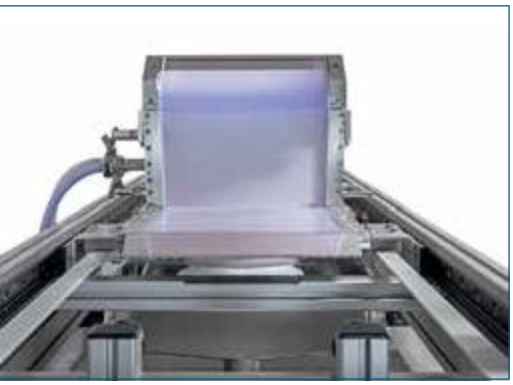

TSE-TableCoater for multilayer curtain coating

Large scale production slot die with positioning system and backing roll

High precision customized TSE-TableCoater

World's Most Precise Slide, Slot and Curtain Dies for Premetered Coating

More than 50 years of experience in the development and production of premetered coating dies have made TSE TROLLER a world leading specialist in applied coating technologies.
TSE has developed advanced coating solutions, which pave the way for the future.

Competences

TSE uses the most precise equipment for producing and measuring the dies in order to guarantee the highest possible quality of the products. Beside precision and surface quality, it is the design of the cavities that plays a crucial role in achieving superb coating performance. The target of the fluid distribution system is a uniform cross-web profile of the coated film as well as long intervals between die cleaning cycles, to achieve high coating line efficiency. This allows a wide range of applications – "from water to honey" with the same die, without any calibration of course.

TSE-TableCoater

When designing new products in the field of flexible electronics, the appropriate components of the coating liquids are often only available in very limited quantities and correspondingly expensive. TSE coating dies achieve a minimized volume by the customer-specific design of the internal distribution system.
In order to ensure the scale-up from the laboratory in a subsequent "roll-to-roll" process, the same application process has to be used from the beginning.
Often only a few samples of a new development step are sufficient in order to analyse their functionality, efficiency and other features. Nevertheless the conditions of the experimental setup should be comparable with later production runs, to minimize risks. For this purpose TSE has developed a modular coating system with small scale dies in the well-known TSE quality.

Large scale production

When it comes to the future production step TSE Troller is your experienced partner with economic single- and multilayer coating equipment for either slot or curtain coating, depending on each particular application. Simultaneously coating multiple layer structures allows new design in the product layout with special layers for performance and production optimization.
For technical details just ask.

TSE TROLLER
COATING SECRET

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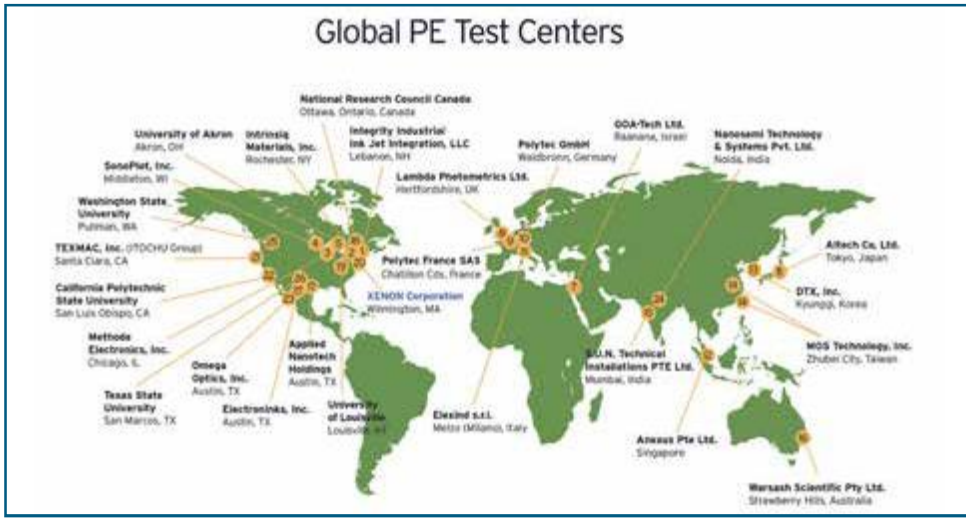
Internet www.tse-coating.ch



XENON Company Overview

XENON Corporation is the global leader in pulsed light technology, with more than 50 years of experience and over 3,000 systems deployed on industrial production lines worldwide.

Founded in 1964, the company focuses exclusively on pulsed light and its applications, from the research laboratory to the production line. Our technology plays a key role in applications as diverse as printed electronics sintering, sterilization, food enhancement, curing of optical disks, semiconductors and displays, and solar simulation.

XENON is particularly focused on helping emerging products grow from the research laboratory to the marketplace. The company has played a key role in jump-starting the printed electronics industry by creating a global network of PE test centers that allow researchers and product developers to access the latest pulsed light technologies, inks, and materials, as well as consulting from experts, thus accelerating commercialization of this important emerging industry.

The company's strengths include:

- A proven history of applying pulsed light solutions in science, industry, medical, health and safety
- An unmatched depth of experience and expertise to help solve the most challenging applications
- A single source for components and complete systems
- A passionate commitment to quality and customer service

At XENON, quality is the standard. Our components and systems are designed precisely to specification and are fully tested before being shipped. The company is always ready to answer the hard questions, to listen to your challenges, and then go to work on the development of innovative applications of pulsed light.

XENON™
The Pulsed Light Experts

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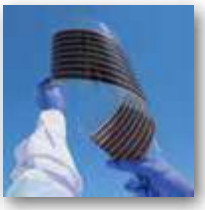
Nanotechnology Lab LTFN
Center for Organic and Printed Electronics Hellas (COPE-H)

LTFN/COPE-H is a leading specialist in OEs (OPVs, OLEDs, OTFTs, Biosensors), thin films & nano materials, vacuum & printing technologies, nano metrology, nano medicine and optical technology

LTFN has established the Center COPE-H for Research & Manufacturing of OE Devices and to provide smart materials and process solutions for energy, lighting, electronics, nano biomedicine, smart food packaging, greenhouses, buildings, wearables, IoT. In the field of OEs, LTFN has founded the spin-out companies Organic Electronic Technologies (OET) and BL NanoMed and it is an open access Hub.

Key technologies:

- R2R printing (inkjet/slot die/screen) pilot line with in-line optical metrology (SE, RS, PL), pulsed laser patterning,
- OVPD pilot line with in-situ optical metrology, metal evaporation
- CVD pilot line with in-situ optical metrology for graphene and 2D materials
- S2S printing & vacuum pilot line
- Encapsulation technologies

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CPI – The UK's National Centre for Printable Electronics




CPI is the UK's National Centre for Printable Electronics. CPI offers world class, open access capability for the scale up and commercialisation of new, innovative printed electronic products and applications.

Our facilities and expertise provide clients with the environment to understand how their products and processes perform under manufacturing conditions and accelerate their commercial realisation.

The Centre for Process Innovation (CPI)
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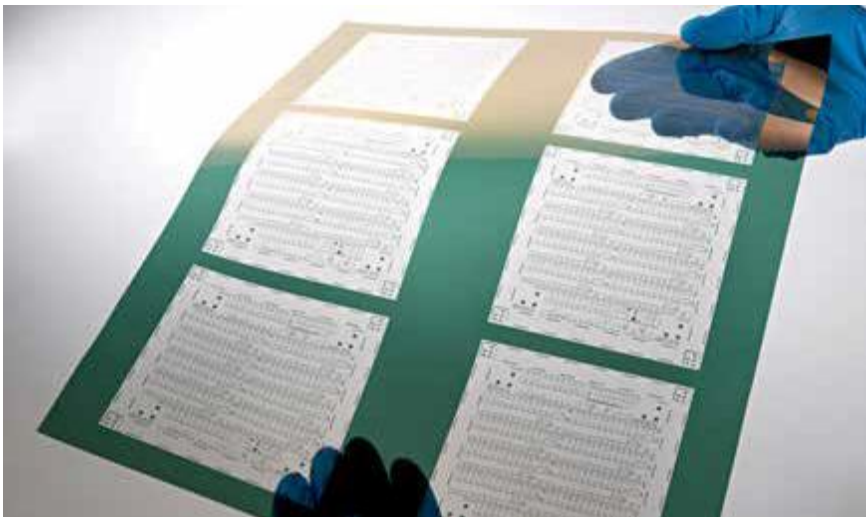
CEA-LITEN is your key partner to develop full printed technologies for electronic devices (e.g. sensors, transistors, passive UHF components, bio sensors ...) and printed PV devices that match your system and market requirements.

Its PICTIC printing platform enables easy customization and fast prototyping on gen1 320 mm x 380 mm flexible substrate, together with a complete set of characterization, electrical test and reliability tools.



CEA LITEN — Full Printing Technologies and Pilot Scale Prototyping

CEA Liten is taking full advantage of its proximity to LETI and LIST CEA institutes to give you optimum and total support, as well as the vicinity of the Grenoble R&D excellence network (ESRF Synchrotron, Neel Institute)

Set of printing equipment

- Screen-print, inkjet, gravure, flexography, slot-die, aerosol jet, µ-dispense in 320 mm x 380 mm format or roll-to-roll (400 mm wide), coupled with thermal, photonic and UV curing, laser structuration
- Metrology: automatic ellipsometry, profilometry, optical inspection and defect classification, electrical qualification, highly sensitive permeation measurements for barrier material qualification, accelerated ageing equipment (illumination, temperature, humidity)

Current portfolio of device skills

- Sensors: temperature, pressure, stress gauge, photodetector, chemical and bio sensors
- Energy harvesting: organic or hybrid (perovskite) PV devices
- OTFT: for digital and analog printed circuits
- Matrix of transistors
- Passive devices: antennae, UHF inductances and capacitances
- Encapsulation materials, processes and characterization for water and oxygen-sensitive materials and devices (vacuum lamination, printing processes, monolithic encapsulation ...)
- Ink formulation, characterization and optimization
- On-foil hybridation of Si chips and CMS parts
- Devices can be advantageously co-integrated on same foil for advanced functionalities: array of sensors, multi-sensing, in-foil sensor amplification

Targeted applications

- Ambient intelligence and internet of things
- Large area array of sensors for structural health monitoring
- RF and UHF filtering and transmission
- Human machine interface and haptic applications
- Wellness and health – silver economy
- Energy harvesting

PictiC

liten cea tech

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COPT Center

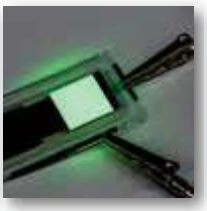
COPT Center is the technology transfer institute of the University of Cologne, Germany. Its task is to develop everyday products having organic and printed electronic functions jointly with industrial partners, predominantly with SME.

Competencies
- Organic light emitting diodes (OLED)
- 3rd generation photovoltaics
- TOLAE components such as organic transistors and sensors

COPT's offer
- Flexible service und individual solutions:
  - Build prototypes with partners in joint projects
  - rent out space for proprietary projects and set up own equipment, in turn, partners par ticipate in the open, innovative infrastructure
  - technical service (measurements, analytics) to partners
  - support in the acquisition of public funding money
  - manage projects
- Lean and cost-efficient infrastructure offering laboratories, a clean room, office space and open-access platforms with extensive scientific and technological equipment on an overall area of 1,000 m²
- Open for worldwide cooperation
- Central, convenient location to allow for short travel times within Germany and Europe

Open-access technology-platforms
- Wet coating and printing methods
- Gas phase deposition methods
- Encapsulation methods
- 3D processing
- Device analytics & lifetime measurements
- Characterization of surfaces and layers

The COPT Center offers individual solutions for companies who address the technology of organic and printed electronics for the first time – from consulting to the realization of their product.

COPT Center • Luxemburger Str. 90 • 50939 Köln • Germany
Phone +49 221 93371014 • E-Mail stephan.kirchmeyer@copt-zentrum.de
Internet www.copt-zentrum.de

CSEM – Technologies that Make the Difference



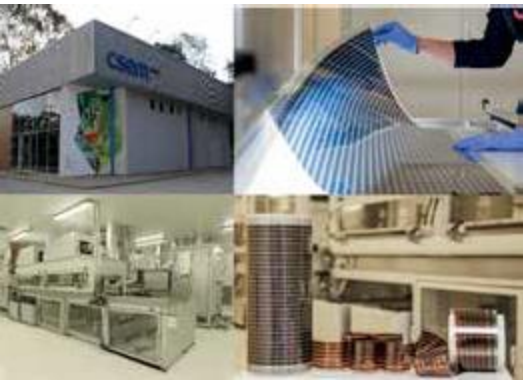

CSEM is a private research and technology organization, ensuring competitiveness through the transfer of technologies and know-how from fundamental research to industry. CSEM solutions include microsystems, surface engineering and integrated devices.

