

# Printed & Flexible Electronics

## Market & Technology Trends in Materials & Equipment for Printed & Flexible Electronics report

*By 2020, equipment & materials market for printed & flexible electronics is a potential US \$1.65B business!*

### REPORT OUTLINE

- Title: Market & Technology Trends in Materials & Equipment for Printed & Flexible Electronics report
- Market & Technology report
- PDF & Excel file
- February 2014
- €5,990 - Multi user license (200+ slides)
- €3,990 - One user license (200+ slides)
- €2,490 - Executive summary (25+ slides)

### KEY FEATURES OF THE REPORT

- Identification of technical hurdles for printed & flexible electronics (OLEDs lighting, OLEDs displays, PV, sensors)
- Threats and opportunities for equipment and materials companies
- 2013-2020 market forecast for equipment and materials in units and US\$ value
- 2013-2020 market forecast for printed & flexible electronics applications in US\$ and m<sup>2</sup> surface
- Application landscape and roadmap
- Processes description and roadmap
- Materials issues
- Devices structure
- Cost structure analysis over time

### VOLUME MANUFACTURING FOR PRINTED AND FLEXIBLE ELECTRONICS WILL SOON BE ENABLED BY EQUIPMENT AND MATERIALS PROVIDERS

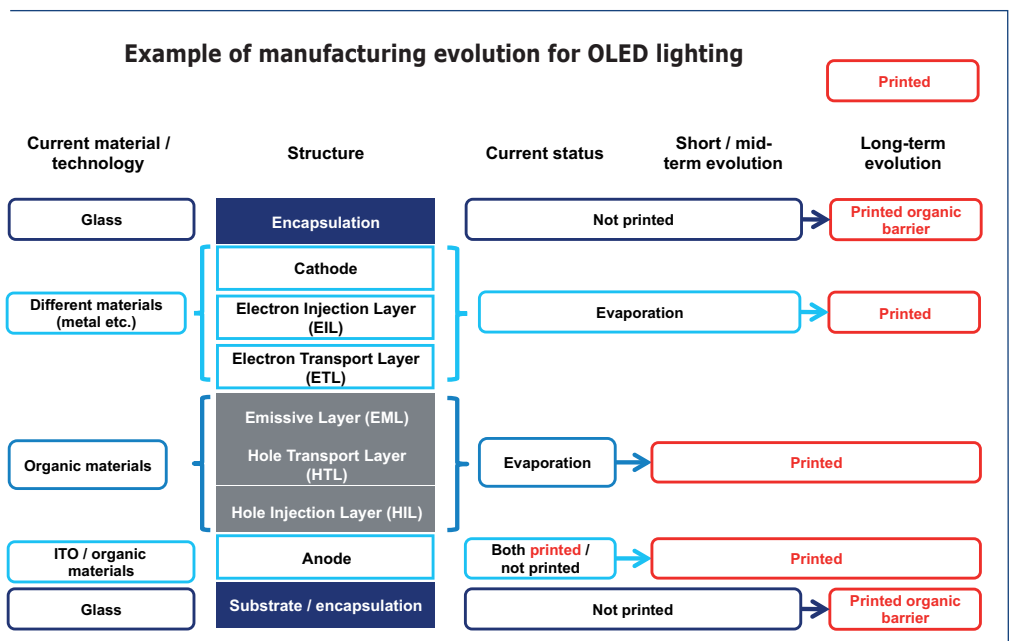
For now, organic electronics are made on rigid substrates and mainly manufactured using vapor deposition techniques, which are costly, generally require high temperatures and generate significant product waste. Printed and flexible electronics has been a very hot topic in this past decade, holding the promise of a tremendous new market. While the printing of electronics is mainly a way to produce large electronic surfaces and reduce manufacturing costs, flexibility will provide higher robustness to the end products as well as new features, designs and shapes.

