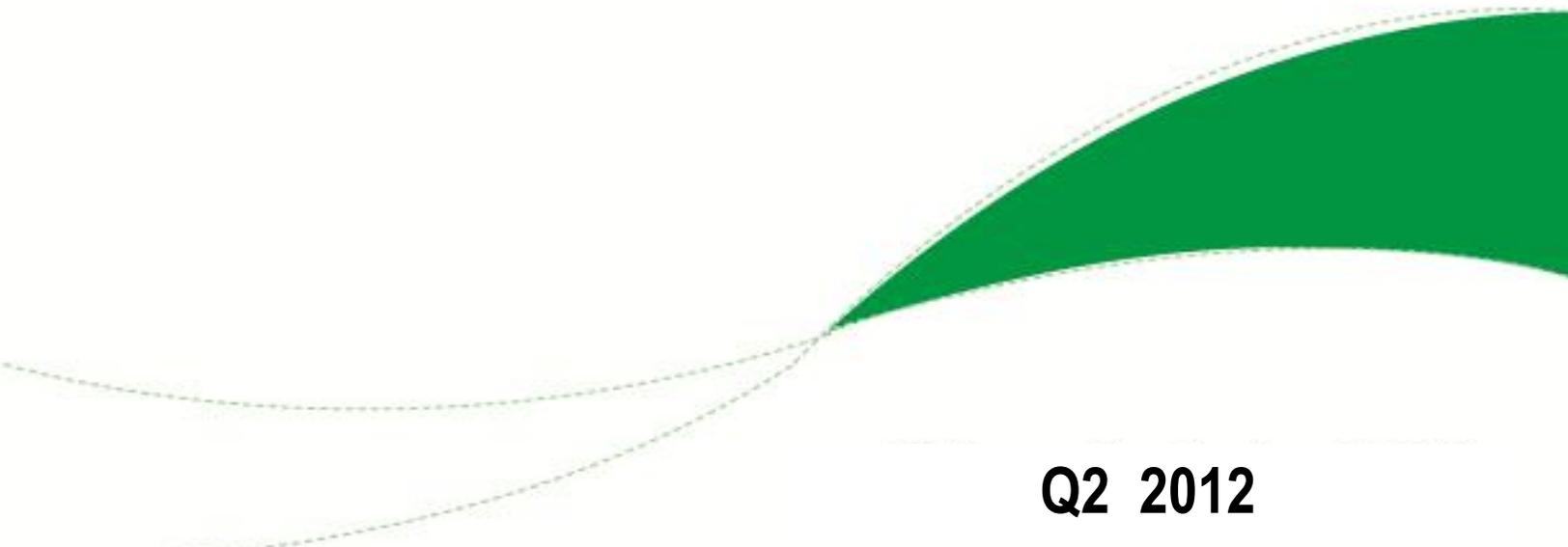


# FlexTech Trends

News from the world of displays and  
flexible, printed electronics



**Q2 2012**

# FlexTech Trends

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# Note from the President

by Michael Ciesinski



FlexTech Alliance extends a warm welcome to our newest members:

- Dowa Electronics Materials Co.
- Imprint Energy, Inc.
- MicroChem Corp.
- Miltec UV International
- National Research Council Canada
- PICA Manufacturing Solutions
- SKC Inc.
- Vitriflex, Inc.

From R&D to materials and equipment suppliers to energy harvesting and storage, these companies represent the broad spectrum of organizations contributing to the flexible electronics value chain. We look forward to seeing our new members at one of our upcoming events.

Our next scheduled event is the *Metal Oxide TFT Devices and Technology Workshop* on July 11, 2012, in San Francisco, CA. With a market that is estimated to reach \$2.1 billion by 2017, metal oxide TFTs are the key to lower manufacturing costs, power consumption reduction, higher stability for OLEDs, and other desirable characteristics for flexible displays, sensors and RFIDs. Look for more details of the workshop and registration information on page 9 of this edition of FlexTech Trends.

Also in this edition is a summary of FlexTech Alliance's *Road to Flexible, Wearable Electronics for Biometrics and Medicine Workshop*. Held on April 11, 2012, the workshop was a great opportunity to build industry consensus and lay out some action items for continuing the forward momentum in wearable electronics.

FlexTech Alliance workshops and other programs are designed to bring together subject matter experts who are developing solutions and enabling technologies.

The annual Flexible Electronics & Displays Conference & Exhibition is a perfect example of this. Year after year, the information exchanged at the conference and exhibition has helped build an industry. The 2012 Flex Conference was the most well attended to date – attendance was up 20% over 2011 and the number of exhibiting companies increased by 30%.

Read a summary of the information presented at the 2012 Flex Conference and insights offered at the conference by Steve Abramson, CEO, Universal Display Corp. in this newsletter. If you were unable to attend, conference proceedings are available for purchase on our knowledge portal. Visit [www.flextech.org](http://www.flextech.org) for information.

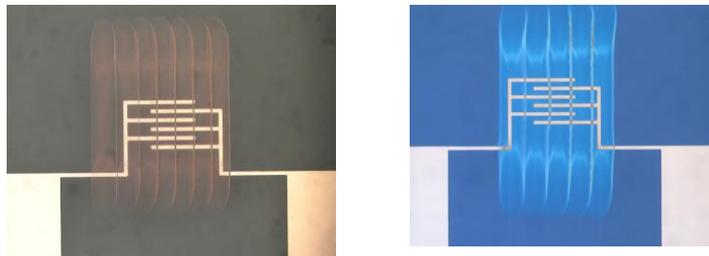
Finally, the latest news from the FlexTech Alliance community appears on pages 13 through 26. If your company has a good product or demonstrator story to tell, please contact Denise Rael at email ([denise.rael@flextech.org](mailto:denise.rael@flextech.org)) for consideration in an upcoming issue of FlexTech Trends.



## Member Profile: Polyera Corporation

### FlexTech Alliance Funded Project with Polyera Produces Printable, High-Performance Organic Semiconductors

*Printed CMOS circuits are now possible, leading to simpler circuit design, lower power consumption, reduced manufacturing costs and novel form factors.*



Optical image of inkjet-printed  
(a) P2100 and (b) N2200 TGBC TFTs and droplets  
Courtesy of Polyera Corp.

Polyera Corporation (Skokie, Illinois) recently completed a FlexTech Alliance funded project with team lead Jonathan Griffiths of Qualcomm, to produce new n-type organic semiconductors. The project has successfully produced high-performance solution-processable organic semiconductors for printed thin film transistors (TFT) devices, CMOS circuits, and displays. The project was chosen to receive FlexTech Alliance funding of \$.3M with the goal of developing organic materials that can be printed on flexible, lightweight substrates, enabling the manufacture of electronics with novel form factors such as roll-up displays, flexible solar panels and disposable diagnostic devices.

Historically, CMOS has not been possible with printed and flexible electronics, because only p-type organic semiconductors have shown the requisite level of performance. With the advent of Polyera's high-mobility n-type organic semiconductors, CMOS circuits are now feasible for the first time, leading to simpler circuit design and lower device power consumption. These new organic materials function similarly to traditional inorganic materials but with a major difference: they can be dissolved into solution. Because the materials are like ink, electronic devices can be printed using ink-jet, rotogravure, and other roll-to-roll printing processes, significantly reducing fabrication costs.

Throughout the project, Polyera met or exceeded all goals set forth. The team optimized and/or developed several new n-channel organic semiconductors for printed TFTs demonstrating unprecedented performance. These chlorine-free formulations are now available to customers. In addition to achieving targeted performance metrics, Polyera has successfully fabricated functional TFTs, CMOS inverters, and complementary ring oscillators.

Complete results of the project are available to FlexTech Alliance members in the Member Reports section of [www.flextech.org](http://www.flextech.org).



## Ushering in the ERA of OLEDs

In February 2012 at the Flex Tech Alliance’s annual Flexible Electronics & Displays Conference & Exhibition, Steve Abramson, president & CEO of Universal Display Corporation, delivered a presentation on OLEDs and AMOLEDs—covering the long term roadmap for commercialization of devices that leverage these display technologies including flexible display applications.

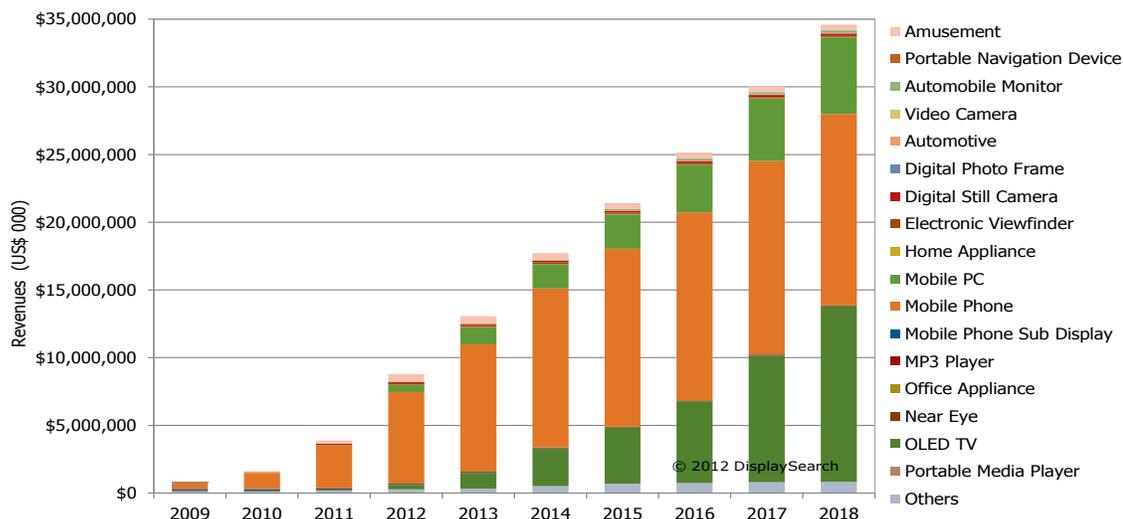


“OLEDs were initially discovered in the 1960’s and the seeds of commercial OLEDs were sown in the 1980’s,” noted Abramson. “OLEDs were going to be the next big thing for the following 20 years, but only in this decade are we seeing the growth of OLED displays long predicted.”

