FlexTech Alliance
for Displays & Flexible, Printed Electronics

FlexTech Trends

News from the world of displays and flexible, printed electronics

Volume 3 - Spring 2009

FlexTech Trends

Table of Contents

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Note from the President

by Michael Ciesinski

Welcome to the newly updated FlexTech Trends. In this issue, among other topics, you will read about:

- DisplaySearch forecasting the OLED market
- Kent Displays revealing their new roll-to-roll manufacturing line
- Abbie Gregg providing an expert's view of cost reduction strategies; and
- Uni-Pixel describing their exciting new display

The purpose of this newsletter is to provide you with a quarterly summary of industry news and – for those who want more information – news links. The newsletter will feature member companies' business activity, along with guest articles describing economic and technology trends. Also, each issue will contain updates on our partners at Arizona State University's Flexible Display Center and Binghamton University's Center for Advanced Microelectronics Manufacturing. If you would like to contribute an article to an upcoming issue of FlexTech Trends, please send a brief summary, along with your contact information, to info@flextech.org.

Every day brings fresh (although not always accurate) reporting about today's economic environment and our insights are no better than the experts. One outcome of the economic slowdown that companies should investigate, however, is the funding provided by U.S. government agencies for R&D and product development activity. This window of opportunity is not likely to be repeated once the crisis has passed. Large, medium and small size companies, along with R&D organizations and academic institutions, all have a potential funding stream. Companies who are not domiciled in the U.S. can find local partners in order to apply. Please see the federal funding summary from Dewey LeBoeuf LLP on page 4 for more details.

Despite the slowdown, pockets of good news exist for the electronic displays and flexible electronics industries, including:

- Heightened consumer interest and widespread market acceptance of e-books
- Continued investment in OLED R&D and production
- Substantial investment in solar with an objective to move some process steps to printing
- Field trials of printed RFID
- Continuous roll-outs from Hollywood of 3D cinema and the eventual migration of 3D entertainment (movies, games) to the home

Ours is an information age, where developing, delivering and displaying content are paramount. In the long term, this bodes well for the success of the display industry and for the flexible electronics industry, which will contribute to delivering information anytime and anywhere.

Cordially,

Michael Ciesinski
President

Breaking News: Substantial R&D funding contained in Stimulus Bill and FY 2009 Appropriations Bill

As a member service, FlexTech monitors federal funding available for R&D and prototype development activity. The following summary was prepared by *W. Clark McFadden II* and *Stephen Lita* at Dewey LeBoeuf LLP.

R&D Funding in Stimulus Bill

The bill contains $21B in R&D funding overall ($18.0B for R&D and $3.5B for R&D facilities and capital equipment, for repair, maintenance, and construction of laboratories as well as large research equipment and instrumentation) made up of the following:

- $10.4B to National Institutes of Health (NIH).
- $3.0B for the National Science Foundation (NSF).
  - $2 billion for other research and related activities.
  - $200 million for academic research infrastructure.
  - $400 million for major research equipment and facilities construction.
  - $300 million for major research instrumentation.
- $2.5B for Department of Energy (DOE) Energy Efficiency & Renewable Energy (EERE) applied research, development, demonstration and deployment including:
  - $800 million for the Biomass Program;
  - $400 million for the Geothermal Technologies Program; and
  - $50 million for information and communications technology.
- $1.6B for the DOE Office of Science for basic research, laboratory research, facilities upgrades and construction and advanced scientific computing.
- $400 million for the new Advanced Research Projects Agency-Energy.
  - Will support high-risk, high pay-off research to accelerate the innovation cycle for both traditional and alternative energy sources and energy efficiency.
- $600 million for the National Institute of Standards and Technology (NIST) including:
  - $360 million for construction of research facilities; and
  - $220 million for research, competitive grants, additional research fellowships and advanced research and measurement equipment and supplies.

R&D Funding in FY 2009 Omnibus Appropriations Bill

- NSF budget increased 5.9 percent ($362.9 million) to $6.5B
- DOE Science budget increased by 18.8 percent ($754.9 million) to $4.8B
- NIST budget increased 8.4 percent ($63.2 million) to $819 million.
  - $65 million for Technology Innovation Program (TIP).
- DOD previously received $13.4B for basic research, applied research and advanced technology development.