CSEM provides flexible, professional services with an industry-friendly IP approach.
CSEM developed considerable expertise and industrial networks (Switzerland and worldwide), including companies throughout the value chain of printed electronics as well as its end users.
CSEM clean room facilities include state-of-the art equipment for process developments in sensors for the life sciences, wearable devices, printable photovoltaics and hybrid electronics.
CSEM services include design, fabrication and characterization of printable electronics.

csem

CSEM • Rue Jaquet-Droz 1 • 2002 Neuchâtel • Switzerland
Phone +41 61 690 6000 • E-Mail info@csem.ch
Internet www.csem.ch

Organic Solar Cells – The Future of Energy is Now



CSEM Brasil is an innovation center focused on R&D in Organic and Printed Electronics (OE), Nanotechnology and Ceramics Microsystems. Our mission is to enhance the competitiveness of industry and to stablish a close link between technology and consumers.

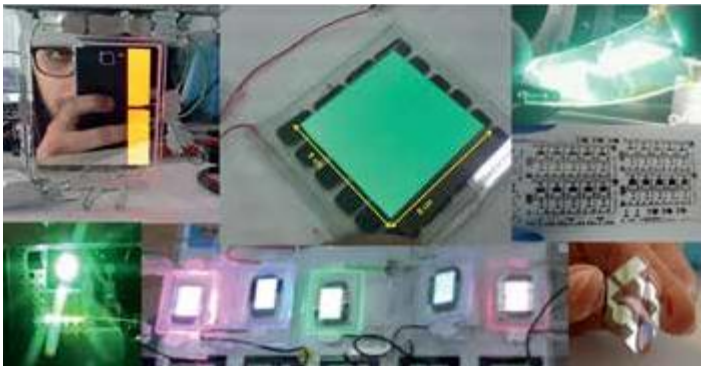
In OE, we have a state-of-the-art equipment and infrastructure to develop or anic solar cells (OP-). e are a leading player in the OPV market, being on the forefront of the technology and achieving excellent efficiency, lifetime and reproducibility.

Our spin-off company SUNEW, is capable of producing modules up to 2,5m length and 0,50m width in lar e volumes. All production is based on solution printing on a continuous roll-to-roll process with five printing stations, with a production capacity of 400,000 m² per year.

csem brasil

CSEM Brasil • Belo Horizonte • Brazil
Phone +55 31 3326 1600 • E-Mail contato@csembrasil.com.br
Internet www.csembrasil.com.br

The “Laboratory of Nanomaterials and Devices”.



Italian National Agency for New Technologies, Energy and Sustainable Economic Development

ENEA SSPT-PROMAS-NANO
is the “Laboratory of Nanomaterials and Devices”.
Activities cover simulation, design, fabrication and testing of FOLAE materials, processes, devices and systems, with special attention to the processes sustainability and to the applications, like lighting, energy, biomedical, agri-food, etc..
Main themes are OLEDs, OPVs, OTFTs, sensors, to improve the devices’ performances, increase lifetime and stability, and reduce the consumption of resources and energy for the preparation and the use, as well as to recover valuable materials from waste.
Available competences include photolithography and photo-masks preparation, UV-NIL, vacuum evaporation, ALD, printing techniques, sputtering, laser-assisted deposition etc., and several electro-optical and physical characterization techniques.

Laboratory of Nanomaterials and Devices (SSPT-PROMAS-NANO)
ENEA - C. R. Portici • Piazzale Enrico Fermi, 1 • Località Granatello
80055 Portici (NA) • Italy • Phone +39 081 7723289
E-Mail paolo.tassini@enea.it • Internet www.enea.it

Fontys Thin Films and Functional Materials

The research group Thin ilms and unctional Materials at the ontys niversity of Applied Sciences cooperates with companies and research institutes to gain knowledge on application of functional materials with thin film deposition techniques.

Examples of projects are inkjet printing of polymers and nanoparticles, pre-treatment of substrates with micro-plasma printing, nanostructured surfaces with anti-reflective properties, transparent conductive coatings and easy-to-clean surfaces.

Students participate, individually or in groups, in these projects and obtain practical training on the equipment available in our laboratory. This equipment, which includes inkjet printing, micro-plasma printing, spin coating, sputtering and vacuum evaporation, is also used for joint (subsidized) research with companies.

Fontys University of Applied Sciences • Expertise Centre Thin Films and Functional Materials
Rachelsmolen 1 • P. O. Box 347 • 5600 AH Eindhoven • The Netherlands
Phone +31 8850 74280 • E-Mail j.bernards@fontys.nl
Internet www.fontys.nl/lectoraten/funmaterials

Printing Technologies for the Manufacturing of Smart Systems Components

The Fraunhofer ENAS department "Printed Functionalities" comprehensively carries out research and development in the field of flexible, large-area, organic and inorganic printed electronics.

The Fraunhofer Institute for Electronic Nano Systems ENAS is a research service provider.
ENAS focuses on MEMS and NEMS development and additionally specializes in advanced applications of printing technologies. We offer customer support in design, simulation, printing and characterization of customized printed products.
Our expertise is in printing and finishing/sintering of conductive, semi-conductive and dielectric inks on different kinds of substrates. The major fields of our activities are application-related developments of conductor tracks, batteries and antennas manufactured by digital fabrication (inkjet) and hybrid printing techniques.
We are well equipped with inkjet, gravure and screen printing modules as part of sheet and web-fed pilot lines.

Fraunhofer ENAS

Fraunhofer Institute for Electronic Nano Systems ENAS
Department Printed Functionalities • Technologie-Campus 3 • 09126 Chemnitz • Germany
Phone +49 371 45001-0 • E-Mail info@enas.fraunhofer.de
Internet www.enas.fraunhofer.de

Applied Research for Organic Electronics

Glass-on-glass laminated OLED processed on Fraunhofer FEP R2R-OLED-line ©Fraunhofer FEP

Fraunhofer FEP works on innovative solutions in the fields of vacuum coating, surface treatment and organic semiconductors with special competences in organic electronics, IC/system design, sputtering, electron beam technology and high-rate PECVD.

Thus, we offer a wide range of possibilities for R&D, pilot production and system integration especially for flexible organic electronics, OLED lighting, OLED microdisplays and sensors as well as processes for ultra-high barrier films for flexible electronics and encapsulation. Furthermore a combination of technologies can be offered, e.g. OLED with sensors or OLED patterning with E-beam. The OLED can be integrated into different flexible substrates, e.g. ultra-thin glass, plastic films or metal strips using R2R- or sheet-to-sheet technologies.
Our aim is to push the innovation potential of organic electronics, E-beam and plasma technology for new production processes, system integration and devices and to make it available for our customers.

Fraunhofer FEP

Fraunhofer Institute
for Organic Electronics, Electron Beam and Plasma Technology FEP
Maria-Reiche-Str. 2 • 01099 Dresden • Germany • Phone +49 351 8823-238
E-Mail info@fep.fraunhofer.de • Internet www.fep.fraunhofer.de

From Materials to Technology

Fraunhofer IAP has been active in organic electronic research over the past 20 years focusing on applications in OLEDs, OTFT, OPV, sensors and actuators.

The main focus is on synthesis of novel materials with improved optoelectronic properties as well as in the device design and manufacture. Quantum Dots (QD) are a new class of nanomaterials in which optical properties can be tuned by adjusting the particle size. These unique properties enable QDs to be used in various applications, for e ample, as luminescent materials in Quantum Dot LEDs and displays, as converting material for lighting application and for bio-analytics.

Additionally, environmentally friendly cadmium-free synthesis methods are being explored. Our concentration is on solution processible systems which can be manufactured by area or digital printing techniques. In a large clean room environment, several processing techniques are available from spin coating for material evaluation in lab devices up to advanced processing techniques such as inkjet printing and high precision slot die coating.

Fraunhofer IAP

Fraunhofer Institute for Applied Polymer Research
Geiselbergstr. 69 • 14476 Potsdam-Golm • Germany
Dr. Armin Wedel • Phone +49 331 568 1910 • E-Mail info@iap.fraunhofer.de
Internet www.iap.fraunhofer.de/en/research/functional_polymer_systems.html

Functional Printing

For selective functionalization, structures can be applied precisely on the required parts or components using printing technologies. Sensors or electronic components can thus be integrated into existing products.

The department of Functional Printing at Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM has gained extensive experience in this domain, focusing on (nano-) composites, nanoporous layers, printed electronics and sensors. Our interdisciplinary team works in cooperation with our customers to develop the concepts for functional integration, combining the materials and manufacturing processes. To implement the integration of functions in manufacturing, various technologies, such as 3D printing, ink-jet printing, aerosol printing, dispensing technology, pad printing and screen printing, as well as sputtering and compounding methods and extrusion are available and open up a broad array of potential applications. Finally, these production processes are qualified through to pilot series maturity.

Fraunhofer IFAM

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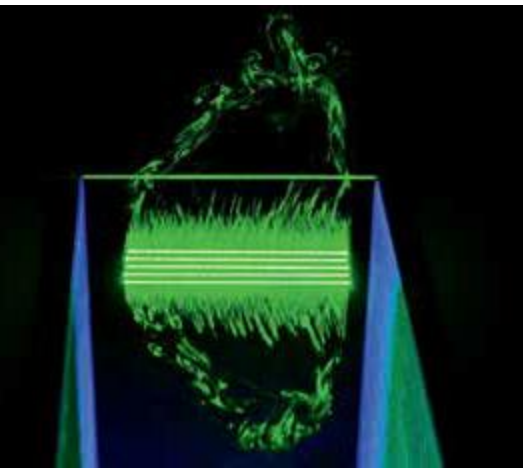
Innovative Laser Processing for Organic Electronics



Fraunhofer ILT is working on industrial laser manufacturing processes and the related laser equipment.

The researchers in Aachen provide innovative solutions for flexible, high-speed, high-resolution patterning of thin films. With laser wavelengths from UV to infrared and pulse lengths from femto to microseconds, specific optical properties of different organic and inorganic materials can be utilized for micromachining of complex devices.

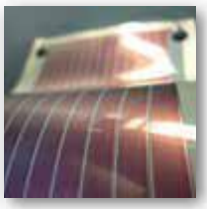
Laser joining is a versatile technology for encapsulation of organic electronic devices, e.g. by novel laser glass soldering processes for glass substrates and high-speed plastic welding for flexible materials. Thin layers of conductors and semiconductors can be modified using high-speed laser sintering or deposited by laser-induced forward transfer and laser metal transfer.

Fraunhofer ILT

Fraunhofer Institute for Laser Technology ILT
Steinbachstr. 15 • 52074 Aachen • Germany
Dr. Arnold Gillner • Phone +49 241 8906-148 • E-Mail arnold.gillner@ilt.fraunhofer.de
Internet www.ilt.fraunhofer.de

Production and Application of Organic Solar Cells



We offer services ranging from fast testing of novel OPV materials up to the design and preparation of demonstrators by roll-to-roll coating and printing. Our R&D expertise also includes in-depth characterization and modeling of OPV cells and modules.

The variety of colors and the possibility of see-through solar cells make OPV the ideal technology where aesthetic considerations are in focus. Examples could be toys, portable devices or building integrated PV. While the technology is still maturing, already today OPV may meet your needs.

The optimum choice of materials as well as the dimensioning of the solar module is highly specific to the foreseen application. Based on modeling and over 10 years of lab experience, we can help you to find out if and how OPV could energize your product.

