PRINTING ELECTRONICS REPORT
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ET TRENDS

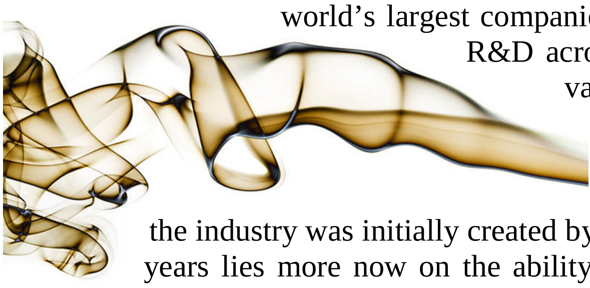
NEWS

Printed Electronics Market - The market for printed electronics (PE), including organics, inorganics and composites, will rise from $1.18-billion in 2007 to $48.18-billion in 2017, according to IDTechEx's 2007 study. The majority of the market in 2007 is for electronics in the following three somewhat conventional categories: (1) Conductive inks for membrane keyboards, PCBs, flex connectors ***[Not sure if this is a fair inclusion - how is PE being defined? I view membrane switches as a 30-year old flex circuit technology, and not even a very sophisticated area. Regardless, these numbers seem quite high]***. (2) Sensors (e.g. disposable glucose sensors for those with diabetes), and (3) organic light emitting displays (**OLEDs**) which are mostly on glass substrates and not printed as yet.

These three products will be rapidly overtaken in terms of market value as hundreds of companies develop according to IDTechEx. Examples are OLEDs on flexible substrates, which are printed thin film transistor circuits (TFTCs), photovoltaics, and many other components. The report finds that 31.6% of the electronics discussed are fully or partially printed in 2007. This rises substantially over the next ten years to 90.3% by 2017. If we look at the market size by territory, most work is taking place in Europe, the US and Japan; Europe is in the lead [***mostly in Germany***]. For instance, the first printed electronics factories are appearing there. But more money is being spent in East Asia; 56. This is because the biggest component, OLED display modules, are made there and bought by companies making devices, such as MP3 players. ***[See Flat Panel Display report for status of OLEDs - they are not doing all that well against LCDs].***

Sectors for printed and thin film electronics: The end point is low-cost devices on low-cost flexible substrates, the most difficult combination to achieve while retaining yield, lifetime and manufacturing ease, but opening up the largest markets.

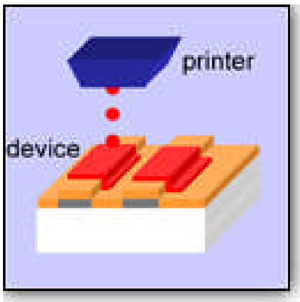
But who is in Charge? - Company positioning is fluid and will continue to be so. Some of the world's largest companies have little application focus but are committed to R&D across a wide breadth of challenges aiming to create a vast intellectual property (IP) portfolio. Others, particularly VC funded companies, are application driven with targets to bring product to market. Of course to some extent all are doing both. Whereas the industry was initially created by material development – its success over the next ten years lies more now on the ability to improve the manufacturing of devices to create high-yield, reliable, low-cost devices. ***[I see PE as disjointed and unfocused at this point. It needs help from a profession organization and less hype from marketeers].***



Commercial viability - Many commercial questions have yet to be answered. While people talk of nearly free fully-printed RFID tags (including the IC), the reality is that material companies may priced their materials as pharmaceuticals do in order to recoup their R&D investment, making the tag price less favorable compared to that of ultra-small silicon chips, which meet existing standards and are more capable and reliable (at least initially). On the other hand, having flexible displays such as e-book readers may be a reason to premium price products, but only if the display quality is good enough. The vast amount of IP may also pose an issue for the industry [***nothing new, this always happens].***

Opportunities - Materials will include the long-standing PTF inks, but add to this organic semiconductors, and probably some nano-materials.