OLEDs to grow in display and lighting markets

by Jennifer Colegrove

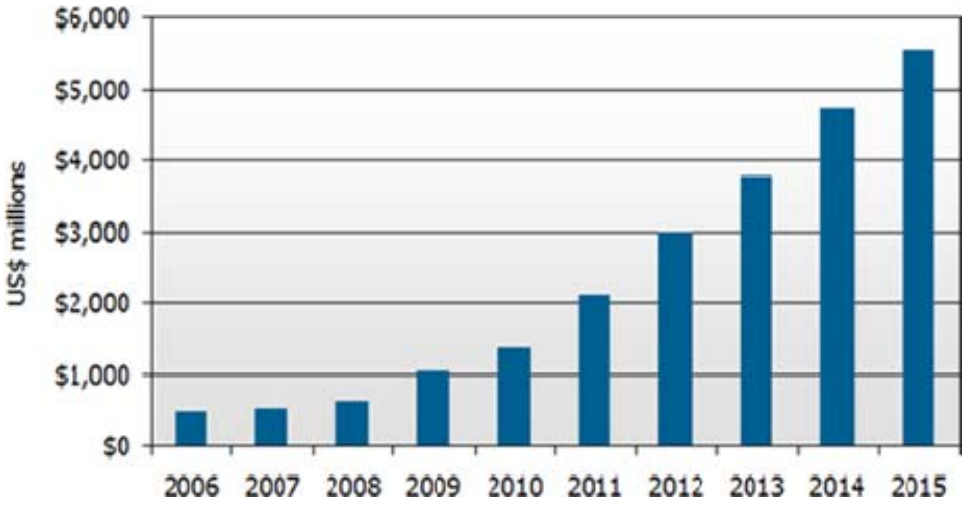
Jennifer K. Colegrove is Director of Display Technologies at DisplaySearch. She is responsible for reports and consulting projects on display technologies, including flexible displays, OLED, bi-stable displays (e-paper), touch-screens, and 3D. Before joining DisplaySearch, Dr. Colegrove was a senior analyst at iSuppli and led the emerging display technology services, including touch screen, flexible display, bi-stable displays, LCD, FED, micro displays and OLED. Prior to iSuppli, Dr. Colegrove was a senior display engineer at Intel, performed due diligence for Intel Capital, the venture capital arm of Intel. She was responsible for display technologies from LCD to OLED to bi-stable displays and reviewed all display-related patent applications as a member of the Intel Mobile IP committee. She has also worked in several start-up companies, including dpiX (a Xerox spin-off), Digilens, Silicon Bandwidth and Crystal Research. Jennifer Kong Colegrove has a Ph.D. from the Liquid Crystal Institute at Kent State University in Ohio. She received both Master's and Bachelor's degrees with honors from Beijing University in Beijing, China.

Worldwide OLED Revenues Forecast to Reach $5.5B by 2015 on Strong AMOLED Growth

DisplaySearch newly forecasts the total OLED display market will grow to $5.5 billion by 2015, from $0.6 billion in 2008, with a CAGR of 37%. Currently, this growth is being driven by the adoption of active matrix OLED displays for the primary display in mobile phones and portable media players. Expansion of AMOLED manufacturing capacity will enable production of larger displays for mini-notebook and notebook PCs, desktop monitors, and larger TVs. DisplaySearch forecasts that in 2015, TV will pass mobile phone main display to become the highest-revenue application at $1.92 billion.

AMOLED displays have become an important differentiating factor for high-end electronic products. AMOLED revenues will exceed those from passive matrix OLEDs (PMOLEDs) in 2009, and AMOLED is likely to pass PMOLEDs in terms of unit shipments in 2010, driven by mobile phone main display applications.

