PRINTING ELECTRONICS REPORT
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MARKET NEWS

Market Study - NanoMarkets is offering a new report on organic materials that predicts that currently "nichey" OLEDs will exceed $1.0 billion in sales by 2010 and then go on to reach $15.8 billion by 2015. But it is going to take some interesting new paths. **Today, organic electronics materials are all about OLEDs.** NanoMarkets thinks that some 80% of materials sold for OE at the present time are for this application. But that is going to change. Coming up fast are OTFT applications in RFID and display backplanes. During 2007, they saw the first tentative steps to the commercialization of both applications. Although the case for neither application has been made fully, OTFTs do seem to be an attractive route to both ultra-low cost RFID tags and flexible backplanes. By 2012, they expect that printed electronics materials sales into the RFID sector will actually exceed sales of materials into the currently all-important OLED market. Sales into the display backplane sector probably never will exceed OLED materials sales, but we still have great expectations for them. At the moment, display backplanes using organic materials account for under $1 million mostly made up of some pentacene and some plastic substrates. NanoMarkets thinks, however, by 2015 we will be talking $1.8 billion of materials sold into the organic backplane sector, if the semiconductors, conductors, dielectrics and substrates are all added up. Not that the OLED market is going to become unimportant for materials makers. This year - 2007 - hasn't been the best of years for the OLED industry. OLEDs have not moved into cell phone main display sector as fast as some people hoped and retooling by display firms in Asia made the second half of 2007 a very poor one for OLED production. Source: NanoMarkets.

Another New PE Market Study - Printed electronics hold the potential to be a game-changer in a wide variety of end markets, according to a new study from ABI Research. Innovative printing techniques have the capability to facilitate high volume, low cost manufacturing of electronics components, which will enable new applications that were not previously addressable with traditional electronics manufacturing techniques. While this **market is currently in its infancy**, ABI Research forecasts that **printed electronics will see very high growth rates through 2012 and beyond**. First products are just now becoming commercially available and market realization will be dictated by fulfillment of the promise of printing capabilities at a very low price point. It will take some time before printing and other cost are optimized and this will certainly vary from market segment to market segment in terms of what customers will accept. This new ABI Research study presents a detailed assessment of the state of the printed electronics landscape today, with market opportunity analysis across the optoelectronics, large area electronics and power generation/management sectors to assess drivers, barriers, key applications, materials and technologies, manufacturing and key industry competition. **Market applications** for printed electronics are: displays, solid-state lighting, electronic paper and displays, transistors, integrated circuits, batteries, and photovoltaics. The greatest market penetration by printing technologies to date has been in displays and lighting for portable electronics. Many of the technologies under development are not quite ready for prime time yet and initial applications are targeting niche markets. The most interesting applications involve leveraging printing for entirely new applications, especially those that can provide added value through needed functionality, industry cost savings, security and resource conservation. Applying printing technologies to solar cell manufacturing can result in better, more efficient materials utilization and manufacturing for greater return on energy investment and capital expenditure. ABI's new report, Printed Electronics, is designed to provide a global picture of key developments and challenges and business cases across this emerging industry. It forms part of the firm's Emerging Technologies Research Service. Source: ABI.

MANUFACTURING

Polymer Vision Starting Mass Production of Displays - ***[We've been tracking this PE company through all of 2007 and they appear to be on track with their goals at this point in time.]*** Polymer Vision Ltd. (Netherlands) announced that it has completed a flexible display plant in the U.K., and will start the world's first PE mass production at the facility. Their first commercial product is a roll-up display (the Readius) that comes in a size similar to a mobile phone and incorporates a 5-inch diagonal screen on the rollable side body. The product displays black and white images using e-ink type technology, but the display drivers are printed using organic inks. Polymer Vision plans to sell the displays targeting mobile handset vendors and will also launch commercial products developed by internally, this month. Source: EMS-Now.

Plastic Logic Get's Ready for Volume Production - This Printed Electronics (PE) company placed a multimillion-dollar order for an extrusion coating line from NexTech Solutions. The FAS Advantage IV Extrusion Coater Line will be fully automated and integrated into Plastic Logic's manufacturing line of **flexible organic active matrix displays**. The patented FASCoat unit is a high-performance extrusion coating system used in the development of flat panel displays. FAS Advantage Coaters are sold as an integrated solution in a full-track system or as a stand-alone solution for R&D applications. ***[Plastic Logic had earlier claimed that they were getting ready for commercial manufacturing in 2008, so this news is a good indication that they're on track.]*** The Plastic Logic has a goal of manufacturing high resolution transistor arrays on flexible plastic substrates by using a low temperature process without mask alignment that is scalable for large area, high volume and low cost. Plastic Logic was spun out of Cambridge University in 2000 to build on 10 years of research and has a team of more than 90 employees. The company has now raised equity and venture finance from financial and industrial investors including Amadeus Capital Partners (UK), BASF (Germany), Bank of America (US), Dow Chemical (US), Intel Capital (US), Morningside (Hong Kong), Merifin Capital (Belgium), Nanotech Partners (an international nanotechnology fund established principally by Mitsubishi Corporation of Japan), Oak Investment Partners (US), PolyTechnos Venture-Partners (Germany), Siemens (Germany), Tudor Investment Corporation (US) and Yasuda Enterprise Development (Japan). Other shareholders include Cambridge Display Technology, Seiko Epson and the University of Cambridge. Venture finance has been provided by European Technology Ventures and European Venture Partners. Source: Market Wire. ***[This press***