In our report, we explain how this market will be addressed by players that do not necessarily come from the semiconductor field. In this emerging part of the electronics industry, chemical companies and printing equipment companies are the players that will enable volume manufacturing and will leverage technical bottlenecks.

Indeed the main challenges today lay in:

- The development of high performance materials which will reach or surpass that of inorganic solutions: their intrinsic efficiency, their ability to be printed at a sufficient resolution, to fully operate in combination with several other materials (not to mix one with another), and their lifetime.
- The capability for chemicals companies to provide formulated molecules with new functionalities as well as very specialized active materials.
- Equipment dedicated to printed electronics, that are able to handle specialized inks and to provide printing accuracy way beyond that of standard printing (in the 10s of μm range).

Technology enablers are therefore not those usually involved in electronics development. The solution printing & coating industry is very far from the standard electronics industry, in terms of equipment and materials and they have completely different industrial cultures.



## EQUIPMENT AND MATERIALS MARKET WILL SOON START THEIR RAMP-UP TO LARGE VOLUMES WITH A GROWTH STARTING IN 2015



In this report, we analyze, estimate and forecast the equipment and material markets for printed and flexible electronics. Equipment and materials markets are still low, and will remain so over the next several years. Nevertheless the start of the industry ramp up is expected before 2020. This start is expected in 2018 for materials. It will be driven by the OLED industry that will represent a global market of almost \$ 170M in 2020 (OLED only). The equipment market will start its ramp up sooner than materials, as device manufacturers will have to prepare for upcoming volumes. Our model for equipment forecasts is based on existing and future projects in printed and flexible electronics. Today it is unclear which deposition process will be used and companies often buy

cluster tools with different deposition processes inside. In our scenario, ramp up is expected to start in 2015, thanks to conformable OLED displays, growing to over \$1.3B in 2020 for the OLED industry alone.

In our materials forecast, our investigations have focused on typical materials and chemistries used for the manufacturing of: electrodes / active organic layers (emitting compounds, photoactive, materials) / charge transport materials / encapsulation systems.

### TODAY, THIS INDUSTRY IS DRIVEN BY BIG 5 COMPANIES, BUT MANY STARTUPS – FROM THE SENSING BUSINESS - COULD ENTER THIS MARKET

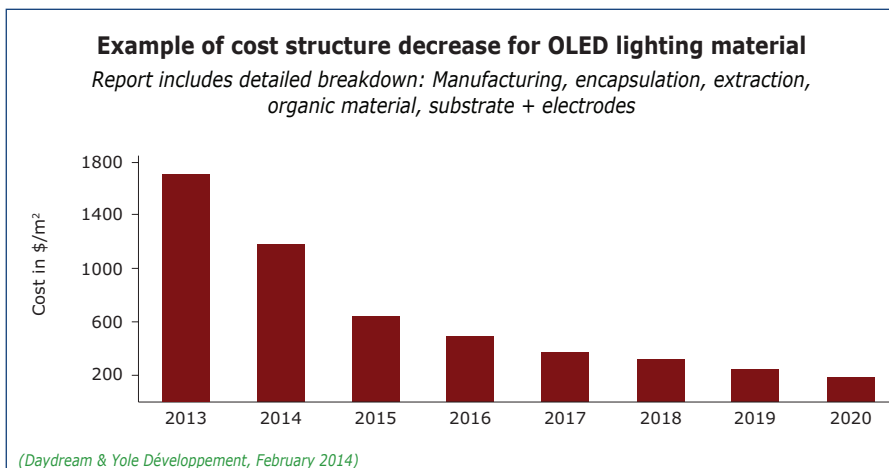
This past decade of investments and developments now begins to pay-off, and printed & flexible electronics is expected to ramp up in the next 10 years, creating the first volumes and stimulating the growth for equipment and materials in this field.