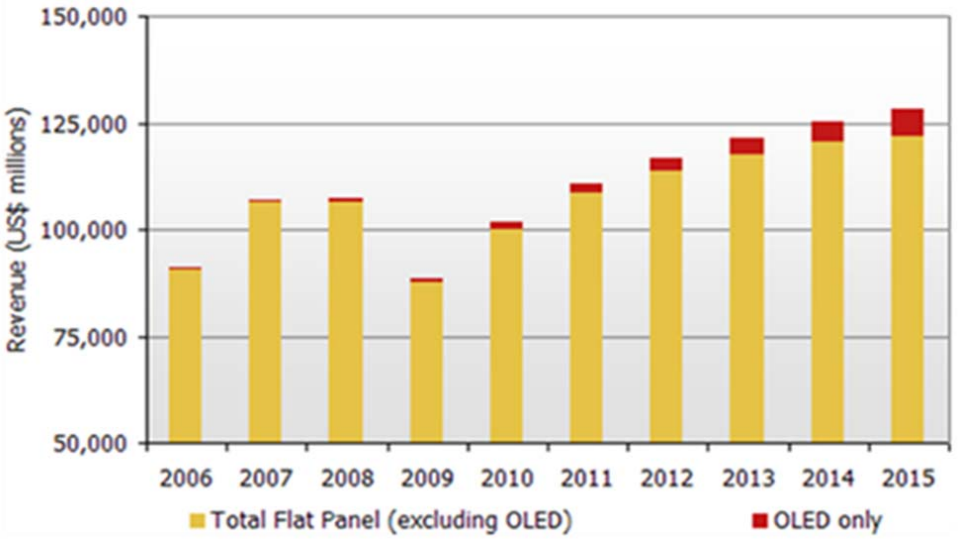
Worldwide OLED display revenue in Q4'08 was $156 million, an increase of 17% Q/Q. OLED revenues for FY2008 reached $615 million, a 24% increase Y/Y. PMOLED had a weak Q4'08, caused by slowing shipments of monochrome and area color OLED. AMOLED experienced a strong quarter, driven by demand for mobile phone main displays, as Nokia, Samsung Electronics and Sony Ericsson heavily promoted AMOLED mobile phones in early 2009. The OLED display industry is at a crossover point, as AMOLED passes PMOLED on a revenue basis. PMOLED makers need to investigate new market and product opportunities such as OLED lighting.



OLED Display Revenue Forecast 2006-2015

Samsung SDI – whose OLED group merged with Samsung Electronics' mobile display business to form Samsung Mobile Display (SMD) in January 2009 – had a strong Q4'08. As a result, Samsung SDI (now SMD) took the #1 position in shipments with a 31% share, passing RiTdisplay. Samsung SDI (now SMD) has been the leader in total OLED revenues for several quarters thanks to its AMOLED shipments.

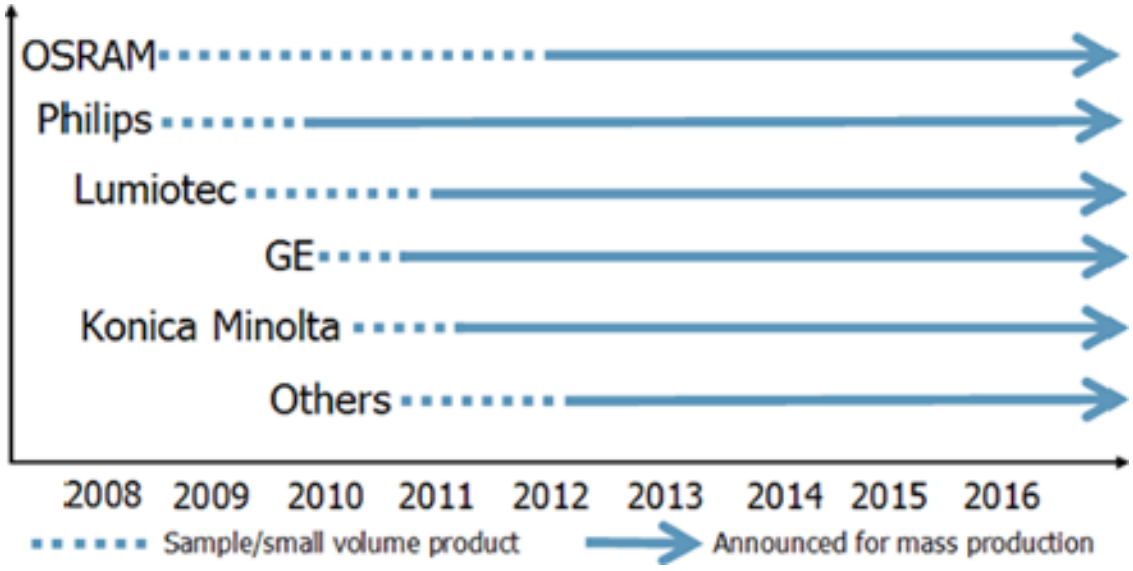
While mature segments of the display and electronic industries have experienced declines due to the economic downturn, active matrix OLEDs have experienced an impressive 110% revenue increase in 2008. Going forward, it will be important for OLEDs to find a niche market where it will be difficult for LCDs for compete, such as flexible or transparent displays, or lighting. OLED developers should also look for opportunities to combine their technology with other hot technologies, such as touch screens." OLED displays accounted for less than 1% of total flat panel display revenue in 2008. DisplaySearch forecasts it will reach 5% in 2015, experiencing a 37% CAGR in revenues, compared to the 3% CAGR predicted for the total flat panel display market.