release goes a long way in validating the feasibility of Printed Electronics that is hard to evaluate because of exaggerated statements from IDTechEx].

Another PE Contender - NANOIDENT AG, a developer and producer of printed semiconductors-based optoelectronic sensors, announced that it has been selected as one of the 2007 Red Herring 100 Global, an elite group of innovative companies that are driving the future of technology. Red Herring 100 winners and finalists from North America, Europe and Asia of the last three years were eligible for this award. The Red Herring editorial team used a very competitive process to whittle down this pool of 1800 eligible promising companies to the 100 winners of this first-time award. All Red Herring 100 companies are evaluated based on both quantitative and qualitative criteria such as financial performance, technology innovation, management, and ecosystem integration; Global winners are also judged on global strategy, and must be set to handle the challenges of internationalization and a global presence. **Nanoindent's goal** is to make it possible and cost-effective for electronic components and even complete circuits to be placed directly onto a variety of surfaces using **printed semiconductor technology**; they expect to enable new products that will enhance healthcare, security, and the environment. Earlier in 2007, Ernst & Young Austria awarded NANOIDENT's founders the prestigious Entrepreneur of the Year Award. Meanwhile subsidiary BIOIDENT was also recognized both by analyst firm Frost & Sullivan and with the Wall Street Journal Technology Innovation Award. In March 2007, NANOIDENT opened the doors to its ORGANIC FAB, the world's first factory for printed semiconductor-based sensors, and the company is developing groundbreaking solutions in partnership with a number of leading companies in the medical diagnostic, environmental testing, security and IT industries. Source: Azonano.com

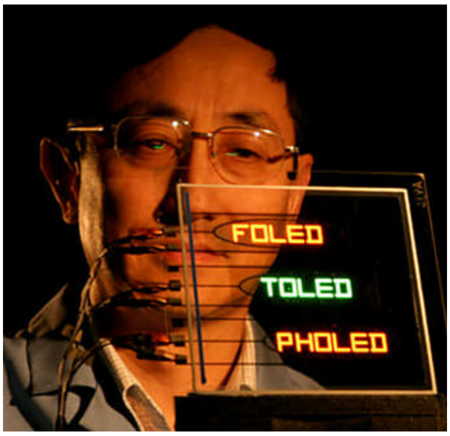
<u>HARDWARE DEVELOPMENT</u>

Ultra-high-resolution Inkjet Printer - Xilinx & UC Berkeley - A monolithic inkjet print head, fabricated with silicon micromachining technology and capable of generating microscale liquid droplets, is developed and shown to function successfully. The print head uses a dense array of thermal bubble inkjet devices, made on a single silicon wafer. Each device is made of a Pt heater stack, a small, shallow fluid chamber, and a refilling channel formed by a Ge-sacrificial etching process, a deep-etched through-wafer feeding hole, and a micron-scale nozzle opened in a thin nitride membrane by plasma etching. Experimental results with a high resolution video imaging system show that this print head is capable of generating water droplets as small as 3 μm in diameter (0.014 pL), about 1/70th the volume of the droplets produced by existing inkjet systems. The printing process is also found to be stable, uniform in droplet size and velocity, and free of satellite droplets at optimum operation conditions. At small distances between the print head and substrate, droplet spreading is also small. This print head is then a capable tool for ultra-high-resolution inkjet printing and can be used in research areas where delivery of micron-scale fluid droplets is desired. Source: Society of Photo-Optical Instrumentation Engineers

<u>PRINTED DISPLAYS</u>

Printable Display Progress - Universal Display Corporation, a major force in today's evolving displays and lighting with its PHOLED phosphorescent OLED technology, reported significant progress in the development of P^2OLED printable, phosphorescent OLED materials for use with solution-based manufacturing processes, which display manufacturers consider a prospective solution for the cost-effective production of large-area OLED displays.