Even though most of the new companies - mostly start-ups or small companies such as ISORG, Canatu or KWJ Engineering - are expected to come from the sensing industry, the growth for equipment and materials will come from a few very large players involved in OLED manufacturing. Those players are easily identified. They are Samsung and LG for OLED displays and mainly Philips, General Electrics, LG and OSRAM for OLED Lighting.

OLEDs for displays and lighting are the only technologies expected to reach high volumes by 2020 with almost 3 million m<sup>2</sup> of processed surface (which represents 77% of the total printed electronics market in 2020). Strong efforts are being made by chemicals companies, such as Merck, DuPont, Dow, BASF and Sumitomo, in order to provide adequate inks and protective coatings that would allow solution printing of OLED devices.

Similarly, equipment manufacturers such as Coatema, Applied Materials or Kateeva aim at offering industry-adapted equipment for OLED manufacturing. Nevertheless it is still uncertain which manufacturing techniques will be preferred by industrials (inkjet, screen printing, spray coating, etc...) for material deposition.

### EXCITING TECHNICAL CHALLENGES FOR THE CHEMICAL INDUSTRY



In this report, we explain how the growing demand for printed and/or flexible electronics will raise the production volumes for all materials. Chemical companies will enter a phase of process upscale, and optimization to guarantee a production at the same level of quality and maintain high margins while prices will progressively decrease. Overall costs of flexible and/or printed electronics have to be decreased in order to compete efficiently against inorganic solutions.

Value for the chemical industry will lay in the development of new molecules supported by computational chemistry but also in their formulations adapted to various printed technologies and end use.

The short commercialization times of most electronic products will be a challenge for the chemical industry that will need to adapt its development habits and follow the innovation pace required.



## MARKET GROWTH AND TECHNICAL INNOVATION WILL BE MORE CHALLENGING IN NON-OLED RELATED FIELDS

On the other hand, growing sales and technological advances are much more complicated when aiming at applications such as photovoltaic and printed sensors.

Contrarily to OLED applications, flexible and printed solutions in photovoltaic are not being financially supported by significant investments of players such as LG or Samsung. Opportunities for new active materials or cost-efficient encapsulations supported by a broad number of research entities will come if new applications (e.g., building integrated PV) start generating sales.

The printed sensor field is extremely fragmented and is generally formed of niche markets.

In this segment, each application requires specific materials and specific equipment dedicated to low volume production. An ink developed for a specific application cannot necessarily be used for another purpose. For example, a semiconductor material dedicated to absorb and react to Infra-Red (IR) light (and thus used for printed IR detectors) cannot be used for visible light sensing. Similarly a material dedicated to sense carbon monoxide (CO) will be unlikely to sense Nitride Oxide (NOx). For this reason, chemical companies will focus on high-end applications where volume could be low but added value will be high. Finding a provider for a specialized active material can then be a challenge for a small start-up with innovative concepts and a commercial limitation in this part of the printed electronics market.

## OBJECTIVES OF THE REPORT

This report, aims at giving insights on:

- The market and applications for Printed & Flexible electronics
- The timeline by applications (displays, lighting, solar cells, sensors, system-in-foil)
- The different production processes and technical challenges
- Equipment forecast
- Technical requirements & challenges for materials
- Cost structure material
- Material forecast
- Main players status