Products featuring OLED displays first hit the scene in the late 1990s, with multi-color OLED displays in mobile phones. Since then, we have seen a wide variety of OLED-based products including digital picture frames, navigational devices and televisions.

According to market research firm, NPD DisplaySearch, OLED technology advanced rapidly in 2011, and the firm expects this trend to continue throughout the decade. The company also mentions that OLED display revenues are forecast to approach \$35 billion by 2018.

Dr. Jennifer Colegrove, Vice President--Emerging Display Technologies, DisplaySearch, notes that “OLED technology has made good progress and is ready to enter large size applications, but low cost manufacturing for large sizes is still a challenge.”



NPD DisplaySearch Quarterly OLED display shipment and forecast report Q1’12

With the successful introduction of Samsung's 10mm Galaxy S series smart phones, Abramson referred to the second decade of OLEDs as the "Inflection Point". In 2011, Samsung invested around \$5B in OLEDs. Companies such as Sony, Google, Nokia, Nikon and Panasonic, among others soon followed suit with the launches of other OLED-based products.

Since then, the market for OLEDs has continued to grow, with the adoption of AMOLEDs for applications such as tablets, handheld devices and even TVs. Looking ahead to the next era of OLEDs, Abramson believes phosphorescence OLEDs (PHOLEDs) will provide even greater benefits to tomorrow's display centric electronic devices, with the phosphorescence enabling even greater energy efficiency, longer lifetime, thinner form factors and lower production costs, all while reducing requirements for heat dissipation components. In the longer term, AMOLED lighting is expected to surge in 2015.

Within the next 10 years, Abramson believes OLEDs will literally provide manufacturers with more design flexibility with the commercialization of flexible OLED displays, enabling applications such as long-awaited rollable displays.

**"Samsung Electronics to launch flexible OLED based products in 2012, probably start with phones" — OLED-info.com**



## FlexTech Alliance Workshop Provides Insiders' Views on the Future of Flexible, Wearable Electronics for Biometrics and Medicine



*Skin sensor contains micro-circuitry like transistors, sensors, transmitters and receivers that are bendable and stretchable like real skin.*

*(Source: mc10)*

***The Road to Flexible, Wearable Electronics for Biometrics and Medicine***, a workshop organized by the FlexTech Alliance on April 11, 2012, focused on how flexible and wearable electronics will create more effective, safer and less expensive methods for many applications. From sports to medical diagnostics to military, the experts agreed that the potential markets for wearable devices are extensive and will provide many opportunities for growth in the flexible electronics sector.

Dr. Malcolm J. Thompson, Chief Technical Advisor for FlexTech Alliance, noted, “this new industry we are creating will have a very broad impact on society by providing low cost distributed manufacturing and fast deployment of products by printing products closer to the user. The workshop was a great opportunity to build industry consensus and lay out some action items for continuing the forward momentum.”

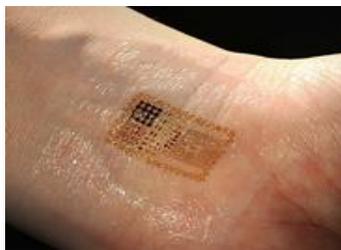
Product development and manufacturing challenges were the primary topics of the one day workshop, which brought together subject matter experts from around the U.S. who are developing solutions and enabling technologies. The workshop was attended by a diverse group of companies from different sectors, including research groups from PARC and GE; large companies in the printing business like Avery Dennison; creative start-ups making flexible electronic products; large defense contractors like Lockheed Martin; consumer companies like Nike and Reebok; and, government organizations including the US Air Force.

Following are some of the highlights of the day:

- Joshua Hagen of the **Air Force Research Laboratory** and Jeffrey Stuart from **Lockheed Martin** opened the workshop and discussed the pressing need for physiological monitoring of warfighters and airmen. A primary point was that aircraft and other modes of transportation contain abundant numbers of sensors to track vital conditions. However, the people operating this equipment need to be given the same consideration.
- Organizations such as **PARC**, **Body Media**, and **Physical Optics Corporation** are working on solutions. PARC has been an early pioneer for body sensors, especially when it comes to monitoring the impact of head trauma. In the future, we'll be able to keep an eye on grandmother's health or monitor weightloss directly on our mobile phones. These are some of the potential applications Body Media is working to make a reality.
- Physical Optics Corporation, with funding from the FlexTech Alliance, is working on a soldier triage project that will gauge vital signs, including heart rate (derived from ECG), respiration rate (derived from ECG), and skin/ambient temperature. Dr. Thompson said “This project was funded by the FlexTech Alliance, as we believe it is extremely important that prototype demonstrations should be available to demonstrate the power of flexible, printed electronics to reduce health care costs for all and provide efficient treatment and monitoring of the elderly, infant, accident victim and soldier in the field.”

- Underlying technologies are needed to bring these products to market. Zhenan Bao, Associate Professor, Department of Chemical Engineering, **Stanford University**, illustrated a clever use of organic and carbon nano materials for electronic skin. Fabricating this skin in an array structure is the key to its elasticity. Dr. Bao presented the super skin and robotic jelly fish project underway at Stanford. Gabe Cortina of Avery **Dennison** pointed out the complexity and effort needed to have sensors adhere to the skin. He shared the practical challenges in adhesives and materials selection faced by Avery Dennison through the development of a 7-day vitals skin-patch.
- Moving to manufacturing is critical. Jeffrey Ashe of **GE Global Research** highlighted recent developments in systems through manufacturing and discussed continuing fabrication considerations and challenges. Benjamin Schlatka, VP Business Development, **MC10** shared an overview of their proprietary process for manufacturing bio stamps on elastomer surfaces. MC10 is currently focusing on monitoring hydration to ensure peak performance, and body temperature variation, which can prevent injury.
- For practical commercial applications, it was generally agreed that data acquisition quality, attractiveness and conformability to the body, and ability to function in “hostile” environments are crucial characteristics for flexible, wearable electronics for biometrics and medicine.
- From a conceptual viewpoint, Paul Litchfield of **Reebok** and Ben Kuris of **Shimmer Research**, gave very informative presentations on the importance of collaboration in getting a product from concept to delivery. Litchfield mentioned the importance of competitors to validate concepts, while workshop attendees from Nike agreed that competition validates concepts and spurs the market forward.
- Complete wearable systems and subsystems that incorporate sensors, data collection, flexible displays, wireless transmission, memory, solar cells and thin batteries have the ability to monitor vital health signs and give immediate feedback into performance and physiological well-being. Integrating all these components will be challenging.

Workshop proceedings are available for purchase. Contact [info@flextech.org](mailto:info@flextech.org) to order your copy.



Workshop sponsored by:



Workshop tour hosted by:





**FlexTech Alliance Presents:**

**Metal Oxide TFT Devices and Technology Workshop**  
**Wednesday, July 11, 2012**  
**10:00 AM - 4:00 PM**  
**San Francisco Marriott Marquis**

[Registration](#) for this workshop is now open.  
Hurry, early bird pricing is in effect until June 2, 2012.

Metal oxide TFTs are the key to lower manufacturing costs, power consumption reduction, higher stability for OLEDs, and other desirable characteristics for flexible displays, sensors and RFIDs.

Attend this workshop and learn about the materials, device characteristics, low temperature processes, deposition and web handling tools available to produce high performance metal oxide TFTs.

Results of successful implementations will be shown.

The distinguished group of speakers for this workshop includes representatives from:

- Sharp
- PARC
- Cambridge NanoTech
- Pennsylvania State University
- and others
- CBrite
- Applied Materials
- Eastman Kodak
- Oregon State University

The workshop will address:

- Device architectures
- Key enablers and applications for ubiquitous thin film electronics
- Improving the performance of device processes at low temperature
- Design of displays, sensors, and other products using high-performance TFTs
- Material handling, device patterning and yield issues associated with R2R manufacturing
- Fine tuning the composition of multi-component films, such as mixed metal oxides

Visit [www.flextech.org](http://www.flextech.org) for more information



### **2012 Flex Conference Experiences 20% Surge in Attendance and 30% Increase in Exhibits**

The 2012 Flexible Electronics & Displays Conference & Exhibition, held February 6-9, 2012, achieved new records in attendance and exhibiting companies, while maintaining a high-level of business and technical content.

The Flex Conference, now completing its 11<sup>th</sup> year, has experienced steady growth in the number of attendees and exhibitors, as well as the diversity of products and technology being presented. This year's conference registered 565 attendees, up 20% over 2011, and 57 exhibitors, a 30% increase that filled the exhibit hall to capacity.

#### **Diverse Industries**

The increase in numbers also reflected the diversity of industries interested in flexible, printable technology. Over the years, the conference has consistently attracted materials, chemical and film manufacturers such as 3M, DuPont, FUJIFILM, and Merck. In 2012 representatives from end-user companies such as BP, Boeing, Estee Lauder, Nike, PepsiCo, and WMS Gaming attended the conference, expressing interest in learning how this technology can be applied to their products to give them a competitive advantage. System integrators such as IBM, Intel, HP, Microsoft, and Qualcomm were also on hand.

Attendees from paper and printing companies such as Goss International, Sappi Fine Paper, Toppan Printing, Mitsubishi Paper Mills, and Daio Paper have been looking for ways to expand into new markets and fully utilize existing printing capabilities. Glass manufacturers Corning, Schott, and Asahi Glass were also present to explore new markets.