Fraunhofer ISE

Fraunhofer Institute for Solar Energy Systems ISE
Heidenhofstr. 2 • 79110 Freiburg • Germany
Phone +49 761 4588-5386 • E-Mail uli.wuerfel@ise.fraunhofer.de
Internet www.ise.fraunhofer.de

Excellence in Education, Research, and Innovation



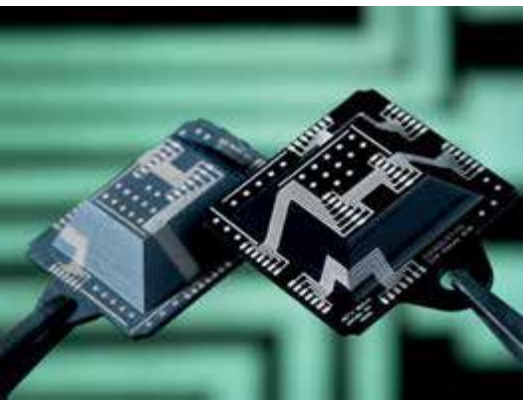
The Center for Organic Photonics and Electronics (COPE) at Georgia Tech is a leading research and educational center that creates new technologies based on organic photonic and electronic materials that have a positive impact on the quality and performance of products in the telecommunications, energy, information technology, and defense industries.

COPE takes a team approach to successfully focus on challenging projects and provide innovative solutions in areas such as OLEDs for lighting and displays, organic and hybrid photovoltaics for portable power, energy storage, and printable organic transistors. COPE brings together multiple expert perspectives from across the Georgia Tech campus – seven Georgia Tech schools and 35 faculty members – and also partners with an international network of leading universities and corporations.

Georgia Tech Center for Organic Photonics and Electronics

Center for Organic Photonics and Electronics
901 Atlantic Dr. • Atlanta, GA 30332-0400 • USA
Phone +1 404 385 3138 • E-Mail sharon.lawrence@ece.gatech.edu
Internet www.cope.gatech.edu

Hahn-Schickard – Visions to Products



Hahn-Schickard stands for client and industry-oriented, application-driven research, development, and production with microsystems engineering.

With a total of 180 employees at our three sites in Germany, we are part of a powerful and innovative network of scientists working in the research and development field of micro technology.

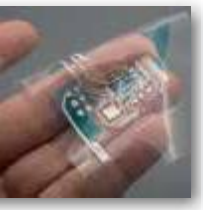
The Stuttgart Institute is specialized in electronic packaging and printing technologies. Printed applications include printed metal lines, protective layers and masks, passive devices, and sensor structures.

We work in flexible and interdisciplinary teams and follow the production process closely at all times: from the initial idea to the finished product – across all industry sectors.

Hahn Schickard

Hahn-Schickard-Gesellschaft für angewandte Forschung e.V.
Allmandring 9 b • 70569 Stuttgart • Germany
Phone +49 711 685-83712 • E-Mail info@Hahn-Schickard.de
Internet www.Hahn-Schickard.de

The Future Belongs to Those Who Create It



Holst Centre is an independent R&D center that develops technologies for wireless autonomous sensor technologies and flexible electronics, in an open innovation setting and in dedicated research trajectories.

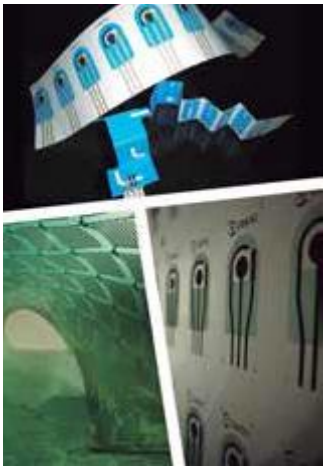
A key feature of Holst Centre is its partnership model with industry and academia based around roadmaps and programs. It is this kind of cross-fertilization that enables Holst Centre to tune its scientific strategy to industrial needs. Holst Centre's fundamentals are to contribute to answering global societal challenges in health care, lifestyle, sustainability and the Internet of Things. This is visible through the motivation of its researchers, its different collaboration models and the choice of its research topics.

Holst Centre was set up in 2005 by imec (Flanders, Belgium) and TNO (The Netherlands) and is supported by local, regional and national governments. Located on High Tech Campus Eindhoven, Holst Centre benefits from, and contributes to, the state-of-the-art on-site facilities. Holst Centre has over 200 employees from some 28 nations and a commitment from more than 50 industrial partners.

Holst Centre
Open Innovation by imec and TNO

Holst Centre
High Tech Campus 31 • 5656AE Eindhoven • The Netherlands
Phone +31 40 40 20 400 • E-Mail contact@holstcentre.com
Internet www.holstcentre.com

IK4-CIDETEC Experts on Printed Electronics for Smart Solutions



Our mission is to enhance business competitiveness and capacity for innovation through the development of new products based on printed electronics.

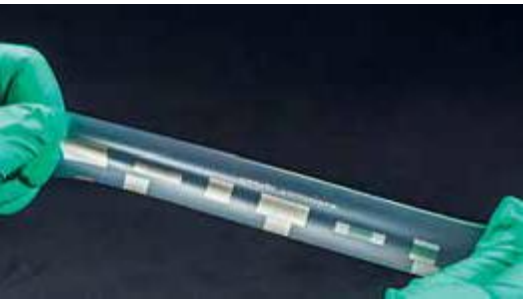
IK4-CIDETEC is a technology centre belonging to the IK4 Research Alliance. It was created in 1997 as a non-profit foundation and specializes in generating and transferring knowledge and technology in the areas of energy storage, surface engineering, polymers & composites and health.
We have a large experience in the design and development of mass-manufacturable sensors based on screen-printing and ink-jet printing technologies for clinical, environmental, agri-food, home security and automotive industries.
The most remarkable feature of our research on printed devices is our own manufacturing capacities, which allow us to modify the design and the materials employed and hence, to offer solutions designed to fit our clients' needs.
Our know-how covers the following areas:

- synthesis of organic and inorganic materials
- ink formulation
- printing on variety of plastic or paper substrates
- all-plastic electrochromic devices
- flexible and large-area printed pressure sensors
- printed electrochemical (bio)sensors

IK4 CIDETEC
Research Alliance
A GREATER FUTURE TODAY

IK4-CIDETEC • Parque Científico y Tecnológico de Gipuzkoa – Pº Miramón, 196
20014 Donostia • San Sebastián • Spain
Phone +34 943 309022 • E-Mail lanorga@cidetec.es
Internet www.cidetec.es

Transparent Conductive Coatings through Photodeposition

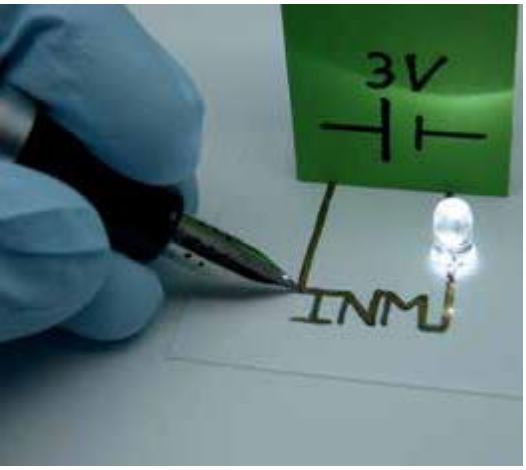


The program division Optical Materials at INM uses optical patterning to create electronics directly on the substrate in a robust, one-step photochemical metallization process.

Our new photochemical metallization process requires only a single step to create conductive paths on diverse substrates that include glass, flexible foils, and even elastic silicone. The resulting metal leads are robust enough to sustain compression and elongation strain when the silicone substrate is deformed. Curved electronics become possible. The photochemical metallization process is based on a photoactive layer irradiated by UV light that converts colorless silver compounds directly into electrically conductive metallic silver with micrometer resolution. INM adapts this process to fit your needs: please contact us to discuss whether this patterning method is suitable for your requirements.

INM – Leibniz Institute for New Materials • Campus D2 2 • 66123 Saarbrücken • Germany
Phone +49 681 9300-148 • E-Mail peter.oliveira@leibniz-inm.de
Internet www.leibniz-inm.de

Flexible Electronics Printed with Hybrid Inks



The program division Structure Formation at INM develops inks with polymer-nanoparticle combinations that self-assemble into conductive leads without the need for sintering steps.

Our hybrid inks combine the benefits of organic and inorganic materials for electronics: a metal (silver, copper, or gold) nanoparticle core with a conductive polymer shell combines mechanical flexibility with the robustness of a metal and high electrical conductivity. Electronic circuits can be printed with standard ink jet printers or even using a simple pen. Ink jet-printed leads (with widths between 10 and 100s of micrometers) are immediately conductive after drying without sintering, they are mechanically flexible, and they are stable against oxygen and water. Their conductivity surpasses that of the pure conductive polymer and the pure nanoparticles. Do not hesitate to contact us if you require a formulation that fits your needs in terms of viscosity, surface tension concentration, and conductivity.

INM – Leibniz Institute for New Materials • Campus D2 2 • 66123 Saarbrücken • Germany
Phone +49 681 9300-389 • E-Mail tobias.kraus@leibniz-inm.de
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InnovationLab – Bridging the Gap between Science and Business

Source: InnovationLab GmbH

InnovationLab (iL) is an application-oriented research and knowledge transfer platform where academic scientists and industrial researchers from various disciplines share the common goal of driving innovation faster into markets.

By enabling cooperative research in a shared facility together with leading industrial companies, it drives scientific excellence, education of young scientists as well as maximizing the results of scientific activities.

To address the fundamental technological questions of printed electronics, five competence centers have been founded within iL:

- Analytics
- Device Physics
- Printing
- Simulation
- Synthesis

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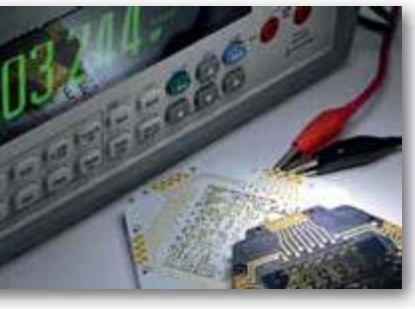
IPC : Towards Smart Plastics and Composites



IPC is the technical industrial center of the French plastics and composites industries. With more than 3,000 SMEs directly connected to IPC, this new French technical center will deliver new smart plastics, connected plastics and composites for markets like packaging, transport, consumer goods and building. IPC is in charge of providing the plastics and composites industries with innovative and high added value facilities and manufacturing pilot lines, cutting-edge expertise and services, covering the full industry value chain.

Smart plastics devices, including 3D-MID (molded interconnect devices) with embedded electronic functionalities, are one of IPC's key fields of expertise.

Key technologies for 3D-MID at IPC:

- laser direct structuring (LDS-LPKF®)
- two-shot moulding
- total and selective plating
- overmoulding of printed electronics
- overmoulding of stretchable electronics
- calendering of smart plastic foils
- integration of electronic in composites

Centre Technique Industriel de la Plasturgie et des Composites
2 rue Pierre & Marie Curie • 01100 Bellignat • France
Phone +33 4 74819260 • E-Mail info@ct-ipc.com
Internet www.ct-ipc.com

Cost-Efficient abrication of Electronic or Sensing Components on lexible Substrates

MATE IALS significantly enlarged its technology portfolio by taking over the anoTecCenter eiz and provides the customers access to the latest technologies required for implementing innovative products and services in the field of printed (organic) electronics or large-area sensing based on e. g. Pyzo lex tech-nology by various printing technologies.