### COMPANIES CITED IN THE REPORT (non-exhaustive list)

3G Solar, 3M, AGC, AGFA, Apple, Applied Materials, Asahi Glass, Ascent Solar, Astron Fiamm, Asys Solar, AUO, BASF, Beneq, Bosch, Boschman, Catrene, CEA LITEN, Ceradrop/MGI, CNM, Coatema, Corning, Creative Materials, DEK, DOW, Dubuit, Dupont Displays, Dupont Teijin, Dyesol, E-ink, EPFL, Epson, EVG, evonik, FHR, First Solar, Flexink, Flisom, Fraunhofer, Fujifilm Dimatix, G24i, GE, Haiku Tech, Heliatek, HelioVolt, Heraeus, Hodogaya Chemical, Holst Center, Hyet Solar, Idemitsu Kosan, IMEC, IMRE, Inkoa, ISET, ISORG, JRT, Kateeva, Kodak, Konica Minolta, KUL, Kunshan Hisense, LG, LPKF, M-Braun, Machines Dubuit, Markandy, Matsushita, Merck, MGI, Miasole, Micro-tec, Mitsubishi Materials, Nanoink, NEC, NewLong, NextInput, Nitto Denko, Novacentrix, Novald, nTact, NTC, Ntera, NVC, NXP, Oike, Optomec, Osram, Panasonic, PARC, PixDro, Philips, Plastic Logic, Plextronics, Prelonic Technologies, Prism Pak, Rolith, SAES Getters, Sakurai, Samsung, Schmid, Schott, Sekisui Chemical, Sigma Aldrich, SiPix, Solarmer, Solaronix, SolarPrint, Sumitomo Chemical, Tazmo, Teijing Chemica, TNO, Toppan, TU Delft, Universal Display Corp., Veeco, Verhaert, Vitex, Von Ardenne, VTT, Wageningen UP... and many more

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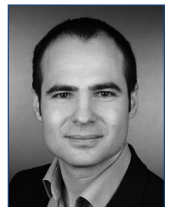
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Since 1998, he is a cofounder of Yole Développement. Eric is in charge of market analysis for MEMS, equipment & material, photonics and Printed Electronics. He is Chief Editor of MEMS' Trends & Micronews magazines. Before joining Yole Développement, Eric worked as a market analyst at CEA Leti. He has a PhD in microelectronics from the INPG in Grenoble.



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Fabrice joined Daydream in 2005 and is Associate Director in charge of the German subsidiary since 2010. Fabrice has performed and managed over 40 projects in chemistry, materials and life science and has a PhD in Chemistry from the Dortmund University (Germany).



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Wenquan works as business analyst for Daydream in Shanghai. He holds two Masters of Science, one in Engineering from the Tongji University (China) and one in Sustainable Development from the Uppsala University (Sweden). Before joining Daydream, Wenquan has worked at the Stockholm Environment Institute and the Asian Development Bank.

# ORDER FORM

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BLZ: 370 501 98  
Kto-Nr.: 1900630540  
IBAN: DE97 3705 0198 1900 6305 40  
SWIFT or BIC: COLSDE33XXX

#### RETURN ORDER BY

FAX: +49 (0)221 35 64 020  
MAIL: Daydream GmbH  
Kaiser-Wilhelm-Ring 13  
D-50672 Cologne - Germany

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contact@daydream.eu

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#### MORE INFO:

www.daydream.eu – contact@daydream.eu

### ABOUT YOLE DEVELOPPEMENT

Founded in 1998, Yole Développement has grown to become a group of companies providing marketing, technology and strategy consulting, media in addition to corporate finance services.

With a strong focus on emerging applications using silicon and/or micro manufacturing, Yole Développement group has expanded to include more than 50 associates worldwide covering MEMS, Compound Semiconductors, LED, Image Sensors, Optoelectronics, Microfluidics & Medical, Photovoltaics, Advanced Packaging, Nanomaterials and Power Electronics. The group supports industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to develop their business.

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  - or
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BLZ: 370 501 98  
Kto-Nr.: 1900630540  
IBAN: DE97 3705 0198 1900 6305 40  
SWIFT or BIC: COLSDE33XXX

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- 3.4 Payment is due by the Buyer to the Seller within 15 days from invoice date, except in the case of a particular written agreement. If the Buyer fails to pay within this time and fails to contact the Seller, the latter shall be entitled to invoice interest in arrears based on the annual rate Refi of the «BCE» + 7 points, in accordance with article L. 441-6 of the French Commercial Code. Our publications (report, database, tool...) are delivered only after reception of the payment.
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