#### **Collaboration**

Collaboration was an especially strong theme echoed throughout the event. The importance of working together was emphasized during "The Path to Commercial Products" panel discussion and the "Pilot Production & Beyond" session. These sessions reinforced the concept that cooperation is required between materials and equipment suppliers as well as system integrators to bring products to market.

Facilitating this type of collaboration is the goal of FlexTech Alliance and its technical program. Results of the FlexTech Alliance R&D program were visible throughout the presentations and in the exhibit hall.

-Corning Inc. explained the applications and benefits of flexible glass. Corning was awarded a grant by FlexTech Alliance to develop commercially viable methods for continuous printed electronic manufacturing on flexible glass substrates. There are a number of applications that can benefit from the inherent qualities of glass, including photovoltaic devices, e-paper, color filters, OLED lighting, large-area sensors, display backplanes and additional photovoltaic devices. At the conference, the company previewed its new video "A Day in Glass 2".

- Cambridge NanoTech presented the progress being made with the FlexTech Alliance awarded contract to develop a high-speed Atomic Layer Deposition (ALD) system. When completed, the system will enable the manufacture of large-area and flexible substrates for use in organic electronics, solar cells, biomedical devices, and displays.

-Henkel shared the outcome of their recently completed project. The result is a process that can utilize the manufacturing infrastructure already in place for LCD displays to fabricate flexible displays or novel form factor applications with minimum process modification or capital investment.

-Solarmer Energy presented the results of a FlexTech Alliance funded project to develop high performance materials for organic photovoltaic cells (OPVs). The project resulted in record breaking OPV efficiencies. The company states that their products have the potential to cut the energy production cost down to 12 to 15 cents/kWh and less than \$1/W by the 2014 timeframe.

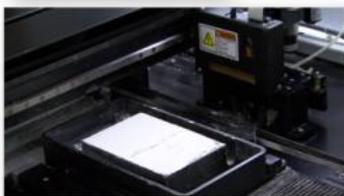
-Western Michigan University revealed a new materials registry program initiated with FlexTech Alliance support and demonstrated the registry in the FlexTech Alliance booth. The project consolidates available information about functional materials into a searchable database to assist technology developers and manufacturers to commercialize and grow their technologies.

- Clemson University had a hands-on printing demonstration in the exhibit hall, producing printed electronic components on site. FlexTech Alliance funded a study at Clemson University to examine the capability of flexography, gravure, and rotary screen printing as high-speed, commercially available roll-to-roll technologies for the manufacture of advanced devices.

### Where is this all leading?

Dr. Jennifer Ricklin, chief technologist at the U.S. Air Force Research Laboratory and the opening keynote speaker of the 2012 Conference, predicted that flexible, printed electronics will usher in the Organic Age, the coming together of nanotechnology, biology and information technologies.

## So What's Next



<http://www.technologyreview.com/article/23316/7nid=nlby&cid=2011-12-18>  
<http://www.eneadest.com/2011/11/30/3d-printed-bone-replacements-coming-soon-to-an-orthopedic-surgeon/>

“So where do I see things headed? I see a confluence of printed electronics and 3D printing,

In December General Electric reported producing a 3D printed fuel injector for a jet aircraft engine. ... Also in December, Washington State University researchers, used a 3D printer to create an artificial bone...

Now imagine inks made of living cells, possible stem cells, added to the 3D printed structure. Imagine organic P.E. sensors embedded in the finger tips and skin to sense pressure, pain, heat, cold, and so on.

Now also imagine aircraft, automobile, or any other mechanical device with embedded electronics capable of doing < you fill in the blank>. We no longer have to think of electronics and mechanics separately – they are merging.” - Dr. Jennifer Ricklin

## Flexible Displays

Steve Abramson, president and CEO of Universal Display Corporation, gave an inspiring and informative presentation on the future (and present) of organic light emitting diodes (OLEDs) technology. OLEDs are a hot trend in display and lighting technology. OLED displays will challenge the liquid crystal display supremacy (LCD) because they have fewer parts, a lower bill of materials, and a superior image.

The 2012 Flex Conference dedicated entire sessions to OLED displays and flexible display technologies with presentations from EMD Chemicals , 3M, HP, Display Technology Center, DuPont, Samsung, Sony, Solvay, Fraunhofer, Plastic Logic, Polymer Vision, and others. These sessions shared information on the state of the art materials and manufacturing techniques needed to get flexible displays and OLED products to market.

## Photovoltaics

Flexible and organic is also the next wave for photovoltaics. James Buntaine, CTO of Konarka presented working examples of off-grid applications of flexible organic photovoltaics (PV) such as bus stations in San Francisco and green houses in the Middle East. The large off-grid population opens new markets for this technology, harvesting energy from earth abundant materials.

Joining Buntaine in a flexible photovoltaic panel discussion at the Flex Conference were experts from Massachusetts Institute of Technology (MIT), Global Solar Energy, Heliatek, Solarmer Energy and IBM. Each company presented their approach to improving efficiency, cost, reliability and the watts per pound ratio.

## Printable Products

The printing industry is increasingly engaged with the electronics industry and this merger of capabilities was explained by John McCooney of DuPont and Kevin Manes of Mark Andy. Both noted that there are multiple printing mechanisms that will print electronic circuitry, with gravure and flexography as the most likely contenders.

Two full sessions were dedicated to printing techniques and materials. And several working products that are fabricated using printing processes were presented including:

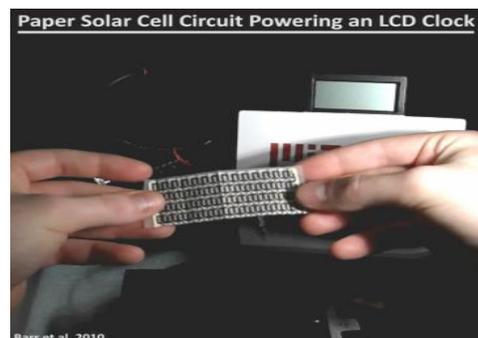
- Printed light bulbs , Nth Degree
- Rewritable memory and logic, ThinFilm Electronics
- Printed batteries, Enfucell
- Printed temperature sensors, PST Sensors
- Near field communications devices, US Army
- Organic complimentary decoder circuits, PARC
- Humidity sensor, New Jersey Institute of Technology
- and many more

## New in 2012 – Evolving Equipment, Metrology & Medicine

Several new topics were added to the 2012 Flex Conference agenda to reflect the maturing of the industry. “Evolving Equipment and New Capabilities” and “Metrology and Standards” underpinned the fact that production requirements now require serious consideration. Finally, the new “Medical” session, along with “Novel Devices” discussed applications where flexible electronics will be a game-changer.



*William Ray from Nth Degree demonstrates a printed light bulb*



*Miles Barr of MIT presented a successful process for printing photovoltaics on paper.*

# News and News Links from FlexTech Alliance

*excerpted from  
Veritas et Visus  
newsletters*

## **FlexTech Alliance announces new Board members**

The FlexTech Alliance announced that Jennifer Ernst of Thin Film Electronics and Michael C. Dudzik of Lockheed Martin have joined its Governing Board. Both industry veterans bring specialized expertise in business development and emerging applications to the alliance. <http://www.flextech.org>

- Jennifer Ernst is currently Vice President North America for ThinFilm Electronics, a supplier of printed non-volatile and flexible memory products. She is working closely with clients and partners to fulfil the vision of fully integrated systems created by printed electronics. Prior to joining ThinFilm, Ms. Ernst was Director of Business Development for PARC, a Xerox company, where she had more than 20 years' experience in technology innovation. As a key player in helping establish PARC's open business model, she expanded PARC's impact into multiple new industries and secured licensing and co-development relationships with companies throughout the U.S., Asia, and Europe. She holds an MBA from Santa Clara University and BA from San Francisco State University.
- Michael C. Dudzik serves as Vice President, Science and Technology Washington Operations at Lockheed Martin. He is an industry executive with extensive engineering design, development and manufacturing experience. Mr. Dudzik is nationally recognized for his expertise in bringing new technology-based products to market. Michael previously held leadership positions at Texas Instruments, ERIM Automotive and Georgia Technological University. He is a former Brigadier General in the United States Air Force Reserve with assignments in advanced technology, system development, and Space operations. He earned a Bachelor of Science degree in Physics at University of Detroit, a Master of Science in Nuclear Engineering from Ohio State University, and a Master of Business Administration from University of Dallas. He has been active on the University and Small Business advisory boards, including: the University of Michigan, Florida State University and the University of Detroit Mercy. He is an SAE Fellow and a Registered Professional Engineer.