Our methods

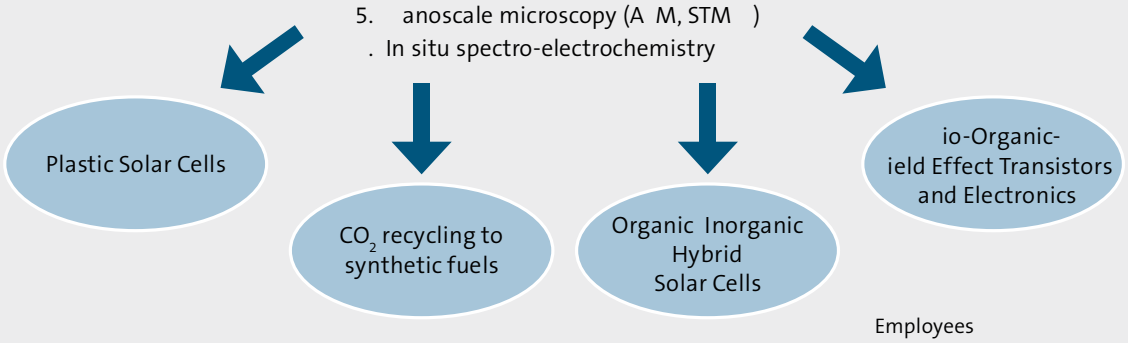
- high throughput roll-to-roll nanoimprinting (V- IL, hot embossing)
- master fabrication by photo, 3D-laser and electron beam lithography, upscaling by step & repeat
- additive printing methods aerosol jet, ink jet, screen printing
- design and optical simulation ASAP, DTD solutions, emax, COMSOL
- various characterization methods

OA E M ESEA CH orschungsgesellschaft mbH
MATE IALS Institute for Surface Technologies and Photonics
ranz-Pichler-Str. 3 1 eiz Austria
Phone 3 31 7 3 E-Mail materials joanneum.at
Internet www.joanneum.at materials

Linz Institute for Organic Solar Cells (LIOS)

Physics and Chemistry of Organic Semiconductors

1. Photoexcited spectroscopy
2. Photoconductivity
3. Thin film characterization
4. anoscale engineering
5. anoscale microscopy (A M, STM)
6. In situ spectro-electrochemistry



Incubator for small high tech spin-off companies

Employees
Turnover 1,2 million euro

Source ohannes epler niversit t Linz

ohannes epler niversit t Linz
Altenberger Str. 9 Linz Austria
Phone 3 732 2 - 752 E-Mail serdar.sariciftci jku.at
Internet www.lios.at

Ecole des Mines de Saint-Etienne (EMSE)

The Microelectronics Center of Provence (CMP) is the 5th education and research institute of the Ecole Nationale Supérieure des Mines de Saint-Etienne (EMSE) located in Gardanne, between Marseille and Aix-en-Provence (France). Our institute offers research expertise in organic printed electronics and thin-film devices for (opto) (bio)electronics applications.

Our know-how starts from the processing to the characterization of thin film devices. It contributes to the fabrication of printed OFETs, OECTs, sensors, passive devices etc. on flexible foils. Research is not only focused on printing development, but also includes photolithography and nanoimprint facilities. It also benefits from the technological platform MicroPackS hosted since 2008 at CMP. MicroPackS, which is available to CMP researchers, includes scientific and technical equipment for microelectronics fabrication and packaging worth more than € 8 million, deployed in 800 m² cleanroom and 200 m² of additional laboratory space.

Microelectronics Center of Provence – Ecole des Mines de Saint-Etienne (EMSE)
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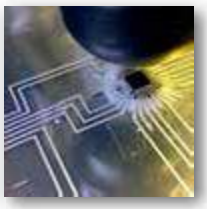
Smart Packages and Interactive Printing Products



In the field of printed electronics, the first international recognition of our university was the awarded interactive book, entitled "Ducky in the Dark", showing unique printed displays and special effects as well as printed batteries and RFID for power supply.

The smart and flexible labels enhance functions and customers' benefits of applications, as packages, books, brochures, furniture and textiles.

The added value is based on components, such as sensors, light, displays, communication devices and power supply.

The labels and their components consist of printed and organic electronics connected to SMD (surface mounted devices) parts.

We develop them for you and our industrial partners are ready to produce high volumes. You either get the smart labels for self-dispensing or already embedded into yourproduct.

Munich University of Applied Sciences • Department 05: Print and Media Technologies
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Phone +49 8137 304672 • E-Mail Ulrich.Moosheimer@hm.edu
Internet www.print-projects.com • www.hm.edu

Print Service for Electronic Paper Products

In-house printing plant for the production of electronic paper products.
Customer ideas for innovative printed applications become reality.

pmTUC, engaged in mass-printed polymer electronics since 1999, offers an in-house printing service for the production of paper electronics.

With this service, companies can try out their ideas for innovative print products, equipped with electronic functionalities or devices. These flexible, low-cost, environmentally friendly applications, printed on substrates like paper or foil, promise high-volume market opportunities, e.g. for advertising, packaging or medicine.

The printing plant is a crucial step towards commercialization of past research results.

Research activities of pmTUC concentrate on adapting conventional offset, gravure and flexo printing technologies to the requirements of mass-printed electronics. Basic research focuses on the formulation of functional inks as well as circuitry design, while applied research includes the development of mass-printed solar cells, loudspeakers, sensors and other applications.

pmTUC • Institute for Print and Media Technology
Prof. Dr. Arved C. Hübler • Technische Universität Chemnitz • Department of Mechanical Engineering
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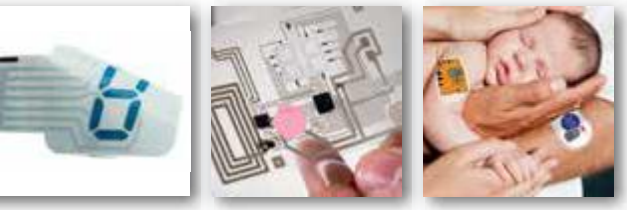
RISE Acreo:
IoT – Wearables – Medtech – Devices – Sensors – Better Connections



Printed Electronics at RISE Acreo is an R&D unit primarily focusing on three application areas: packaging, Internet of Things and health care.

We operate the **Printed Electronics Arena** which is a state-of-the-art facility for materials development, printing, chip mounting and small scale pilot production – creating flexible printed systems and hybrid systems with great versatility.
RISE Acreo offers innovative and value-adding ICT solutions – from idea to prototype – for sustainable growth in industry and society in the areas of digital communication, life science, clean technologies and industrial production.
RISE – Research Institutes of Sweden is a network of research and technology organizations with 3000 employees and a turnover of € 300M. In global co-operation with academia, enterprise and society, we create value, growth and competitiveness through research excellence and innovation.

RISE Acreo • Isafjordsgatan 22 • 16440 Kista • Sweden
Phone +46 10 522 00 30 • E-Mail info@acreo.se
Internet www.acreo.se

Enabling the Electronics of the Future

Tampere University of Technology (TUT) is an active scientific community of 2,000 employees and more than 10,000 students and an international leader in cooperation between industry and academia.

The Laboratory for Future Electronics performs research in novel materials, architectures and processes that will enable a truly sustainable Internet of Everything and novel soft electronics for health, sports and well-being.

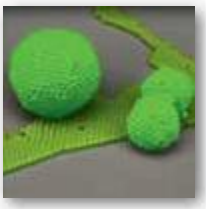
Some of our expertise and areas of activity:

- Non-toxic energy harvesting and storage systems
- Hybrid systems integration
- Printed and energy autonomous sensors, devices, circuits and systems
- Wearable, stretchable body measurement devices

TAMPERE UNIVERSITY OF TECHNOLOGY

Tampere University of Technology (TUT)
Korkeakoulunkatu 3 • PO Box 692 • 33100 Tampere • Finland
Phone +358 40 849 0614 • E-Mail donald.lupo@tut.fi
Internet www.tut.fi

Printing Beyond Color!



The Department of "Digital Printing and Imaging Technology" carries out research and development in printed electronics.

Focus of our research are printed functionalities beyond color, linked to digital fabrication strategies based on hybrid printing systems.

In numerous projects, we explore the processing of functional inks to develop manufacturing processes for transistors, sensors, antennas, batteries, microsieves, supraballs and further printed smart objects.

We are well equipped with inkjet, gravure and screen printing modules as part of sheet and web-fed pilot lines.

The "Chemnitz Inkjet-Technikum" opens our equipment for international R&D partners and organizes workshops and hands-on trainings for interested parties in appropriate technologies.

Please visit **http://www.inkjettechnikum-chemnitz.com.**

TECHNISCHE UNIVERSITÄT CHEMNITZ

Technische Universität Chemnitz • Department Digital Printing and Imaging Technology
Reichenhainer Str. 70 • 09126 Chemnitz • Germany
Phone +49 371 531-23610 • E-Mail digitech@mb.tu-chemnitz.de
Internet www.tu-chemnitz.de/mb/DigiTech/professorship.php

Institute of Printing Science and Technology

Our research aim is to contribute significantly to the scientific understanding of printing processes. We analyze the formulation of inks, the physics of ink transfer as well as drying processes, and develop technical solutions for functional printing.

Our laboratory is separated into three stages – printability proofing, lab scale and production-like printing. At every stage, equipment for all important printing techniques – namely gravure, screen, flexo, offset and inkjet printing – is used. Extensive equipment for studying wettability, rheology and topography is available. Concerning 3D printing, we focus on FDM and SLA techniques.

TECHNISCHE UNIVERSITÄT DARMSTADT

idd printing science technology

Technische Universität Darmstadt • Institute of Printing Science and Technology • Magdalenenstr. 2 • 64289 Darmstadt • Germany
Phone +49 6151 16-22780 • E-Mail office@idd.tu-darmstadt.de
Internet www.idd.tu-darmstadt.de

From Basic Research to Application

The Dresden Integrated Center for Applied Physics and Photonic Materials (IAPP) at TU Dresden is a center of organic electronic research that has been existing for 25 years and is the origin of several successful spin-offs, including Novaled and Heliatek.

The IAPP is an interdisciplinary research center focused on organic electronics, ranging from research on basic properties to devices, e.g. OLED, OPV, OTFT, and organic lasers.

We cover the full range of topics and techniques for this field, starting from organic synthesis to novel deposition methods, device fabrication and tests, alternative electrodes, lifetime, degradation and more.

We are in the core of Organic Electronics Saxony (OES), Europes's largest cluster on organic electronics.

TECHNISCHE UNIVERSITÄT DRESDEN

Dresden Integrated Center for Applied Physics and Photonic Materials
Technische Universitaet Dresden • 01062 Dresden • Germany
Phone +49 351 463 34389 • E-Mail info@iapp.de
Internet www.iapp.de

ELORPrintTec – University of Bordeaux




ELORPrintTec is the technology platform for Organic and Printed Electronics at the University of Bordeaux. It is built to give academic researchers and companies access to state-of-the art semi-industrial equipment and let industrial players benefit from the latest academic know-how.

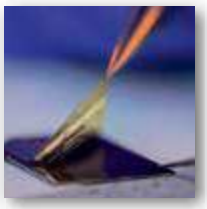
The platform consists of an 850 m² ISO6 clean-room which integrates a full range of processing and characterization equipment to enable the conception, understanding and fabrication of new materials as well as their integration into innovative device systems.

The facilities allow lab-scale R&D as well as upscaling towards industrial scale on synthesis, formulation, micro and nanofabrication, printing and vacuum deposition. These R&D activities are supported by a large range of characterization techniques including STM, SEM, XPS and many more.

ELORPrintTec • Université de Bordeaux
Allee Geoffroy St. Hilaire B8 • 33615 PESSAC • France
Phone +33 5 4000 3660 • E-Mail elorprinttec@u-bordeaux.fr
Internet elorprinttec.u-bordeaux.fr

Your Gateway to Printed, Flexible and Large-Area Electronics Manufacturing Research





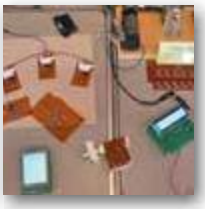

The EPSRC Centre for Innovative Manufacturing in Large-Area Electronics addresses the technical challenges of scale-up and manufacture of LAE systems, with a particular focus on multi-functional system integration.

Our Centre is a partnership between the four largest UK academic centres of excellence in large-area electronics (LAE) research at Cambridge, Manchester, Swansea and Imperial College London. Working with a wide range of companies that are pioneering this next revolution in electronics, we are supporting the emergence of a vibrant new manufacturing industry in LAE.

The Centre works extensively with industry and we welcome enquiries on any aspect of LAE. We particularly invite you to join us and meet the community at our annual conference, **innoLAE** (www.innolae.org).

EPSRC Centre for Innovative Manufacturing in Large-Area Electronics • Electrical Engineering
University of Cambridge • 9 JJ Thomson Avenue • Cambridge CB3 0FA • United Kingdom
Phone +44 1223 748370 • E-Mail info@largeareaelectronics.org
Internet www.largeareaelectronics.org

University of Novi Sad

Our demonstrators at the LOPEC

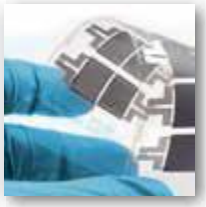
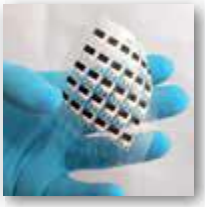
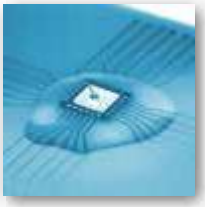
University of Novi Sad (UNS) is the second largest university in Serbia with around 5,000 employees and 50,000 students. Our expertise in areas of interest to OE-A members includes:

- design and fabrication of components, circuits and systems on flexible and rigid substrates;
- design, modeling, simulation and fabrication of different types of conforming sensors (pressure, humidity, linear/angular position, etc.);
- dynamical systems, structural optimization, biomechanical modeling, computational studies comprising nonlocal and nonsmooth operators;
- testing and implementation of fabricated devices and models in biological systems.