TECHNOLOGY



More on PE - But How Much is Hype? - We are being promised a world where living room wallpaper doubles as your TV set, and you can download and print out a battery or a full-color computer display on your desktop printer, and entire high-rise buildings are sheathed in solar electronic billboards made of a transparent film resembling Saran wrap. The technology exists today in items ranging from handset displays and keyboard touch pads, to inventory tracking and fingerprint sensors, to interactive children's toys and games. Indeed, a whole new industry and supply chain are forming around the concept of what is being called printed electronics. It is not yet possible to use printed semiconductor technology to make complex devices like microprocessors, but soon it will be, according to industry executives. ***[What say the guys that actually have to do this?].*** Here's what the CEO of NanoIdent Technologies AG (Lenz, Austria) had to say, "I predict we will see the first printed integrated circuits within the next few years. And even microprocessors are not that far away. In five to 10 years, we will see complete computers made of printed electronics." ***[I wonder if most of the promises come from one company, a market research firm, IDTechEx Ltd. of Cambridge, England).]*** IDTechEx says that by 2015, the market is expected to balloon to more than $30-billion; and 20 years from now the printed electronics market will have surpassed $300-billion in revenue.

Using printing techniques to create electronic devices offers a couple of advantages. One is that circuit size can be very large, on the order of an area comprising several square meters, enabling the creation of whole new classes of devices. Price and production time are also drastically reduced. Industrial printing systems today can print 100,000 m^2/hr, that's a surface area equivalent to 65 times the capacity of a modern chip fab, while a typical silicon chip takes several weeks or even months to go through the fabrication process. This doesn't mean that printed semiconductors will displace traditional silicon chips in mainstream electronic designs. Rather, printing is seen as a way to enable new uses for technologies that today are limited by cost and inflexible substrate materials, such as RFID, displays, photovoltaics and optoelectronics. Today, the bulk of printed electronics R&D is going toward RFID ***[antennas are mostly etched copper at this point]*** and display applications, and rightly so, analysts said. The market for RFID tags is expected to reach $3-billion by 2009, according to market research firm In-Stat (Scottsdale, Ariz.). NanoMarkets projects that OLEDs used in displays and lighting applications will become a $10.9-billion market by 2012.

The industrial printing industry is becoming increasingly interested in this emerging technology. Large printing and materials companies with interests in the electronics manufacturing space, such as Canon, Dai Nippon Printing, HP, Sharp, Toppan and Xerox, have a vested interest in the printed electronics arena. Several companies in Europe are said to be involved in the area of printing EU passports, which contain some simple electronics circuitry, for instance.

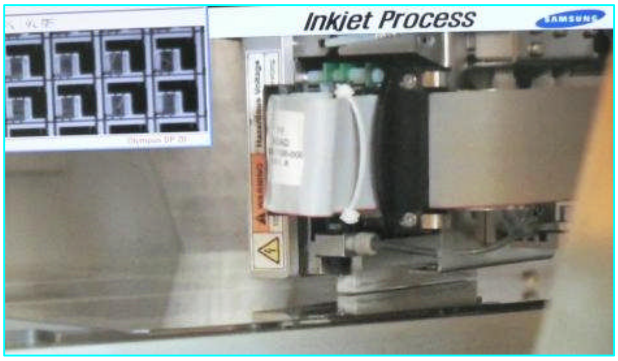
As with the traditional electronics industry, the question of whether to manufacture in-house or outsource will depend on economic factors, although the cost of a new fab for printed semiconductors is cheap, on the order of $100-million, compared with $3-billion to construct and equip a state-of-the-art silicon fab. There are at least a half-dozen companies building printed electronics plants to manufacture their own designs, and more are sure to follow. NanoIdent's OFAB is thought to be the only one currently in volume production. Other companies, such as Motorola, are working with outside printers. While printing semiconductors onto flexible or organic substrates might seem a natural extension for silicon manufacturers, which use printing techniques to "etch" circuitry onto wafers, thus far there is not much movement in that direction within the foundry camp. For one thing, the cash register isn't yet ringing loudly enough to lure volume-oriented foundries. For another, the immediate need is for manufacturing partners with printing expertise. This could change as the semiconductor manufacturing chain becomes savvier about printed electronics. But for the time being, technology developers are seeking out industrial printing suppliers rather than those with classic semiconductor skills. Traditional silicon companies are also keeping a hand in this emerging sector. Intel Corp., which tried unsuccessfully to develop a commercially viable form of organic nonvolatile memory, has shifted its strategy to one of arm's-length involvement. Through its Intel Capital investment arm, the company is now funding startups like E Ink Corp. and Plastic Logic Ltd. Other chip companies like STMicroelectronics and Advanced Micro Devices Inc. are internally developing plastic or organic electronics. ***[Actually, organic memory appears to be progressing just fine].***

Commercial products using printed electronics, such as the Motofone are still, are just getting started, as are the technology and manufacturing infrastructure needed to develop them. It may be decades before TV sets are commonly embedded in wallpaper. But some applications have begun to seep into everyday culture without much notice. Board game maker Hasbro collaborated with E Ink to give a high-tech, interactive feel to its Clue game, which was nearly dead in terms of sales. Conductive inks embedded in game boards, combined with conventional coin-cell batteries, could create and break circuits as players moved game pieces around the boards. Hasbro said that it sold $30-million worth of Clue game sets.