## **FlexTech Alliance project with Solarmer Energy yields high efficiency organic photovoltaic cells**

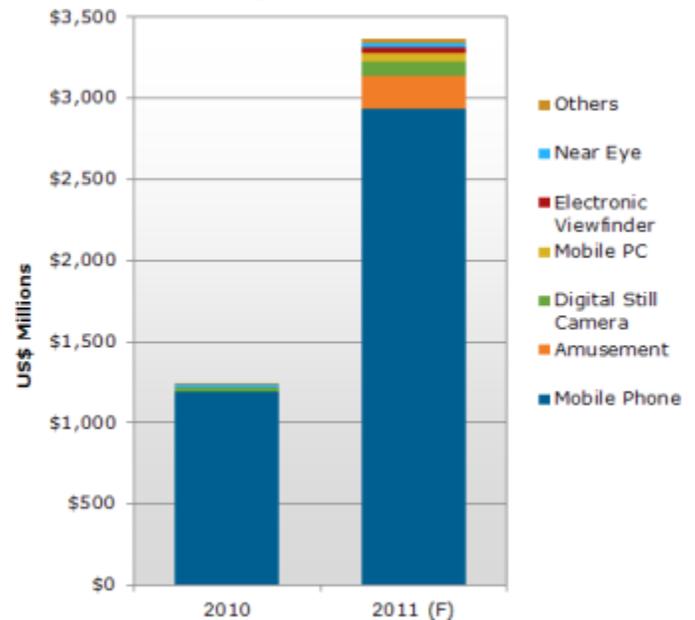
FlexTech Alliance announced the completion of a multi-year project with Solarmer Energy. The objective of the project was to develop high performance polymers for organic photovoltaic cells (OPVs). Polymer solar cells offer many advantages over traditional photovoltaic cells such as low weight, flexibility, and low cost fabrication in a variety of sizes. Target applications are widespread and unique including: low power portable electronics, building integrated photovoltaics, off grid power for rural areas, and ultra lightweight power for military applications. OPVs are expected to produce electricity at 10-20% of the cost of silicon solar cells, making them comparable to fossil fuels. This presents a tremendous opportunity to provide clean energy free from dependence on fossil fuels with zero CO<sub>2</sub> emissions. However, the biggest hindrance to achieving the light-to-electricity conversion rate needed to make OPVs practical has been the lack of materials with the requisite properties for a high efficiency device. To solve these problems, Solarmer Energy, with funding from FlexTech Alliance, designed and synthesized new electron donor polymers with smaller band gap, suitable energy levels, and higher carrier mobility – all contributing to higher energy conversion. When the Solarmer project was initiated, the world record for OPV efficiency was ~5%. During the project, the Solarmer team made substantial progress in OPV technology, including successful development of high quality donor polymers enabling several National Renewable Energy Laboratory (NREL) certified world records in OPV efficiencies – from 6.8% to 7.6%, 7.9% and 8.13%. Since the completion of the project, Solarmer has continued to push efficiencies to 8.48%. <http://www.flextech.org>

### FlexTech Alliance announces governing board appointments

The FlexTech Alliance announced its 2012 leadership appointments. Dr. John Batey has been re-elected as chairman of the Governing Board and Michael Ciesinski was re-appointed President and CEO. Dr. Keith Rollins, Chief Innovation Officer for DuPont Teijin Films US Ltd., has been named vice chairman of the Governing Board. Dr. Rollins will join with Dr. Batey in providing industry direction to FlexTech Alliance on development and deployment of technology and applications for flexible, printed electronics and displays. Other directors elected were Thomas Edman, Applied Materials, Michael McCreary, E Ink, Malcolm Thompson, MJT & Associates, David Morton, U.S. Army Research Laboratory, Frank Caris, dpiX, Jennifer Ernst, Thin Film Electronics ASA, Richard Wilson, Cambridge Display Technology, Wim Vanderpoorten, Cytec, and Michael Dudzik, Lockheed Martin. In his new role as FlexTech Alliance vice chairman, Keith Rollins will share responsibility with John Batey in overseeing the organization's decisions on policy, program content, and disposition of funds available to the consortium for sponsoring technology-related R&D projects. They will work with the Governing Board and all FlexTech Alliance stakeholders to further the organization's development in a manner that increases the consortium's value. <http://www.flextech.org>

### DisplaySearch predicts AMOLED display revenue to surge 169%

The year 2011 was pivotal for OLED displays, particularly AMOLED displays. With strong growth in smart phones, AMOLED shipments are estimated to have reached 90 million units in 2011, up 97% Y/Y, while revenue is expected to grow to \$3.36 billion, up 169% Y/Y, according to the latest NPD DisplaySearch Quarterly Small/Medium Shipment and Forecast Report. As it competes with TFT LCDs, AMOLED penetration into the small/medium (9-inch and smaller) display market has been increasing. In 2010, AMOLEDs had a 6% share of small/medium active matrix flat panel displays (TFT LCD and AMOLED), and is expected to double its share to 12% in 2011. The growth of AMOLED in the small/medium segment is dominated by smart phones. Revenues for the smart phone segment more than doubled in 2011, with increasing shipments and higher ASPs due to larger screen sizes and increased display performance.



*Annual small/medium AMOLED revenue by application*

The success of AMOLED can particularly be seen in larger smart phone displays. In the first three quarters of 2011, shipments of AMOLED displays 3.5-inch and larger for smart phones reached 59.7 million units, up three-fold from the same period in 2010. "Samsung Mobile Displays has been a key driver of the growth of AMOLEDs, with the company accounting for 97.5% of all AMOLED shipments," notes Hiroshi Hayase, NPD DisplaySearch's vice president of small/medium display research. "Looking to capitalize on the growing market demand, LG Display, AUO, and CMI also are planning to ship AMOLEDs for smart phones in 2012." Samsung's Galaxy line of smart phones has been the leading adopter of AMOLED displays with high contrast and motion picture response time, while Apple's iPhone uses a high-resolution TFT LCD with IPS technology. The competition between the iPhone and Galaxy has brought increased attention to the AMOLED displays, currently produced only by Samsung Mobile Display. With the successful mass-production of AMOLEDs and a new Gen 5.5 fab running, Samsung Mobile Display is producing larger AMOLED displays for applications such as Samsung's Galaxy Note and Tab tablet PCs, as well as supplying outside customers. AMOLEDs are also penetrating new market segments such as Sony's PS-Vita portable game, which features a 5-inch AMOLED; LG Display is shipping AMOLEDs to LG Electronics for external mobile phone displays. In addition, LG Electronics announced plans to produce a 55-inch AMOLED TV in 2012. <http://www.displaysearch.com>

### DisplaySearch reports OLED display technology moving to compete in the TV market

According to the recently-released NPD DisplaySearch OLED Technology Report, OLED technology advanced rapidly in 2011, a trend that NPD DisplaySearch forecasts will continue through this decade. OLED technology has progressed in areas including organic materials, color patterning, electronic driving methods, and encapsulation. However, the ability to scale OLED display manufacturing to fabs larger than the current Gen 5.5 has yet to be demonstrated, and the cost of larger panels is not yet clear. OLED emerged in the 1980s from laboratories at Eastman Kodak in the US and Cambridge University in the UK, and was first commercialized in the late 1990s. Enthusiasm has increased recently as Samsung Mobile Displays has started manufacturing active matrix AMOLED displays in a Gen 5.5 fab and announced plans to build a Gen 8 fab (as did LG Display), and several other suppliers entered or re-entered OLED display manufacturing, including AUO, CMI, IRICO, Tianma, and BOE.

OLED is now a mass-market technology in small/medium displays, particularly in smart phone applications. Investments in Gen 8 (2200x2500mm) fabs indicate that AMOLED will compete in larger size applications, such as in TV and mobile PCs, within two years. Samsung released a 7.7-inch AMOLED tablet PC in December 2011, and more tablet and other mobile PCs are expected in 2012. LG is expected to enter the market in 2012 with a 55-inch AMOLED TV. With technology improvements, NPD DisplaySearch forecasts AMOLED will enter other applications as well. While nearly all AMOLEDs on the market are currently based on LTPS, several companies are developing AMOLEDs using oxide or a-Si TFT backplanes, and are likely to start production in 2012.

Characteristic	LTPS	a-Si	Oxide TFT
Electron mobility	Excellent 10-500 cm <sup>2</sup> /VS	Poor 0.5 cm <sup>2</sup> /VS	Good 1-40 cm <sup>2</sup> /VS
Uniformity	Poor	Excellent	Good with amorphous type, poor with crystalline type
Stability	Excellent	Poor	Poor
Scalable	Limited to <40"	Excellent, >100"	Potential to 100"
Process temp	High >400°C	Typical ~300°C, some low temp process can be ~150°C	Typical ~200°C, but some anneal at 350°C
Cost	High	Low	Medium
Availability	Yes MP	Demo for AMOLED; Announced by RiTdisplay and IGNIS; MP by end of 2011	Demo for AMOLED; MP estimated by end of 2012
Challenges	Uniformity, cost, scalability	Poor mobility; poor stability	Threshold voltage unstable; manufacturing process not mature

#### Comparison of LTPS, a-Si, and oxide TFT for AMOLED

Organic materials of all types have efficacies ranging from less than 10 to nearly 100cd/A. Large increases in efficiency have been obtained with phosphorescent materials, especially in red and green. Nearly all AMOLED displays are made using thermal evaporation through a fine metal mask (FMM) for color patterning. However, this method has low material utilization and is limited to small substrate sizes. Manufacturing processes with higher material utilization and better uniformity, such as linear and area sources, are likely to be adopted. Other color patterning methods, such as white with color filter and solution-processed materials, are also evolving and ready to be adopted for mass production in larger generation fabs. <http://www.displaysearch.com>

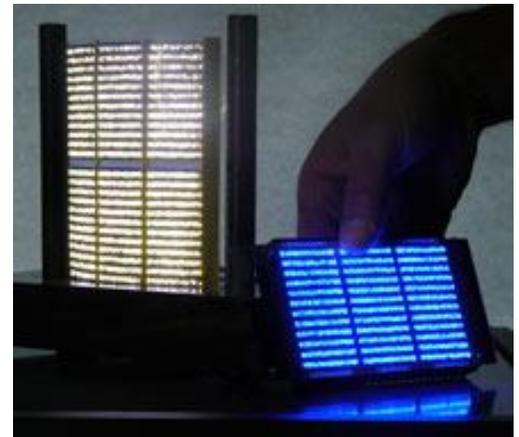
### **Plextronics and Cambrios co-market OLED electrode solution**