Reported jointly with Seiko Epson Corporation (Epson) at the recent International Display Workshop (IDW) Conference, these advances are the result of a 3-year joint development program during which the two companies focused on the successful demonstration of Universal Display's P^2OLEDs for application to **Epson's proprietary ink-jet printing process** technology. The efforts to develop P^2OLED materials and technology for use with Epson's ink-jet printing technology have been highly productive and they have accelerated progress toward our commercial targets to enable the production of OLED displays that are low-cost, high-efficiency, thin, bright, and beautiful for a variety of consumer markets including large-area TV's. Most appreciate the potential of printable OLEDs, but the challenge for commercialization has been significant. The two companies reported progress in red, green and blue P^2OLED device performance in **spin-coated devices and ink-jet printed devices**. Demonstrating the high luminous efficiency of PHOLED technology, the team made significant progress in extending the operating lifetimes of its red and green material P^2OLED systems: Red with CIE (0.66, 0.33), luminous efficiency of 9 cd/A and greater than 50,000 hours of operating lifetime to 50% of initial luminance (at 500 cd/m (2)) and green with CIE (0.33, 0.63), 35 cd/A and greater than 50,000 hours (at 1000 cd/m (2)). The team also reported data for a new sky blue P^2OLED with CIE (0.19, 0.40), 18 cd/A and greater than 3,000 hours (at 500 cd/m (2)). In addition, results with ink-jet printed P^2OLED devices were reported which demonstrate the excellent film-forming ability of the small molecule layers. Ink-jet printed green P^2OLED devices were also demonstrated to have the same efficiency as those of the spin-coated control P^2OLEDs following an in-depth study of solvent selection and process optimization. Source: OLED TV Tech.



<u>PRINTED SOLAR</u>

nanosolar

CIGS Ink - Nanosolar claims a unique technology for producing cost-efficient solar electricity. The company says that the new technology is significantly superior to existing solar cell techniques, both in its versatility and in its availability. The technology enables production of several hundred feet of “solar sheet” per minute and relies on recent advances in the field of nano-structured materials. The centerpiece of Nanosolar’s technique is a proprietary ink developed by the company, which is used to print the semiconductor of the solar cell. The ink is based on various proprietary forms of nano-particles and associated organic dispersion chemistry. Once it is deposited on a flexible substrate, the ink's nano-components align themselves via molecular self-assembly, creating a homogenous mix of nano-particles that ensure the perseverance of the correct atomic ratios of the elements involved even across large areas of deposition. The material on which the cells are printed is metal foil substrate. Their thin-film solar cell consists of an absorber semiconductor layer, sandwiched between the top and bottom electrode layers. If the thin films of a solar cell are deposited directly onto a highly conductive metal foil (as opposed to glass or stainless steel), then the bottom electrode gets much simpler because the substrate can do the job of carrying the current. Nanosolar's technology uses a **CIGS (Copper Indium Gallium Diselenide)** thin-film semiconductor, capable of achieving considerably higher efficiency rates (up to 19.5%) than are achieved when using other thin-film technologies, such as Cadmium Telluride (CdTe) or Amorphous Silicon. In fact, a thin 1-nanometer-wide film of CIGS can generate as much electricity as a 200-300 nanometer-wide crystalline silicon wafer. However, such maximal efficiency rates can be achieved only in laboratory conditions (at this stage). Using expensive processing technology, mass produced CIGS solar cells usually have efficiency rates of 12%-15%, – making them about half as efficient as their crystalline silicon counterparts. The main advantages of Nanosolar's technique are its relatively high speed and the highly precise manufacturing process. According to the company, its thin-film solar films are more than 100 times thinner than silicon-wafer cells and therefore, have correspondingly lower materials costs – between 10%-20% of the current industry standard per kilowatt. The "printing" technique is executed in a "roll-to-roll" manner, in which meters-wide and miles-long rolls of solar panels are created and cut to a desirable size, much like the way in which newspapers are printed at printing houses. As opposed to the method of processing separate wafers or glass plates, a roll-to-roll printing process can be maintained for the entire length of the roll, eliminating undesirable start-ups and other cycle overhead costs – a key advantage, according to the company. Nanosolar provides a 25-year warranty for its products, and claim the cells are tested under much harsher conditions than mandated by official certification standards. During product development, the solar cells are exposed to extreme temperatures, frequent changes in the environment, intense UV light, and humidity. These examinations help the company to study the nature of various degradation mechanisms within a short period. ***[CIGS research has been sponsored by the US government for many years; there are SBIRs going back to at least 2004; one was issued to Foster-Miller].***

NANOSOLAR CELLS

When a quantum dot absorbs a photon from the sun, it gives off 2 electrons and 2 holes, which contribute to the electric current flowing from the cell's terminals into the storage battery