Equipment: PulseForge, Inkjet printer DMP-3000, LPKF Protomat, VNA up to 50 GHz, RF Wafer probe station, Nanoindenter G200, Profilometer, Impedance analyzer, HMS-3000, SEM, AFM, etc.
Projects in the field: MEDLEM, APOSTILLE, SENSEIVER, GRAPHSENS, IF4TM, etc.
Demonstrators: Tag&Find (internet of the lost things), active shelf (for detecting number of products on shelves at stores), flexible sensors for angular position/velocity, antennas on foils, eddy current sensors, etc.

UNIVERSITY OF NOVI SAD
Dr Zorana Djindjica 1 • 21000 Novi Sad • Serbia
Phone +381 21 4852552 • E-Mail sgoran@uns.ac.rs
Internet http://nano.flex.ftn.uns.ac.rs

University of West Bohemia / RICE

The Regional Innovation Centre for Electrical Engineering (RICE) at the University of West Bohemia is focused on R&D in smart textiles, in printed and large-area electronics. RICE covers the full range of research activities from the theoretical research and modeling to the production of samples or prototypes and their comprehensive testing.

The main objective of the R&D activities:

- Printed and large-area components: antennas, passives, interconnections, OECT transistors.
- Sensors: chemoresistive, electrochemical, CNT-based gas sensors, RH and T printed sensors.
- Smart textiles: smart protective suits, gloves, bed linen, textile-based sensors and antennas.
- Flexible systems: hybrid integration of printed and conventional components on foils and textiles.
- Industrial deposition technologies: aerosol jet printing (OPTOMEC 300 UP), screen printing (EKRA E2).

University of West Bohemia / RICE
Univerzitni 8 • 306 14 Pilsen • Czech Republic
Phone +420 377 634 542 • E-Mail rsoukup@rice.zcu.cz
Internet www.rice.zcu.cz/en/

VTT – Realizing Printed and Hybrid Electronics

Create products that have the potential to disrupt existing value chains and markets.

VTT application-oriented R&D services leverage disruptive advances in material technology and related processing methods. Customers of VTT printed intelligence benefit from our unique offering, which combines pilot-scale R&D services and supporting intellectual property rights to help exploit the exciting new business opportunities that our technologies help to create.

Our offering makes use of VTT's multi-technological know-how and unique roll-to-roll pilot-scale manufacturing capabilities. Our expertise covers a wide range of printed intelligence technologies, from material formulation and process development to pilot-scale roll-to-roll production of individual components and realization and fast prototyping of integrated systems.

VTT Technical Research Centre of Finland
Kaitoväylä 1 • 90570 Oulu • Finland
Phone +358 20 722 111 • E-Mail antti.kemppainen@vtt.fi
Internet www.vttprintedintelligence.fi

OE-A Products & Services Directory

www.oe-a.org

Products & Services Directory

• products & services • competence

Region code
AU: Australia
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EU: Europe
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Company	Company profile on page	Region	Core competence code	Substrates						Materials								
				paper	plastic	metal	glass	textiles	other substrates	organic conductor	inorganic conductor	p-type organic semiconductor	n-type organic semiconductor	inorganic semiconductor	dielectric	carbon nanotubes	graphene
3D-Micromac		EU																
Adphos Digital Printing		EU		•	•		•	•	•	•	•							•
Adphos North America		NA		•	•	•	•		•	•					•			•
AIST - Flexible Electronics Research Center		AS			•		•	•	•	•	•	•	•	•	•			
Aixtron		EU		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Altana		EU									•				•			
Arjowiggins Creative Papers	30	EU		•	•													
Armor		EU			•	•				•	•	•	•	•	•	•	•	•
BASF Coatings Schweiz		EU																
BASF New Business	31	EU			•		•					•	•		•			
Beneq Oy		EU		•	•	•	•	•	•		•	•	•	•	•			
Bosch Rexroth	32	EU																
Brewer Science	34	NA			•				•	•	•	•			•	•	•	
Brückner Maschinenbau		EU			•													
BST Eltromat International	33	EU		•	•													
Carestream Contract Manufacturing	36	NA			•	•			•	•	•				•	•		
CDT - Cambridge Display Technology	37	EU								•		•			•			
Ceradrop	38	EU		•	•	•	•		•		•				•			
Coatema Coating Machinery	39	EU		•	•	•	•	•	•									
Coherent		EU		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Coruna Printed Electronics		EU																
Cynora	40	EU			•		•					•	•					
Dowa HD Europe	41	EU																
DuPont Advanced Materials		EU		•	•	•	•	•	•	•	•			•	•			
DuPont Teijin Films	43	EU			•													
Elantas	44	EU		•	•						•				•			
Engineered Materials Systems		NA			•					•					•			
EppsteinFoils		EU		•	•	•			•									
Erhardt+Leimer	45	EU		•	•			•										
Ersa		EU																
Evonik Industries		EU			•		•				•	•		•	•			
Exakt Advanced Technologies	46	EU									•					•	•	

Products & Services Directory

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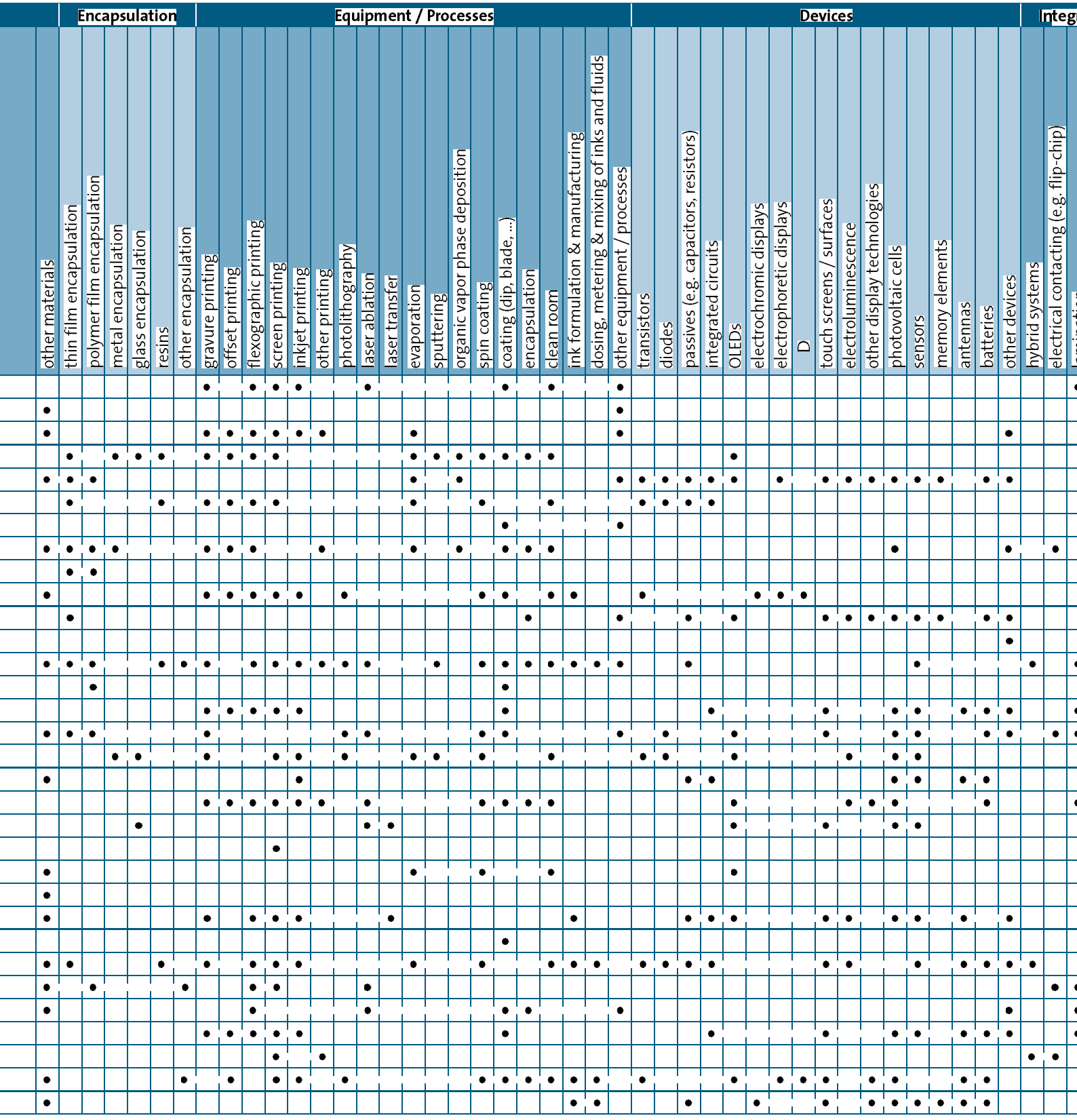
Company	Company profile on page	Region	Core competence code	Substrates						Materials							
				paper	plastic	metal	glass	textiles	other substrates	organic conductor	inorganic conductor	p-type organic semiconductor	n-type organic semiconductor	inorganic semiconductor	dielectric	carbon nanotubes	graphene
Felix Böttcher		EU															
FlexEnable		EU			•				•	•	•	•			•		•
Folex Coating		EU			•					•							
Fujifilm Dimatix	47	NA								•	•	•	•	•	•	•	•
Genes'Ink	48	EU									•		•	•			
Giesecke & Devrient		EU		•	•					•	•						
		EU															
GSI Technologies		NA		•	•	•	•	•	•	•	•				•	•	•
Heliatek		EU			•					•		•	•				
Heraeus Deutschland	49	EU			•		•			•	•						
Heraeus Noblelight		EU															
HNP Mikrosysteme		EU															
Hoffmann + Krippner		EU			•					•	•				•		
InkTec		EU		•	•	•			•		•				•		
InovisCoat		EU		•	•			•		•					•		
ISORG		EU			•		•			•							
JT International Germany		EU															
Karl Knauer		EU		•	•				•								
Kroenert	51	EU															
KSG Leiterplatten		EU			•												
LG Technology Center Europe		EU															
Liquid X Printed Metals	52	NA			•		•		•		•	•		•	•		
LunaLEC		EU															
M-Solv		EU			•		•				•			•		•	•
M. Braun Inertgas-Systeme		EU															
Merck	53	EU										•	•	•	•		
MMC Ryotec		AS															
SW		EU		•	•					•	•	•	•	•	•		
Mühlbauer		NA							•								
NeuDrive		EU										•			•		
Nissha Europe		EU		•	•	•	•										
NovaCentrix	54	NA		•	•	•	•	•	•	•	•			•	•	•	•

Integration
Test
Applications by Industry
Applications
Other Services
Education
hybrid systems
electrical contacting (e.g. flip-chip)
lamination
integration into packaging
other (integration)
electrical characterization
physical/optical characterization
simulation / circuit optimization
lifetime
environmental testing
quality / process control
chemical characterization
other tests
printing and graphic arts
packaging
automotive
consumer electronics
healthcare, medical and pharmaceutical
lighting
energy
building and architecture
logistics
textiles and fashion
sports goods, wellbeing
other applications by industry
transistors
displays
lighting
sensors
solar cells
smart objects (e.g. smart cards, games, gadgets)
-
speakers
smart textiles
wearables
other applications
technical consulting
business consulting
management of R&D funding programs
research and development
bachelor/master thesis
PhD thesis
internship

Products & Services Directory of OE-A members
in the organic and printed electronics sector.
Please refer to the company profile or the member
registry for more detailed information.
Also see www.oe-a.org

Core competence color code

- Material supplier
- Device manufacturer
- End-user
- Equipment manufacturer
- Consulting & other services
- R&D institute
- University