Plextronics and Cambrios have begun co-marketing an electrode solution for OLED devices. Supported by the US Department of Energy (DoE) Solid-State Lighting (SSL) program, the two start-ups have developed a cost-effective material to improve the manufacturing process and quality of OLED lighting, in place of indium tin oxide (ITO). ITO is expensive due to high processing costs. To produce OLED lighting cost-effectively in the long-term, production needs to occur on roll-to-roll equipment, processing that is compatible with plastic substrates as opposed to glass. Plextronics' proprietary Plexcore OC material, which functions as a critical component in the OLED stack known as the hole injection layer (HIL), is applied on top of Cambrios' ClearOhm material to create a transparent electrode. This forms a transparent conducting hole injection (TCHI) electrode. Voltage performances achieved by demonstrator devices containing Plexcore and Cambrios material layers, and produced on Plextronics' in-house production line, compare to ITO with evidence of good stability. Plextronics is sampling inks for use on pilot lines by customers as they develop processes able to achieve cost reductions in OLED lighting panel production. For Cambrios the partnership enables the company to start developing materials for the organic electronics industry, where projected demand for devices such as OLED lighting and organic solar cells will be substantial in the coming years. <http://www.plextronics.com>



### **Nth Degree Technologies develops lighting sheets made of tiny LEDs**

Nth Degree Technologies has developed glowing sheets made up of LEDs. The company's first commercial product is a two-by-four-foot-square light, which it plans to start shipping to select customers for evaluation. The technology could allow for novel lighting designs at costs comparable to the fluorescent light bulbs and fixtures used now. Light could be emitted over large areas from curved surfaces or unusual shapes. The printing processes used to make the lights also make it easy to vary the color and brightness of the light emitted by a fixture. Nth Degree makes its light sheets by first carving up a wafer of gallium nitride to produce millions of tiny LEDs – one four-inch wafer yields about eight million. The LEDs are then mixed with resin and binders, and a standard screen printer is used to deposit the resulting ink over a large surface. In addition to the LED ink, there is a layer of silver ink for the back electrical contact, a layer of phosphors to change the color of light emitted by the LEDs (from blue to various shades of white), and an insulating layer to prevent short circuits between the front and back. The front electrical contact, which needs to be transparent, is made using an ink that contains invisibly small metal wires. The new transparent electrical contact could itself prove important as a replacement for ITO used in touch screens and other displays. ITO is brittle and can't be printed, so it is not suitable for flexible displays. The devices emit 20 lumens per watt, compared with about 80 lumens per watt for typical overhead fluorescent lights and 65 lumens per watt for compact fluorescents. A 60-watt light bulb from GE gives about 14 lumens per watt. The goal is 50 lumens per watt for the first products and 75 lumens per watt by next year, which is comparable to many other LEDs. The best LEDs produce over 200 lumens per watt. The new design also makes the bulky heat sinks used on conventional LED lights unnecessary. Since the tiny LEDs are thinly and evenly distributed, they don't get hot. The advantage of not having a heat sink is, however, offset by the fact that the LEDs require a substantial power source. To incorporate this power source, the company's first light fixture will have to be two inches thick, even though the light-emitting surface is thin and flexible. <http://www.nthdegreetechnology.com>



*Tiny LEDs printed on a surface using standard screen printing*

### BASF and Philips first to develop OLED lighting for use as a transparent car roof

BASF and Philips have achieved a practical breakthrough in the development of OLED technology that allows it to be integrated in car roofs. The OLEDs are transparent when switched off, allowing for a clear view outside the vehicle, yet providing light only within the vehicle when switched on. This OLED lighting concept for car roofs is the result of a longstanding cooperation between BASF and Philips in the research and development of OLED modules. In addition to offering completely new design possibilities, the transparent OLED lighting concept also allows new approaches to automotive engineering. The transparent OLED sandwich structure can be combined with equally transparent solar cells. <http://www.basf.com/news> <http://www.newscenter.philips.com>



As members of a consortium assembled by Germany's Federal Ministry of Education and Research, the two companies have created OLED panels and installed them in the roof of a car. When switched on, the panels glow, lighting the cabin of the car - when switched off, they simply go transparent.

*Because the film is just 1.8 mm thick, it can also be combined with transparent solar cells. This would allow the roof panels not only to provide illumination at night, but to generate electricity during the day.*

### **Thinfilm builds out ecosystem for printed electronic systems**

Thin Film Electronics announced technology relationships for its integrated addressable memory systems designed to help enable the “Internet of Things.” Thinfilm has signed a non-exclusive licensing agreement with Acreo, which develops printed displays for a variety of applications. Thinfilm has also entered into a technology assessment agreement with Imprint Energy, which is developing a printed battery technology. <http://www.thinfilm.no>

### **The US Department of Energy recognizes UDC for advances in efficient white OLED lighting**

Universal Display Corporation announced that the company was recognized by the US Department of Energy (DOE) for outstanding achievements in solid-state lighting throughout 2011. This is the fifth consecutive year that the company has received this DOE award. This year's award is for Universal Display's demonstration of an all-phosphorescent OLED lighting system with greater than 55 lumen per watt system efficacy in an under-cabinet application. This under-cabinet demonstration is an excellent example of the myriad lighting applications that can benefit from white OLEDs, as a result of their energy-efficient and cool operation, their ultra-thin form factor, and their pleasing color emission. The US DOE has estimated that solid-state lighting, including OLED lighting, could lead to a 50% reduction in energy use for lighting by 2030, or enough electricity to power more than 24 million homes in the US. Recent advances in OLED lighting, including those made by Universal Display, now allow OLEDs to meet a variety of niche lighting performance targets and to demonstrate the potential for OLEDs to achieve general lighting targets established by the US Department of Energy. Universal Display's phosphorescent OLED technology and materials offer up to a four-to-one power advantage over other OLED technologies, resulting in record energy-efficient OLEDs. In addition, OLED lighting may enable a range of exciting new product concepts with innovative form factors, transparency and flexibility. <http://www.universaldisplay.com>

### **Konica Minolta launches OLED display printhead**

Konica Minolta has launched the first inkjet printhead capable of printing OLED displays. The printhead, KM128SNG-MB, is a high-precision inkjet which can be used to produce the displays, as well as other printed electronics. It is manufactured from silicon MEMS technology, which allows the printhead to be small, measuring just 38mm wide, with 128 nozzles a row, according to the SlashGear.com website. The development could lead to OLED displays being produced using roll-to-roll manufacturing. The printhead is optimized for resistance to the ink used, and for low viscosity inks that are used in industrial applications. It will go on sale in sample quantities in Q2 2012. <http://www.konicaminolta.com>



### **Thinfilm and PST Sensors to jointly develop printed temperature tags to monitor food**

Thin Film Electronics ASA announced a partnership with PST Sensors Ltd to jointly develop a printed temperature sensor system that will monitor the temperature of perishable goods such as food and pharmaceuticals. These systems are a successful example of how low cost electronics can be manufactured in high volumes for a fraction of the cost compared to traditional silicon microelectronics. The printed sensor system will be able to monitor individual packages to ensure that their contents have been kept at a safe or optimal temperature. The first demonstration prototype is expected this year. Thinfilm is a leading provider of roll-to-roll printed, rewritable non-volatile memory products. The company recently demonstrated the first working prototype of a printed non-volatile memory device addressed with complementary organic circuits, the organic equivalent of CMOS circuitry. Thinfilm Addressable Memory combines Thinfilm's polymer-based memory technology with PARC's transistor technology using complementary pairs of n-type and p-type transistors to construct the circuits. The addressable memory can be integrated with other printed components to create fully printed systems for interaction with everyday objects - a key part of the vision of the “Internet of Things” where virtually any item can communicate with another. PST Sensors, a spin-out of the University of Cape Town NanoSciences Innovation Centre, is a leading developer of ambient processed printed silicon electronics with a focus on physical sensors. Recently PST has demonstrated a portfolio of prototypes including decorative large area temperature sensors and thermal imaging arrays. PST's temperature sensors are based around a core technology of a printed silicon NTC thermistor – a device whose electrical resistance decreases when it is heated. Being both printable and electronic, the sensors can be fully integrated with Thinfilm's memory and with complementary organic circuits. <http://www.thinfilm.no>

**IDTechEx announces Printed Electronics USA 2011 award winners**

The annual printed electronics award winners were announced by IDTechEx. The awards recognize outstanding progress in the development and commercialization of printed electronics, an industry that produces a huge amount of technical innovation which will be used in many products. The entries were judged by a panel comprising of Professor Malcolm Keif, California Polytechnic State University; Professor Yang, UCLA; and Joshua Windmiller, University of California, San Diego. In summary, the winners for each category are as follows: Best Technical Development Manufacturing Award – Coatema; Best Technical Development Materials Award – Opalux; Academic R&D Award - Stevens Institute of Technology and US Army ARDEC; Best Product Development Award - Vorbeck and MWV; Best Commercialization Award – Peratech; Best in Show Award large booth – Novacentrix; Best in Show Award small booth - PST Sensors; Best Poster - Stéphanie Dupont, Stanford University. <http://www.IDTechEx.com>