Motorola Inc. has had a small R&D team working on printable and flexible electronics technology for some time. Last year, some of this research found commercial application in the Motofone, an ultra-thin handset targeting emerging markets such as India and Brazil. The mobile phone was the first to use low-power electrophoretic display technology, known more commonly as electronic paper. EPD technology has been around since the late 1960s, but has only recently shown up in low-end notebook computers and removable flash drives, according to reports. Although Motorola's main area of interest is the wireless arena, the research group, which is part of Motorola Laboratories, is looking beyond the technology's wireless applications like RFID tags, to possible uses in solar panels, for example. In one industrial application, Thin Battery Technologies Inc. teamed up with Sealed Air Corp.'s TurboTag solution to develop printed RFID tags for cargo containers that store temperature-sensitive products. The device senses temperature over time, stores the information and downloads it at the end of the supply chain via an RFID reader. TBT's aim is to partner with makers of RFID chips in early-stage design to enable printing of a complete RFID system in one circuit, said Leonard Allison, TBT's director of business development. Though the 0.7-mm-thick carbon-zinc battery is twice as thick as polymer lithium-ion batteries, the materials are less expensive and a special fab is not required.

NanoIdent is using printing techniques to create optoelectronic circuits on bendable, ultra-light plastic foil substrates. BioIdent is also using its printable optosensor technology to develop tiny, disposable lab-on-a-chip devices for cost-sensitive applications in both the medical and industrial arenas. Source: CMP

Samsung Can Inkjet Electronics - Samsung Electronics (Korea) has formed an organic TFT array substrate using inkjet method. The company developed the technology with the goal of drastically slashing the cost of TFT substrates used in LCD panels. Samsung set up a microscope in front of the inkjet-formed organic TFT array substrate and had visitors closely see that the TFT array was sufficiently formed through a magnified image of the array. This organic TFT drive employs the bottom gate structure. Organic semiconductor solution is inkjet-printed and inkjet printing at up to 140 ppi high-resolution is supported, the company said. Source: TechOn.



MATERIALS

Nanoink - High-resolution organic transistors on flexible polymer substrates is a critical step towards all-printed electronics. One key is the use of laser-sintered, inkjet-printed metal nanoparticles – a technique that came to light back in 2004. Researchers from the University of California, Berkeley, US, and ETH Zurich, Switzerland say they are close to hitting the required price points and expect to roll out a prototype large area display within the next 4-years. Other applications set to benefit include ultra-low cost RFID tags, thin-film photovoltaics and flexible sensors. At the heart of the printing process is a nano-ink of gold particles (diameter 1–3-nm) stabilized by a self-assembling monolayer (SAM). The size of the nanoparticles and the fluidic properties of the carrier solvent are some of the most important considerations," Seung Ko told nanotechweb.org. The size-dependent melting temperature depression is critical to our work and can be observed only for particles smaller than 10-nm. Bulk gold starts to melt above 1063°C, whereas the melting point of a 2-nm diameter gold nanoparticle is just 150°C. The team uses an argon ion laser beam (wavelength 514.5-nm) to selectively sinter the original printed pattern, reducing the line-width from an inkjet limited resolution of around 50µm to less than 10µm. According to the researchers, laser-sintered gold lines show much greater uniformity and higher resolution (down to 1–2 µm) than inkjet printed patterns that have simply been treated with a heater. Surplus nano-ink is easily washed away using an inorganic solvent. The SAM protected nanoparticles are very stable and can be re-applied to reduce manufacturing costs without affecting the quality of the device. Ko and his colleagues have shown that their plastic compatible process suits the fabrication of organic field effect transistors (OFETs), a building block for more complex devices. To evaluate the sintered electronics, the team compared its OFET with a device fabricated using conventional lithography. ***[OK, so we have gold wires, but where's the organic transistor?]*** Source: Nanotechweb.