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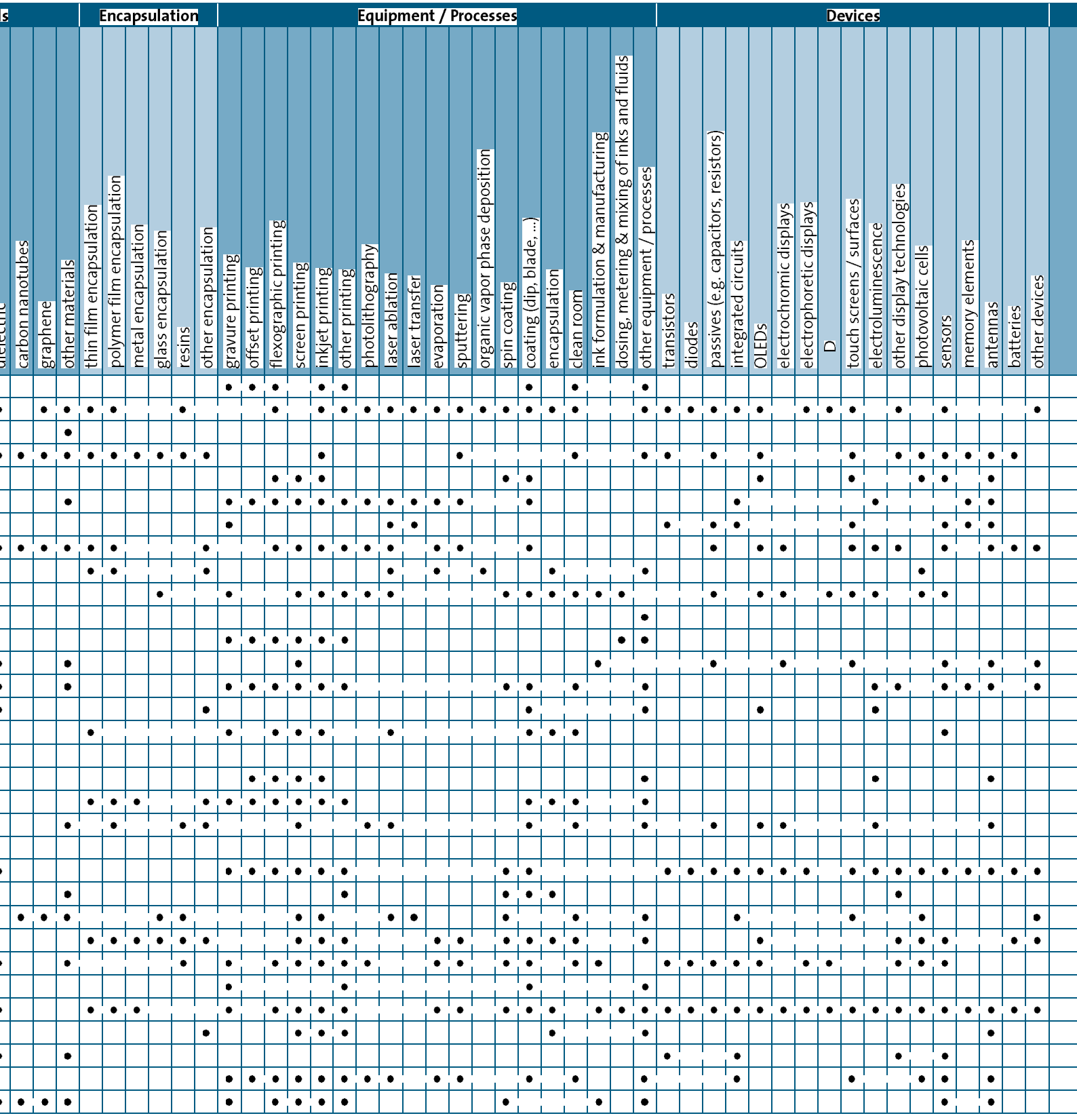

Integration
hybrid systems
electrical contacting (e.g. flip-chip)
lamination
integration into packaging
other (integration)
Test
electrical characterization
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simulation / circuit optimization
lifetime
environmental testing
quality / process control
chemical characterization
other tests
Applications by Industry
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packaging
automotive
consumer electronics
healthcare, medical and pharmaceutical
lighting
energy
building and architecture
logistics
textiles and fashion
sports goods, wellbeing
other applications by industry
Applications
transistors
displays
lighting
sensors
solar cells
smart objects (e.g. smart cards, games, gadgets)
-
speakers
smart textiles
wearables
other applications
Other Services
technical consulting
business consulting
management of R&D funding programs
research and development
Education
bachelor/master thesis
PhD thesis
internship

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				paper	plastic	metal	glass	textiles	other substrates	organic conductor	inorganic conductor	p-type organic semiconductor	n-type organic semiconductor	inorganic semiconductor	dielectric	carbon nanotubes	graphene
Novaled		EU				•	•			•		•	•					
Novasep		EU								•								
nsm Norbert Schläfli	55	EU																
Organic Electronic Technologies		EU		•	•	•	•	•		•	•	•	•	•	•		•	
Oxford Photovoltaics		EU										•	•	•				
Piezotech		EU													•			
Plastic Logic		EU			•					•		•			•			
PolyIC	56	EU			•					•	•	•	•		•			
Poly-Ink		EU								•					•	•		
PragmatIC Printing		EU									•			•	•			
Printcolor Deutschland		EU		•	•	•	•	•	•		•				•		•	
Printed Electronics	57	EU		•	•	•	•	•	•	•	•				•		•	
Profactor		EU			•		•	•		•	•				•		•	
Promethean Particles		EU									•			•	•			
Pütz Folien	58	EU			•					•					•			
PV Nano Cell		AS		•	•	•	•		•		•				•			
Quantumatica		EU			•				•	•		•	•			•	•	
Reisewitz Beschichtungsgesellschaft	59	EU		•	•			•										
Remondis Argentia		EU		•	•	•	•	•	•									
RK Siebdrucktechnik		EU			•													
Rolic Technologies		EU			•		•			•		•	•		•			
ROWO Coating		EU			•						•			•	•			
SAES Getters	60	EU			•	•	•				•				•			
SAIT Europe		EU			•	•	•		•	•	•	•	•	•	•	•	•	
Schoeller Technocell		EU		•	•				•									
Schreiner Group		EU																
SI-CAL Technologies		NA		•	•	•	•	•							•		•	
SmartKem	62	EU			•		•				•	•			•			
Sumitomo Chemical		AS			•		•					•	•		•			
SunaTech	64	AS								•		•	•					
Surteco		EU		•	•													
Teknek	65	EU		•	•	•	•											

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Company	Company profile on page	Region	Core competence code	Substrates: paper	plastic	metal	glass	textiles	other substrates	Materials: organic conductor	inorganic conductor	p-type organic semiconductor	n-type organic semiconductor	inorganic semiconductor	dielectric	carbon nanotubes	graphene
Thieme		EU		•	•	•	•	•	•								
Thin Film Electronics	66	EU			•					•	•	•	•		•		
Toppan Europe		EU								•	•	•	•	•			
Toray Industries Europe		EU			•			•								•	
Toyobo		AS			•					•	•						
TSE Troller	67	EU															
Varta Microbattery		EU							•		•						
VDL Flow		EU		•	•	•	•	•	•								
Xenon Corporation	68	NA			•											•	
Xymox Technologies		NA			•				•		•				•		
Ynvisible		EU		•	•				•								
R&D Institute / University																	
Aristotle University of Thessaloniki - LTFN	69	EU			•		•	•		•	•	•	•		•		
Bauhaus-Universität Weimar		EU															
BRNO University of Technology		EU			•		•	•		•	•	•	•				
CEA Liten	70	EU		•	•	•	•	•			•					•	•
Centi - Centre for Nanotechnoloy & Smart Materials		EU		•	•	•	•	•	•	•	•	•	•	•	•	•	
Centre Technique du Papier		EU		•						•					•		
CNR - ISMN		EU			•	•	•			•	•	•	•	•	•	•	•
CPI - Centre for Process Innovation	69	EU		•	•	•	•	•	•	•	•	•	•	•	•	•	•
CSEM	72	EU															
CSEM Brasil		SA			•	•	•		•	•	•		•		•		
CSIRO		AU			•	•	•			•	•	•	•	•	•	•	•
ENEA	73	EU			•		•		•	•	•	•	•	•	•	•	
Eurecat		EU		•	•	•	•	•	•	•	•	•	•		•		
Fachhochschule Köln		EU			•	•	•				•			•	•		•
Fontys University of Applied Sciences	73	EU		•	•		•			•	•	•	•				
Fraunhofer ENAS	74	EU		•	•	•	•			•	•				•	•	
Fraunhofer FEP	74	EU		•	•	•	•	•	•	•	•	•	•				•
Fraunhofer IAP	75	EU			•		•	•				•	•	•	•		
Fraunhofer IFAM	75	EU		•	•	•	•	•	•		•				•		•

Integration					Test								Applications by Industry										Applications										Other Services		Education		
hybrid systems	electrical contacting (e.g. flip-chip)	lamination	integration into packaging	other (integration)	electrical characterization	physical/optical characterization	simulation / circuit optimization	lifetime	environmental testing	quality / process control	chemical characterization	other tests	printing and graphic arts	packaging	automotive	consumer electronics	healthcare, medical and pharmaceutical	lighting	energy	building and architecture	logistics	textiles and fashion	sports goods, wellbeing	other applications by industry	transistors	displays	lighting	sensors	solar cells	smart objects (e.g. smart cards, games, gadgets)	-	speakers	smart textiles	wearables	other applications	technical consulting	business consulting	management of R&D funding programs	research and development	bachelor/master thesis	PhD thesis	internship
●		●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	●				●	●							●												●	●		●									●			
		●								●				●																●											
			●												●							●																			
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Products & Services Directory of OE-A members
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Core competence color code

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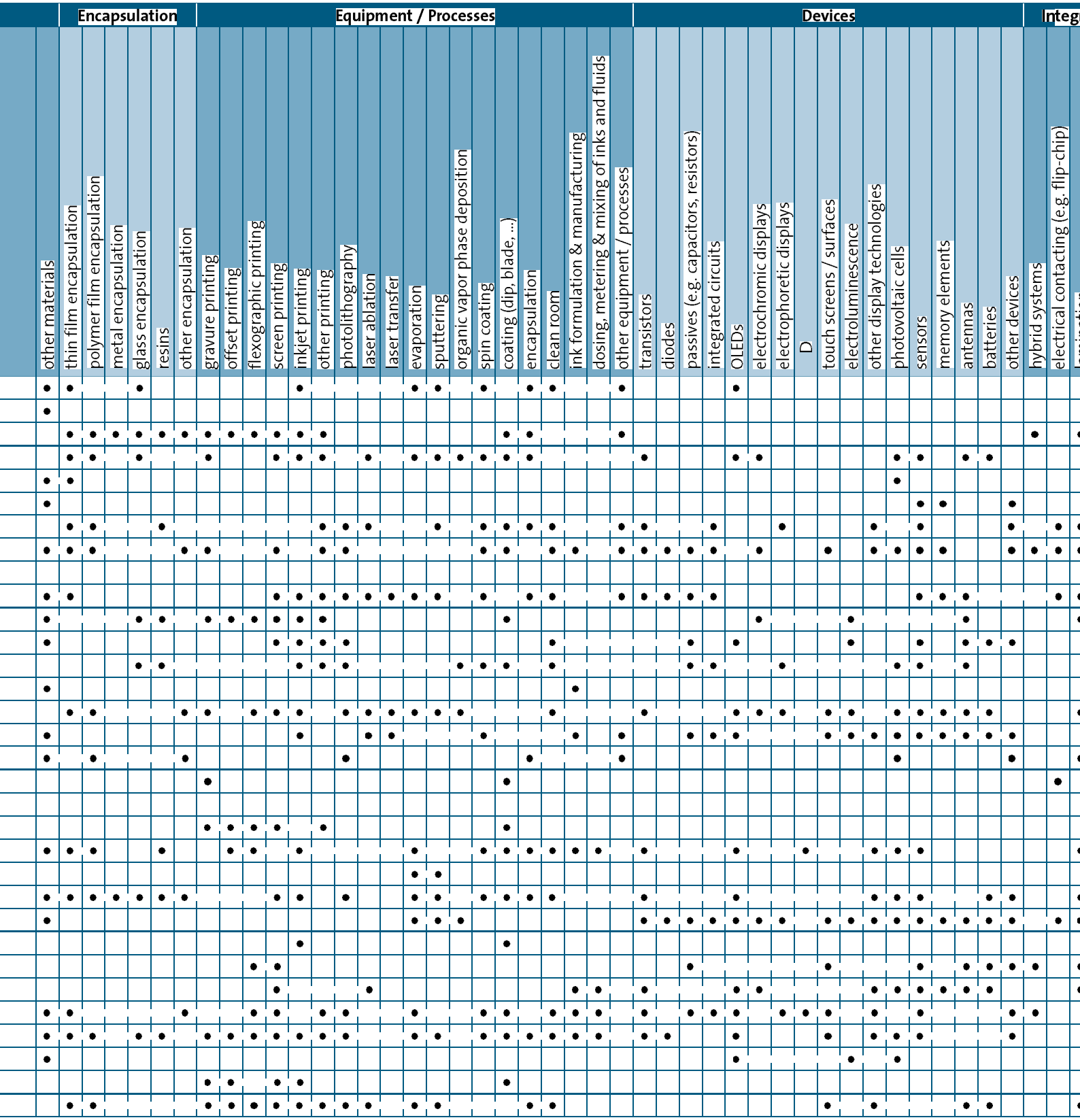
- Device manufacturer
- End-user
- Equipment manufacturer
- Consulting & other services
- R&D institute
- University