- Coatema won its award for its Smartcoater system. The Smartcoater is a R2R lab unit with a working width starting at 100mm and a wide range of coating applications and production speed. Complex products can be produced with a minimum use of substrate and chemistry. The base unit offers a 5-in-1 coating module including slot die, knife, dipping, micro-roller and engraved roller application functions. Unlike other tools there is no need to purchase individual modules for each of these applications. In addition other modules are being added rapidly including: screen printing; flexo printing; UV spraying and others necessary for producing all layers of a product.
- Opalux Inc. has developed a number of technologies based on active photonic crystal materials addressed by stimuli such as pressure, heat, shear and chemical activation to effect a color change. The company won the award for ones of these technologies - Photonic Ink (P-Ink) which is electrically tuned to reflect any desired spectral color and can also be tuned to provide UV and IR reflection. Activation at voltages of less than 1.5V and microampere currents gives bright, highly saturated and bistable color states that can be switched at high speeds.
- A team of researchers from Stevens Institute of Technology and US Army ARDEC have been exploring the evaporative assembly of graphene oxide (GO) nanosheets during inkjet printing, as a transformative means of producing 2D and 3D graphene micropatterns for a variety of flexible electronics applications. The ability of producing graphene oxide supercapacitor electrodes by inkjet printing and subsequent thermal reduction was demonstrated by the researchers. This approach provides a scalable manufacturing platform to fabricate economically viable supercapacitor electrodes particularly for miniaturized flexible supercapacitor applications.
- Vorbeck and MeadWestvaco (MWV) won their award for the new anti-theft retail package product. Vorbeck's Vor-ink has provided the enabling technology for the development of the MWV package product. This new technology, called Siren, is part of MWV's Natralock product line, and will be on store-shelves at major retailers including Home Depot in early 2012. This unique design will prevent theft or tampering by setting off an alarm on each individual package itself if cut, torn, or upon attempted theft. This adds a level of protection over the standard EAS tags currently in use, which only set-off in-store alarm towers if the whole package is removed from the store. Since Siren technology is embedded within the package itself, it allows high-theft products to be displayed as any normal package would be, giving the customer full access to the product and information rather than having to be protected behind locked cases, thereby improving product visibility to influence buying decisions.
- Peratech is the inventor of Quantum Tunnelling Composite (QTC) technology. QTCs are electro-active polymeric materials made from metallic or non-metallic filler particles combined in an elastomeric binder. These enable the action of touch to be translated into an electrical reaction, enabling a vast array of devices to incorporate very thin and highly robust sensing of touch and pressure. QTCs' unique properties enable it to be made into force sensitive switches of any shape or size. QTC switches and switch matrices can be screen printed allowing for development and integration of switches that are as thin as 75 microns. Having spent its initial years researching and understanding this completely new area of material science, Peratech is now focused on commercializing this technology. It uses the well proven IP licensing model that comprises of researching and designing a solution to a customer's problem and then licensing the design of this solution along with supplying the required form of QTC.

### IDTechEx announces Printed Electronics Europe 2012 award winners

The annual printed electronics award winners were announced at the IDTechEx Awards Dinner in Berlin, Germany on April 3rd. The awards recognize outstanding progress in the development and commercialization of printed electronics, an industry that produces a huge amount of technical innovation which will be used in many products. The entries were judged by Professor Iain McCulloch, Imperial College London, and Professor Elvira Fortunato, University of Lisbon. The winners for each category are: Best Technical Development Manufacturing Award – VTT; Best Technical Development Materials Award – Heliatek; Academic R&D Award - University of California, Los Angeles (UCLA); Best Product Development Award – Thinfilm; Best Commercialization Award – Printechnologies; Best Poster - Lappeenranta University of Technology; Best in Show Award - exhibition booth – Printechnologies.



VTT won their award for building up a printed electronics pilot factory capability. The facility includes a R&D printing environment from small lab scale material testing to proof-of-production. In addition to extensive roll-to-roll printing facilities pilots are available e.g. for thermal nanoimprinting, printing in nitrogen atmosphere, laser processing and post-processing. Helitek won their award for achieving the world record in OPV efficiency using new oligomer absorber materials. With this new type of absorber material, Heliatek was able to set two new efficiency world records in the field of low temperature processed organic solar cells. All materials that have been used in the currently best solar cell with an efficiency of 9.8% are suitable for production. Best modules (122cm<sup>2</sup>) with a series interconnection show efficiencies of up to 9.0% on the active area. This shows the excellent scalability of the process. UCLA in collaboration with Anevee Nanotechnologies has developed the first fully printed ink-jet CNT transistor technology platform. These unique transistors employ the superior electronic performance of semiconducting carbon nanotubes (CNTs), going beyond materials such as amorphous silicon and metal oxide semiconductors that are typically used in display backplane applications. Performances such as  $\mu=50\text{cm}^2/(\text{Vs})$ ,  $I_{\text{on}}/I_{\text{off}}=1000$ ,  $V_{\text{th}}=1.0\text{V}$  have been demonstrated. Thinfilm won their award for the creation of the world's first printed, rewritable memory device addressed with complementary organic circuits, combining Thinfilm's polymer-based memory technology with PARC's transistor technology. Designed for commercial production, Thinfilm addressable memory is the first step in integrating Thinfilm memory with other devices such as sensors, displays, power sources and antennas. Printechnologies won their award for producing more than 20 million "Touchcodes" in 2011 which were used in a wide variety of markets. Touchcode bridges the gap between physical products and digital contents. Within seconds common paper communicates with smart phones, tablets or information displays just by a simple touch - without using a camera or any other special reading device. Thus, the technology creates a seamless unity between products and digital contents for the first time. <http://www.PrintedElectronicsUSA.com>

### "Hiss Pop" interactive experience debuts at Exploratorium using Thinfilm rewritable printed memory

Thin Film Electronics ASA (Thinfilm) memory cards and readers were used to drive "Hiss Pop", an immersive multimedia game launched at the Exploratorium in San Francisco, California, produced by game developers Ken Eklund and Sara Thacher. Hiss Pop is "an interactive adventure set in the days when vinyl was king and the corner record store beckoned as a musical Shangri-La." During the Exploratorium After Dark event, Thinfilm Memory cards introduced participants to a set of intertwined stories and characters set in earlier days of the San Francisco music scene. Players discovered game activities taking place in the museum's exhibit areas through a kiosk-style card reader, and players' progress through the game was tracked on the cards. Thinfilm produces a unique, highly affordable printed memory in the form of a sticker. The rewritable memory can be affixed to cards or to any flat or slightly curved surface. Containing no silicon, heavy metals or other toxic materials, the flexible, non-volatile stickers are inexpensive, resistant to water, impervious to magnetic exposure, and safely disposable. Also introduced was a new card handling system designed for use with Thinfilm Memory cards. The system is built around Thinfilm's core technology developed for toys and games, and has been extended to include an automated card transport that will be suitable for use in kiosks, loyalty card applications, and other public, high-traffic situations. <http://www.thinfilm.no>

**Thinfilm receives contract for parts identification using printed memory**

Thin Film Electronics announced receipt of a contract to develop prototypes using Thinfilm Memory for identifying parts contained in custom manufactured hardware. Prototypes will be delivered in Q2 2012. Thinfilm's client, an international manufacturer of security products, produces systems that can be customized to nearly one million configurations. Prototypes will utilize the Thinfilm Memory to record parts configurations in a sample system. "The unique form factor of Thinfilm Memory – flexible and thinner than a human hair – along with its resistance to magnetic fields and the low cost have sparked customer interest in this new application," says Davor Sutija, Thinfilm CEO. Thinfilm Memory is a non-volatile, rewriteable ferroelectric memory marketed originally for toys and games. This represents Thinfilm's first prototype order for printed memory in a completely new market. <http://www.thinfilm.no>

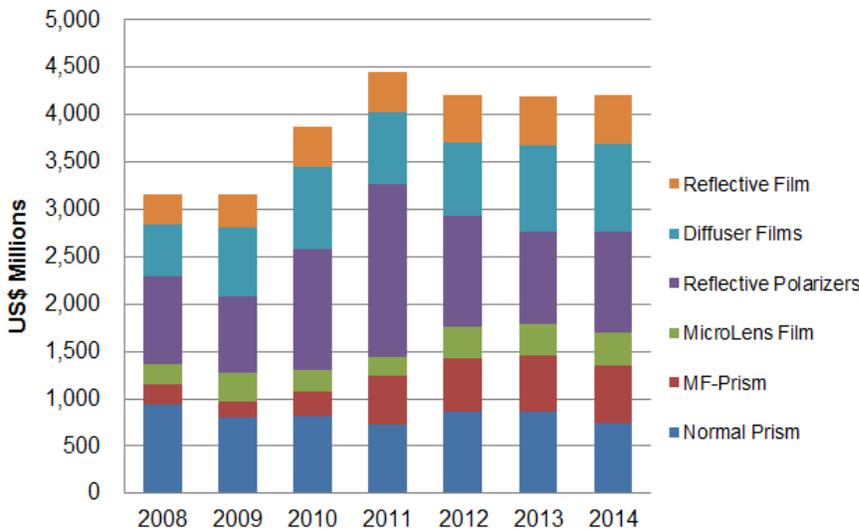
**DisplaySearch reports optical film market continues to experience cyclic trends**