Products & Services Directory of OE-A members
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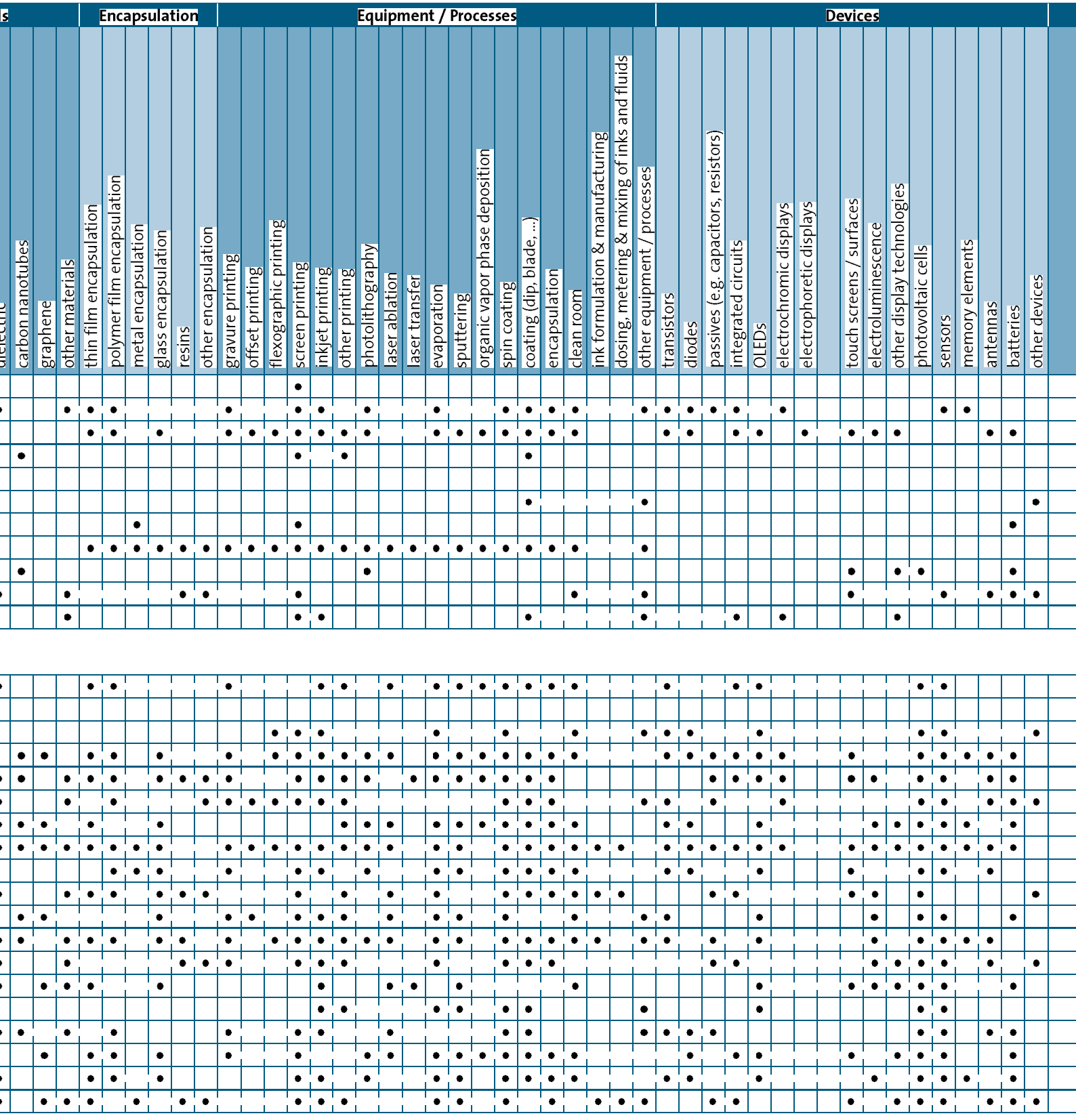

Integration					Test								Applications by Industry									Applications										Other Services			Education		
hybrid systems	electrical contacting (e.g. flip-chip)	lamination	integration into packaging	other (integration)	electrical characterization	physical/optical characterization	simulation / circuit optimization	lifetime	environmental testing	quality / process control	chemical characterization	other tests	printing and graphic arts	packaging	automotive	consumer electronics	healthcare, medical and pharmaceutical	lighting	energy	building and architecture	logistics	textiles and fashion	sports goods, wellbeing	other applications by industry	transistors	displays	lighting	sensors	solar cells	smart objects (e.g. smart cards, games, gadgets)	-	speakers	smart textiles	wearables	other applications	technical consulting	business consulting	management of R&D funding programs	research and development	bachelor/master thesis	PhD thesis	internship
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Products & Services Directory

• products & services • competence

Region code
AU: Australia
NA: North America
AS: Asia
EU: Europe
SA: North America

R&D Institute / University	Company profile on page	Region	Core competence code	Substrates						Materials							
				paper	plastic	metal	glass	textiles	other substrates	organic conductor	inorganic conductor	p-type organic semiconductor	n-type organic semiconductor	inorganic semiconductor	dielectric	carbon nanotubes	graphene
Fraunhofer ILT	76	EU						•			•				•		
Fraunhofer ISC		EU			•						•			•	•		
Fraunhofer ISE	76	EU			•	•	•			•	•	•	•	•	•		
Fraunhofer ISIT		EU									•			•	•		
Fraunhofer POLO		EU			•			•			•				•		
Friedrich-Schiller-Universität Jena		EU			•	•	•		•	•	•	•	•	•	•	•	
Georgia Tech - Center for Organic Photonics and Electronics	77	NA		•	•	•	•			•	•	•	•		•	•	•
Ghent University		EU			•			•				•			•		
Hahn-Schickard - Institut für Mikroaufbautechnik	77	EU															
Hochschule der Medien - IAF, IAD		EU		•	•	•	•	•	•	•	•				•	•	
Hochschule Niederrhein		EU							•	•	•				•		
Holst Centre	78	EU			•	•	•		•	•	•	•	•	•	•		
ICI - Printability and Graphic Communications Institute		NA		•	•					•	•	•	•	•	•	•	•
IK4-CIDETEC	78	EU		•	•		•	•		•	•	•	•	•	•	•	•
InnovationLab GmbH	80	EU		•	•		•		•	•	•	•	•		•		
Institut für Mikroelektronik Stuttgart		EU					•		•								
Instytut Technologii Elektronowej		EU		•	•		•		•		•			•	•	•	
IPC - Technical Centre of Plastics Engineering	80	EU			•			•		•	•				•		
ITRI - Industrial Technlology Research Institute		AS			•							•	•	•			
Joanneum Research	81	EU			•		•			•	•	•	•		•		
Johannes Kepler Universität Linz - LIOS	81	EU		•	•	•	•		•	•	•	•	•	•	•	•	
Karlsruher Institut für Technologie - KIT		EU															
Kent State University		NA			•		•	•		•				•			
Leitat Technological Center		EU		•	•	•	•	•	•	•		•	•		•	•	•
Metropolia University of Applied Sciences		EU		•	•		•	•	•	•	•	•	•		•	•	
MINES Saint-Étienne - Microelectronics Center of Provence	82	EU								•	•	•		•	•		
Munich University of Applied - Sciences Print and Media Technologies	82	EU		•	•	•		•		•	•				•		•
National Research Council Canada		NA		•	•		•	•		•	•	•	•	•	•	•	
NPL - National Physics Laboratory		EU															
Palo Alto Research Center		NA								•	•	•	•	•	•	•	•
RISE Acreo	83	EU		•	•	•				•	•	•		•	•		
RWTH Aachen University - ITA		EU						•			•					•	

Products & Services Directory

• products & services • competence

Region code
AU: Australia
NA: North America
AS: Asia
EU: Europe
SA: North America

R&D Institute / University	Company profile on page	Region	Core competence code	Substrates: paper	plastic	metal	glass	textiles	other substrates	Materials: organic conductor	inorganic conductor	p-type organic semiconductor	n-type organic semiconductor	inorganic semiconductor	dielectric	carbon nanotubes	graphene
Singapore Institute of Manufacturing Technology		AS			•					•	•						
Suzhou Institute of Nanotech - PERC		AS			•		•		•		•	•	•	•	•	•	•
Tampere University of Technology	84	EU		•	•		•	•		•	•	•			•	•	•
Technische Hochschule Nürnberg Georg Simon Ohm		EU		•	•						•						
Technische Universität Chemnitz	84	EU		•	•		•	•		•	•	•			•	•	•
Technische Universität Darmstadt - IDD	85	EU		•	•	•	•		•	•	•	•	•	•	•		
Technische Universität Dresden - IAPP	85	EU			•	•	•				•	•	•		•		
Technische Universität München - MSE		EU			•		•			•	•	•	•	•			
The Hebrew University of Jerusalem - Casali Center of Applied Chemistry		AS															
TOPIC - Thailand Organic and Printed Electronic Innovation Center		AS										•	•				•
University of Barcelona		EU			•		•			•	•	•			•		
University of West Bohemia - RICE		EU		•	•		•	•	•	•	•		•		•	•	
University of Bordeaux	86	EU			•					•		•	•		•		
University of Bucharest - CETTI		EU		•	•	•	•										
University of Cambridge - Electrical Engineering Division	86	EU			•		•			•	•	•	•	•	•	•	•
University of Leeds - Digital Print		EU		•	•	•	•	•		•					•	•	
University of Manchester		EU		•			•	•		•		•			•		•
University of Novi Sad - Faculty of Technical Sciences	87	EU		•	•		•				•	•		•	•		•
University of Pardubice		EU		•	•		•	•		•	•			•	•	•	
University of St Andrews - Organic Semiconductor Centre		EU			•	•	•			•		•	•			•	
VTT - Technical Research Centre of Finland	88	EU		•							•			•			•
WCPC - Swansea University		EU		•	•	•	•	•	•							•	•
Xerox Research Centre of Canada		NA									•	•	•	•	•	•	•
Yamagata University		AS		•	•		•			•	•	•	•		•	•	

Integration					Test								Applications by Industry												Applications											Other Services				Education		
hybrid systems	electrical contacting (e.g. flip-chip)	lamination	integration into packaging	other (integration)	electrical characterization	physical/optical characterization	simulation / circuit optimization	lifetime	environmental testing	quality / process control	chemical characterization	other tests	printing and graphic arts	packaging	automotive	consumer electronics	healthcare, medical and pharmaceutical	lighting	energy	building and architecture	logistics	textiles and fashion	sports goods, wellbeing	other applications by industry	transistors	displays	lighting	sensors	solar cells	smart objects (e.g. smart cards, games, gadgets)	-	speakers	smart textiles	wearables	other applications	technical consulting	business consulting	management of R&D funding programs	research and development	bachelor/master thesis	PhD thesis	internship
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Products & Services Directory of OE-A members
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Core competence color code