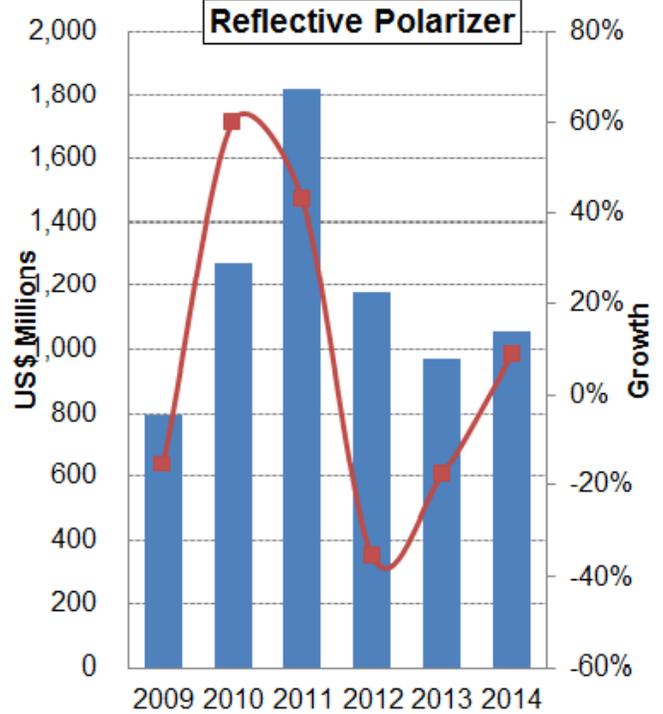
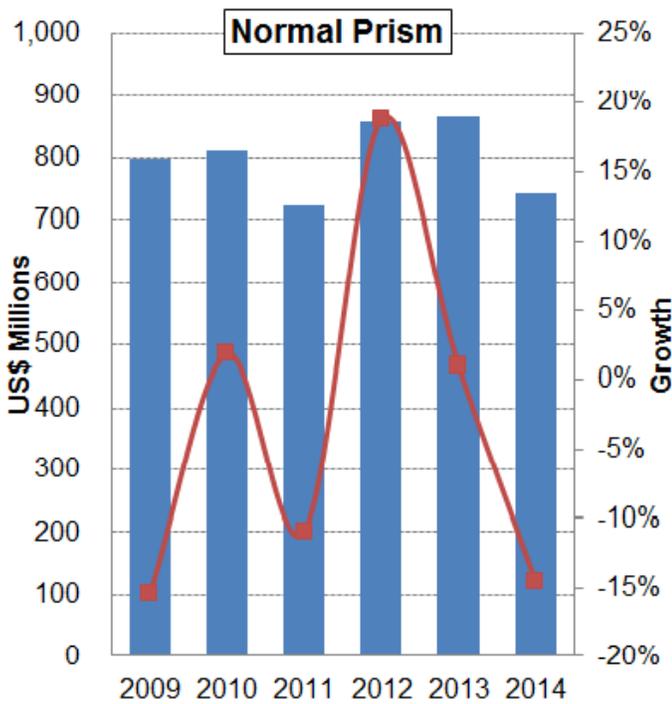
Growth in display optical film revenues is shifting from positive to negative in 2012, according to NPD DisplaySearch Q1'12 Quarterly Display Optical Film Report. From 2009 to 2011, the market for optical film used in LCD backlights grew at a compounded annual rate of 19%, from \$3.2B to \$4.5B, but it is expected to fall to \$4.2B in 2012 due to a decline in the market for reflective polarizers. In contrast, prism and micro lens film markets are expected to grow to \$858M and \$331M in revenue, respectively. The current decline in the reflective polarizer market is expected to turn around in 2014. Prior to 2009, the high price of reflective polarizers was due to the proprietary manufacturing technology used. Pressure on prices over the past few years led panel makers to reduce the cost of backlights (at the expense of energy efficiency) through the use of diffusers and micro lens film instead of reflective polarizers. The emergence of LED backlights for TVs has changed this situation. However, the trend will reverse again in 2012. LED prices have fallen so sharply during the past few years, with a CAGR of -50%, that it now seems beneficial for panel makers to use more LEDs rather than expensive reflective polarizers. Therefore, contrary to the trend seen during the past few years, panel makers will remove reflective polarizers and compensate for the luminance loss by applying more 2-chip LED packages. Adoption of prism and micro lens film is expected to be used as a more cost-effective solution. The report suggests that prism revenue is expected to decrease again in 2014. In contrast, reflective polarizer revenue is expected to grow at the same time. Changes in this trend seem to be related to the LED bar structure. With the evolution of the LED bar structure, there will continue to be a reduction in LEDs per set. However, there is discontinuity in the number of LEDs per set among different LED bar structures. When the LED structure is changed from a 2-bar (bottom or side) structure to a side 1-bar structure or a corner LED

structure, there is a large change in the number of LEDs per set. For these structures, reflective polarizers may be required again to compensate for luminance loss.

<http://www.displaysearch.com>

*Revenues of display optical film types for TFT LCD applications*





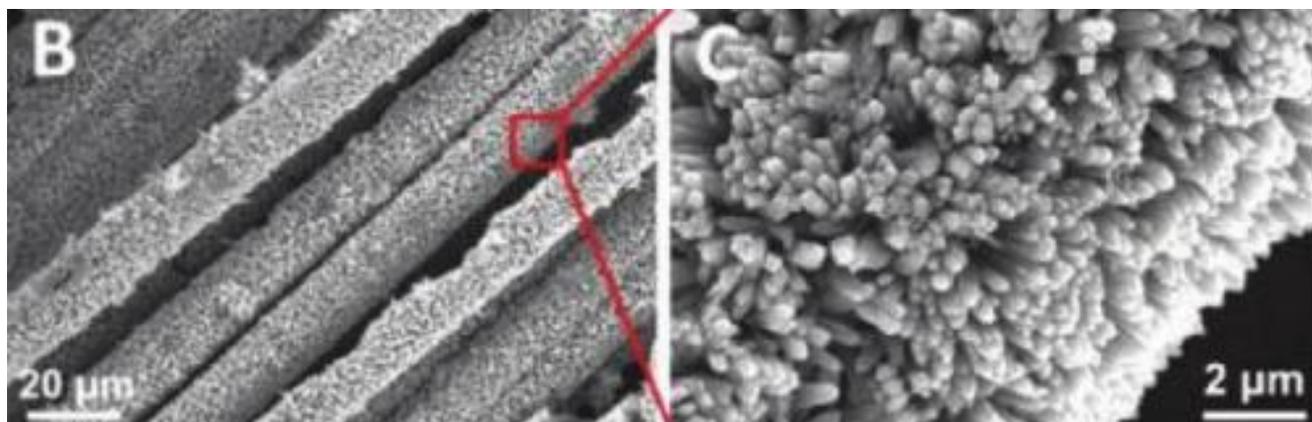
*Changes in revenue of prism and reflective polarizer for TFT LCD applications*

**Thinfilm receives first order for scalable array printed memory**

Thin Film Electronics ASA announced receipt of its first engineering order for Thinfilm Passive Array Memory, a non-volatile rewriteable fully-printed memory suitable for a number of applications, including use in secure documents and value cards. With passive array memories, the number of contact points needed to read and write the memory is reduced, allowing more compact designs and improved contacting accuracy. "This unlocks markets and opens up opportunities for new applications, as the number of bits in passive array memories is no longer limited by pad count and we can scale to 100 bits and higher in the same area we use currently for 20 bits," says Dr. Davor Sutija, Thinfilm CEO. The passive array architecture separates the memory from the read/write electronics and dispenses with the need for active circuitry within the memory array and memory cell. Thinfilm's roadmap has expanded from stand-alone memories to include printed electronic system products. Thinfilm 20-bit single-line memories are commercially available. The first public application occurred at the Exploratorium in San Francisco. Additional applications will be launched later this year. Thinfilm Passive Array Memory: delivery of engineering samples will begin in Q2 2012, to customers seeking compact memory designs and higher bit count. Thinfilm Addressable Memory was demonstrated last October, and recognized last month with the FlexTech 2012 Innovation Award in Printed Electronics, given for the most significant commercial innovation in the industry, Thinfilm Addressable Memory combines Thinfilm Passive Array Memory with printed CMOS-equivalent logic, and is a technology platform that enables printed systems such as temperature sensors, disposable price labels, and non-contact ID tags. An integrated system prototype is expected by the end of 2012. <http://www.thinfilm.no/>

**Georgia Institute of Technology develops tube-shaped solar cells that could be woven into clothing**

A team of researchers from the Georgia Institute of Technology in Atlanta, Georgia, and Xiamen University in Xiamen, China, have recently developed a new method for preparing uniform titanium dioxide ( $\text{TiO}_2$ ) nanorods on carbon fibers. The new method has advantages over the commonly used sol-gel method, which requires high temperatures and can cause cracks in the materials. The new study is published in a recent issue of the Journal of the American Chemical Society and reported in PhysOrg. Fabricating tube-like solar cells is challenging due to the multiple steps involved, which include transforming pure Ti foil into  $\text{TiO}_2$  nanorods, coating carbon fibers with the nanorods, and uniformly arranging the nanorods on the fibers. As the researchers explain, an ideal solution for preparing  $\text{TiO}_2$  nanostructures on carbon fibers is to grow them directly on the fiber's surface. They did so here using a "dissolve and grow" method for transforming Ti into vertically aligned single-crystal  $\text{TiO}_2$  nanorods on carbon fibers. Then, in an attempt to further improve the device's performance, the researchers used an "etch and grow" method to etch the nanorods into rectangular bunched arrays using a hydrothermal treatment with hydrochloric acid. After assembling the nanorod-covered carbon fibers as photoanodes in tube-shaped dye-sensitized solar cells (DSSCs), the researchers experimentally tested the solar cells' performance. The results showed that the rectangular bunched nanorod configuration achieved an energy conversion efficiency of 1.28%, compared with 0.76% for the unbunched configuration. The researchers attribute the difference to the larger surface area of the bunched nanorods, which enables more dye molecules to be adsorbed, resulting in more electron excitations. The large surface area gives the tube-shaped solar cells the ability to capture light from all directions, which could make them attractive for applications under intensively forced sunlight. Besides solar cells, the method for growing  $\text{TiO}_2$  nanowires on carbon fibers could be extended to fabricating photocatalysts and lithium ion batteries. But perhaps the most unique application would be weaving them into fabrics. <http://www.gatech.edu>



*Scanning electron microscope images of  $\text{TiO}_2$  nanorod arrays uniformly covering the carbon fibers.*

**Georgia Institute of Technology develops protective polymers for plastic solar cells**

A new universal technique to decrease the work function of a conductor in printable electronics has led to the development of the first completely plastic solar cell. Scientists at Georgia Institute of Technology have spread an ultrathin layer of a polymer, about 1 to 10nm thick, on the surface of a conductor to produce a strong surface dipole. The interaction turns air-stable conductors into low-work function, efficient electrodes. The team used commercially available polymers that can be easily produced from dilute solutions in solvents like methoxyethanol and water. These polymers are inexpensive, environmentally friendly and compatible with existent roll-to-roll mass production techniques. The technology requires conductors, such as calcium, lithium or magnesium, with a low-work function to create light or energy by injecting or collecting electrons. These conductors are chemically very reactive. Once exposed to moisture and oxygen, they oxidize and stop functioning, which is why electronics in solar cells and TVs, for example, need to be covered with a rigid, thick barrier such as glass or expensive encapsulation layer. Replacing the reactive metals with stable conductors, including conducting polymers, completely changes the requirements of how electronics are manufactured and protected. Their use can pave the way for lower cost and more flexible devices. The team evaluated the performance of the polymers in organic LEDs and organic thin-film transistors using their universal technique,

and developed the first completely plastic solar cell. The polymer modifier reduces the work function in a wide range of conductors, including silver, gold and aluminum. The process is also effective in transparent metal oxides and graphene. <http://www.gatech.edu>