- Material supplier
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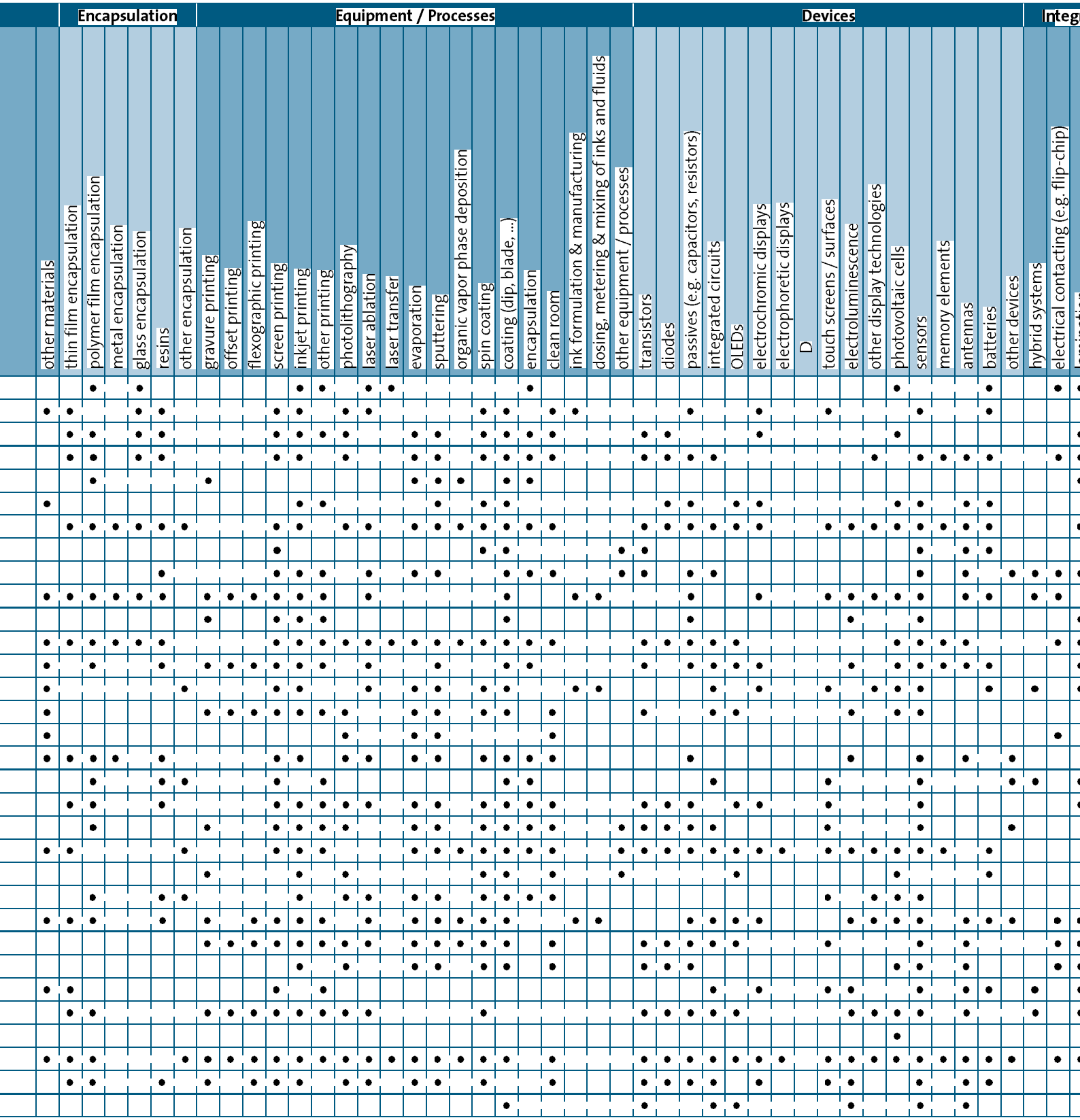
- R&D institute
- University



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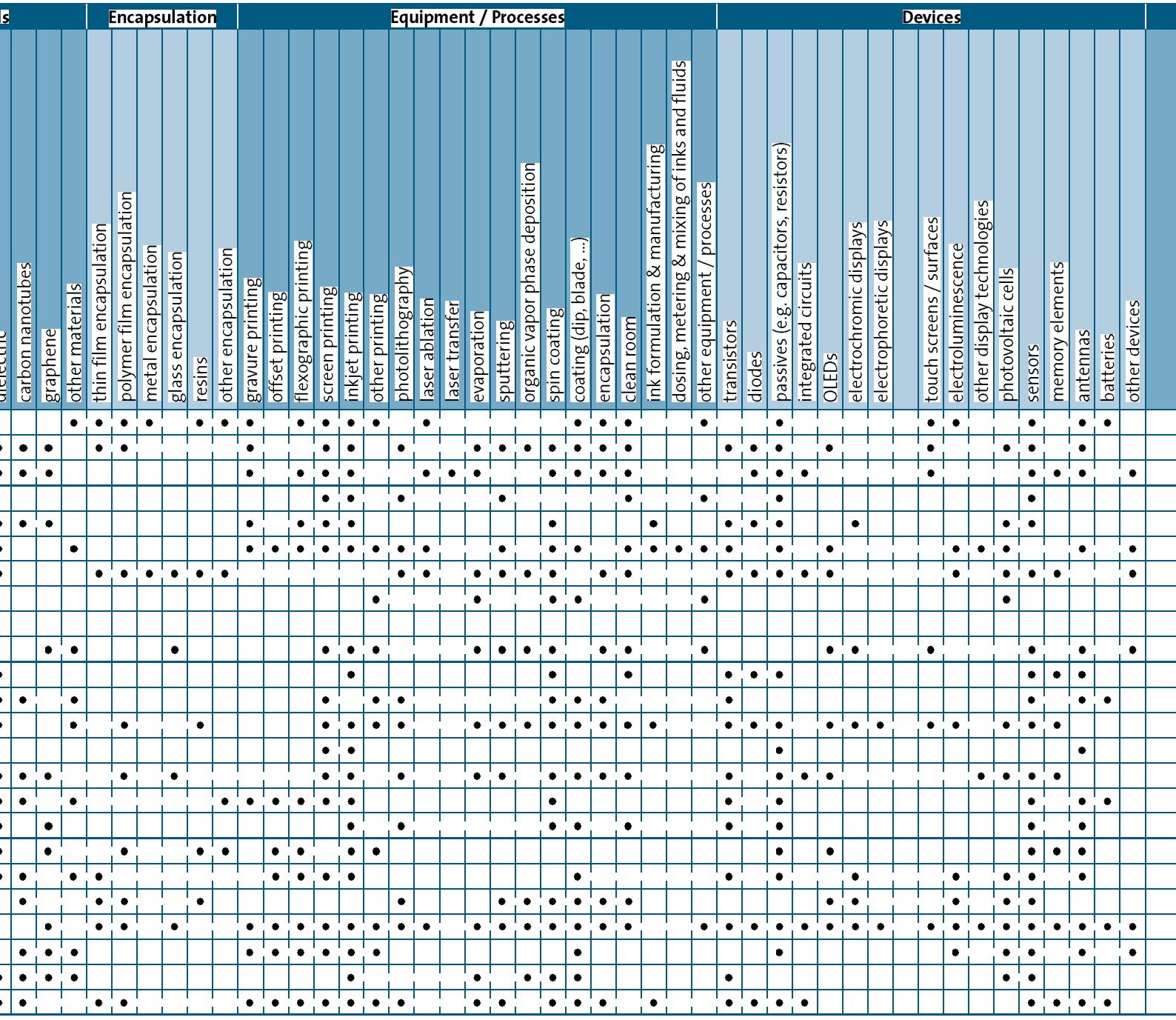

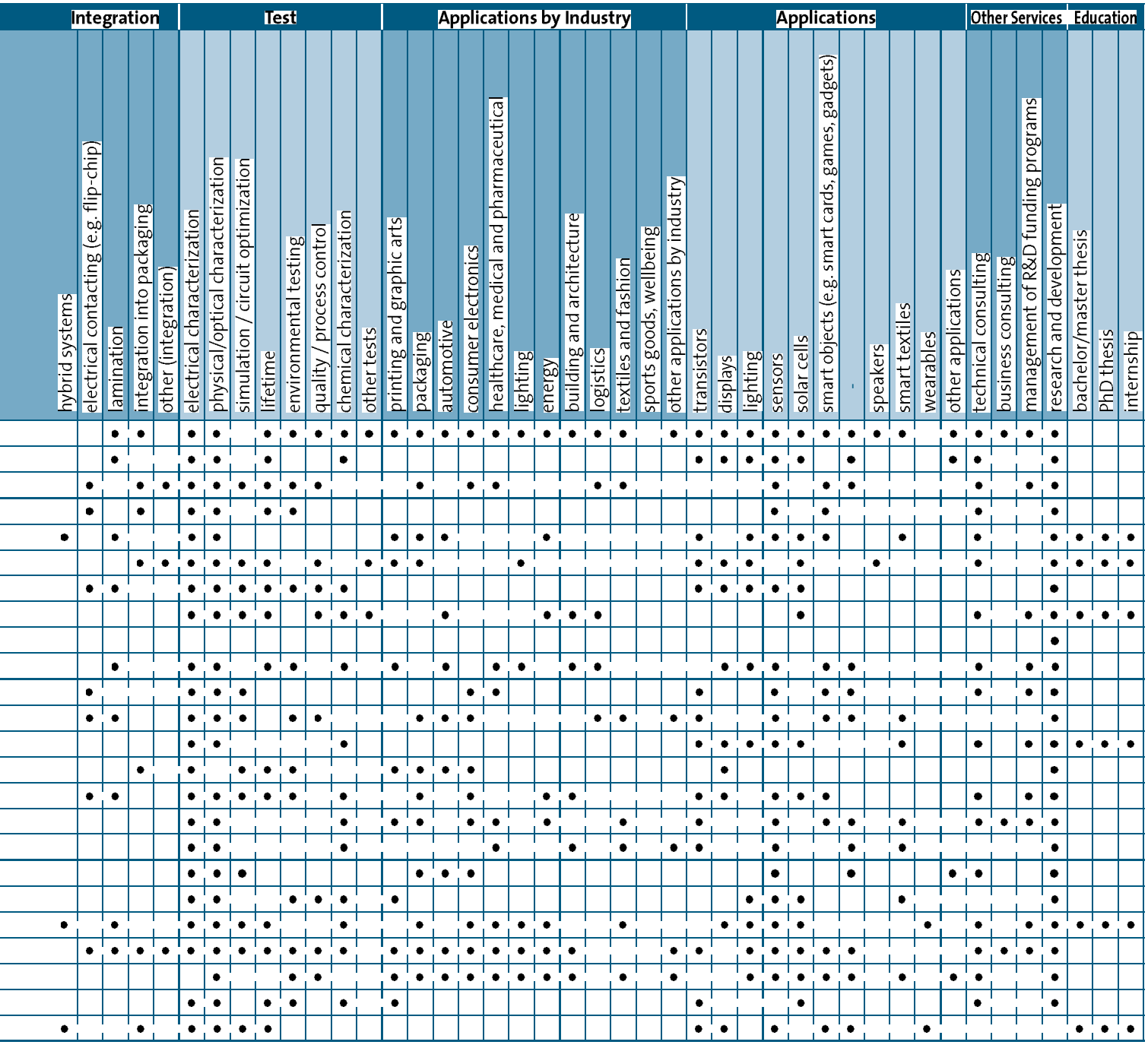
Integration
hybrid systems
electrical contacting (e.g. flip-chip)
lamination
integration into packaging
other (integration)
Test
electrical characterization
physical/optical characterization
simulation / circuit optimization
lifetime
environmental testing
quality / process control
chemical characterization
other tests
Applications by Industry
printing and graphic arts
packaging
automotive
consumer electronics
healthcare, medical and pharmaceutical
lighting
energy
building and architecture
logistics
textiles and fashion
sports goods, wellbeing
other applications by industry
Applications
transistors
displays
lighting
sensors
solar cells
smart objects (e.g. smart cards, games, gadgets)
-
speakers
smart textiles
wearables
other applications
Other Services
technical consulting
business consulting
management of R&D funding programs
research and development
Education
bachelor/master thesis
PhD thesis
internship

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