*After introducing what appears to be a universal technique to reduce the work function of a conductor in printable electronics, a team led by Georgia Tech's Bernard Kippelen has developed the first completely plastic solar cell*

#### **Novald cooperates with Marcus Tremonto on development of a new transparent OLED suspension light**

New York artist and designer Marcus Tremonto, in cooperation with Novald AG, a company specializing in OLED technologies and materials, has designed PAD, a new transparent OLED suspension light. This ultra slim light, which was conceived and developed by Tremonto entirely from an organic perspective, was exhibited at the 2012 Frankfurt Light+Building trade show. Based on the pad-like fingers of the red-eyed tree frog, PAD uses transparent OLED panels to create three types of illumination. The first two types occur when the PAD light is switched on, during which the bottom of the lamp gives off a rich white light, while the top emits ambient light in a variety of colors. The third type of illumination occurs when PAD is switched off, during which ambient light surrounding the lamp will pass through its transparent OLED panels, creating colored shadows similar to the effect of light passing through stained glass. The OLED panels are also partially transparent when PAD is switched on, creating a combination of light and technology that highlights the unique design potential of transparent OLED light sources. PAD light can be modified, depending on the purpose and requirements of the lighting installation, to create larger area lighting designs. <http://www.novald.com>



### **NovaCentrix launches new PulseForge model**

NovaCentrix announced the presentation of the PulseForge 3200-X2, the newest PulseForge model. The new PulseForge variant offers increased production speeds and decreased consumables cost in comparison to the other PulseForge tools, which already lead the industry. Additionally, the new X2 variant optimizes the high-speed drying capabilities of the PulseForge tools. The PulseForge 3200-X2 is being demonstrated as integrated into a MicroFLEX roll-to-roll web processing system offered by 3D-Micromac AG ([www.3d-micromac.com](http://www.3d-micromac.com)). This integrated tool is printing NovaCentrix Metalon ICI copper-oxide reduction inks and curing them to copper in a single operational sequence on-site in real-time. PulseForge photonic curing tools process high-temperature materials on low-temperature substrates, and are ideal for drying, sintering, annealing, and reacting the functional materials of interest in the emerging printed electronics industry. Unlike traditional oven technologies, the patented photonic curing process selectively heats thin films to very high temperatures using microsecond-scale flash lamp pulses without damaging low temperature substrates, such as polymers and paper. By adjusting the pulse attributes using the touch-screen interface, temperature profiles in the film and substrate can be closely controlled and optimized to achieve high-performance properties at high-speed roll-to-roll processing rates. These capabilities are critical for customers developing new applications in photovoltaics, RFID, displays, sensors, and batteries. <http://www.novacentrix.com>



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### **Applied Ventures invests in Infinite Power Solutions**

Infinite Power Solutions announced that it has successfully completed a \$10M Series D financing. The funds will be used to expand IPS' manufacturing capacity in response to growing customer demand, to complete the build out of its global sales channels and to further support advanced research and development of its eco-friendly THINERGY solid-state rechargeable Micro-Energy Cell (MEC) products. Existing financial investors Generation Investment Management, D. E. Shaw Ventures, Polaris Venture Partners and Core Capital Partners co-lead the financing, which also included participation by Applied Ventures, LLC, the venture capital arm of Applied Materials, Inc., In-Q-Tel and two additional strategic investors. <http://www.InfinitePowerSolutions.com> <http://www.appliedmaterials.com>

### **Eastman to acquire Solutia**

Eastman Chemical Company and Solutia announced that they have entered into a definitive agreement, under which Eastman will acquire Solutia. Under the terms of the agreement, Solutia stockholders will receive \$22.00 in cash and 0.12 shares of Eastman common stock for each share of Solutia common stock. Eastman and Solutia share several key fundamentals, such as complementary technologies and business capabilities, a polymer science backbone, similar operating philosophies and a high performance culture. In addition, the overlap of key end markets is expected to provide opportunities for growth. Eastman has identified annual cost synergies of approximately \$100 million that are expected to be achieved by year-end 2013. Key areas of value creation include the reduction of corporate costs, raw material synergies, and improved manufacturing and supply chain processes. <http://www.eastman.com> <http://www.solutia.com>

### **QD Vision awarded \$1.38 million Department of Defense contract**

QD Vision announced it recently was awarded a \$1.38 million contract with the Department of Defense for specialized devices based on electroluminescent quantum dots. The 12-month program will result in the development of prototype devices that can be tested under real-world conditions, and that will ultimately be employed by U.S. forces. Quantum dot technology developed at QD Vision provides unique advantages in numerous display and lighting applications. Quantum dots are semiconductor nanocrystals that can be tuned to emit light at specific wavelengths, and quantum dot LEDs (QLEDs) are thin-film, low-voltage devices with the capability to emit in both monochrome and full-color modes. <http://www.qdvision.com/government-contracts>.

### E Ink segmented display used in Casala numbering system for chairs

E Ink Holdings announced that their segmented display product used by the prominent contract furniture maker Casala has won the internationally acclaimed Red Dot Award for 2012. E Ink's technology in the Zifra numbering system for chairs has helped Casala to continue to establish itself as a leader within the contract design furniture industry. Zifra is an innovative, easily updateable numbering system for rows of chairs. The E Ink segmented display is located on the backrest of each chair, and is programmed and updated by a contactless scanner. This is the first commercial display device of this type to operate without batteries or a power cord, and it is made possible through E Ink's image stable display technology. E Ink displays require no power to maintain an image, in contrast to LCD displays, which require a continuous power charge. In the Zifra product, the display consumes power only when it refreshes to relink with a different chair, using a radio-frequency (RF) system. The marriage of this E Ink technology and (RF) system enables the display system to be incorporated with a Casala chair without the worry of the battery replacements required by almost all other display devices, in turn lowering maintenance requirements. In addition to its low-power advantage and display conformability, E Ink displays features a 180-degree viewing angle with a sharp contrast, qualities that are highly desirable for a hall chair display. The display is impact-resistant, waterproof, and guarantees a long operating life. <http://www.casala.com> <http://www.eink.com>



### Continuously adjustable pulse width capability from Xenon

Xenon Corporation is released the Sinteron 2010, a device for sintering conductive Cu and Ag metallic inks, curing thin-film substrates, and for solar and surface modifications. Whereas the last generation – Sinteron 2000 – featured four preset values for the pulse widths, the Sinteron 2010 allows for digitally programmable pulse widths. The ability to dial up just about any desired width makes the Sinteron 2010 extremely flexible and valuable to process development. A number of attractive features are designed into this 19-inch rack-based stand-alone system. The pulse amplitude can be adjusted like the Sinteron 2000. The pulse width for the Sinteron 2010 is adjustable in increments of 5 $\mu$ s in the range of 100 $\mu$ s to 2,000 $\mu$ s. By having total control of the pulse amplitude and pulse width, the optical energy delivered by the system can be precisely controlled. As the pulse profile is very linear at maximum amplitude a relationship of 1000J/ms can be assumed. The Sinteron 2010 allows connection for either Spiral or Linear Lamp housings. These can provide optical footprints of 19mm x 305mm (0.75 inches x 12 inches) or 127mm (5 inches) diameter areas. As Xenon Corporation manufactures Lamps and Lamp Housings, other optical profiles are readily available. <http://www.xenoncorp.com>



## Member Company Benefits

Member benefits are focused on providing commercial advantages in a competitive marketplace.

### Technical Program

#### Opportunity for pre-competitive R&D Funding

FlexTech Alliance sponsors an industry-wide R&D funding program available exclusively to its members.

#### Gap Analysis and Roadmapping

Members receive complimentary admission to FlexTech Alliance workshops and tours of R&D and production facilities. Workshops are designed to identify and resolve key technical challenges.

### Industry and Market Research Reports

FlexTech Alliance research reports provide valuable insights into the technological and economic trends of our member companies' primary markets. Free to members\*, the data package consists of reports from :

-DisplaySearch

-NanoMarkets

-Veritas et Visus

-Insight Media

-FlexTech Alliance

\*Restrictions apply

### Networking Events and Partnership Opportunities

#### The Flexible Electronics and Displays Conference and Exhibition

Members receive significant discounts to the annual Flex Conference. Attendees span the roles of technical, marketing, product development, manufacturing, and business planning functions.

#### Regional Workshops, Meetings, and Business Conferences

Hosted at member locations, these one-day events provide a great venue for networking with industry experts throughout the supply chain.

### Educational Events

Members receive discounts on FlexTech Alliance short courses. These courses provide valuable, up-to-date education and information on trends in technology and business. Webinars are being planned for 2012

### Member Marketing

**Advocacy** - FlexTech Alliance provides a strong and effective industry voice with the media, investment community, federal and state governments.

**On-line resources** – Members are featured prominently on [www.flextech.org](http://www.flextech.org), a popular resource for journalists, industry and financial analysts, and consultants.

**Branding opportunities** - Members receive an expanded and highlighted listing in the searchable on-line directory as well as posting rights and advertisement placement on FlexTech's home page.

**Product demos** – FlexTech Alliance can help facilitate the development of product demonstrators.

**To schedule a membership overview meeting, call FlexTech Alliance at (408) 577-1300**