OLED display penetration into the FPD market 2006-2015

OLED lighting predicted to take off in 2011

The OLED lighting market is setting the stage to take off in 2011, with OLED lighting revenues forecasted to surpass PMOLED displays in the 2013/2014 timeframe, reaching $6 billion by 2018. The unique features of OLED lighting are inspiring the imagination of designers. OLED lighting devices emit from the surface, can be made flexible/rollable, and even transparent like a window or reflective like a mirror. OLED lighting is thin, rugged, lightweight, and has fast switch-on times, wide operating temperatures, no noise and is environmentally friendly. The power efficiency of OLED lighting has also improved dramatically in recent years. In a new report from DisplaySearch, the company forecasts market size, in both area (m^2) and revenue ($) through 2018, with breakdowns for six applications, including automotive, display backlights, decorative/general lighting, healthcare, industrial, and signage/advertising. Market forecasts are also given by substrate type, detailed by flexible versus rigid. Looking into the future, the OLED lighting industry will pick up in 2011, with Philips, GE, Konica Minolta, Lumiotec and OSRAM entering mass production (*see figure*).



OLED lighting manufacturing participant roadmap

Kent Displays begins roll-to-roll production of flexible Reflex LCDs in Ohio facility

by Al Davis

Al Davis is the Senior Director of Sales and Marketing for Kent Displays. Al is a display industry veteran having pioneered the sales and marketing of touch panel, plasma, microdisplay and other technologies actively offered in the markets today. Al began his career in sales at IBM and held senior sales and marketing positions with various technology companies such as Fujitsu, Three-Five Systems, Carroll Touch, S-Vision and Clairvoyante. Al has a Bachelor of Business degree (Marketing) from the University of Georgia and a Master of Arts (Management) from Pepperdine University. To learn more about Kent Displays' line of Reflex displays, including a portfolio of glass-based products, visit http://www.kentdisplays.com.

The display industry is changing right before our eyes. Every day brings design and manufacturing advances that allow displays to be used in new and exciting applications. Many of these new applications have the potential to literally change the way we live our daily lives.

Kent Displays, manufacturer of Reflex LCDs, is one of the companies at the forefront of these advances. Founded in 1993 in Kent, Ohio, the company experienced steady growth over its first 15 years, primarily through its line of bistable glass LCD modules. Based on that solid foundation, Kent Displays embarked on a major capital project in 2008 that stood to have a dramatic impact on both the direction of the company and the entire display industry itself. This project was the design of the world's first roll-to-roll plastic display manufacturing line, installed in October of 2008 at its Kent headquarters.

Installation of that line is now complete and final commissioning is in its last phase. The line is on target to reach full production capabilities early in the third quarter of 2009, positioning the company to be a market leader in the flexible display industry. The Kent facility has capacity to add more lines in the future as product demand increases.

Unlike traditional sheet-based methods for flexible display production, the roll-to roll line produces finished Reflex displays from rolls of plastic. The highly automated process has many advantages over its labor intensive predecessor. In addition to much higher output capabilities, per unit cost and waste water/chemicals are substantially reduced. Ultimately, the line truly opens the door to the commercialization of flexible displays on plastic substrates, the applications for which are nearly endless. Many of these applications were previously unachievable with glass displays and cost-prohibitive with existing flexible displays production methods.

Kent Displays installed a roll-to-roll production line in October 2008, believed to be the first in the world for manufacturing flexible LCDs.

Flexible Reflex displays are ideally suited for a myriad of new and unique applications because of their conformability, thinness, ruggedness, and light weight. When these features are added to those common of all Reflex displays – excellent optical characteristics, no power image retention and sunlight-readability – the potential applications expand even further. Of the new applications in which flexible Reflex displays can be utilized, there are three initial areas of focus for Kent Displays: smart cards, electronic writing tablets and electronic skins.

Smart Cards: Perhaps no other application utilizes the total feature set of flexible Reflex displays more than smart cards. This feature set, combined with the Kent Displays' capability to meet production volume requirements of card manufacturers, brings real viability to mass market smart cards with stored value, one time password, promotional and medical record systems capabilities. While Reflex displays include the flexibility that all smart card applications require, their other characteristics – no power image retention, thinness (less than .3mm typical), durability and segmented or graphic output – are equally important in making smart cards a true commercial reality.

The feature set of flexible Reflex displays makes them ideal for smart card applications.

Electronic Writing Tablets: Electronic writing tablets represent the second initial focus application for flexible Reflex LCDs. For this application, Kent Displays has developed its own direct-to-consumer product, the eNote LCD writing tablet. A cost-effective, environmentally-friendly alternative to traditional pen and paper, the eNote tablet incorporates a pressure sensitive, flexible Reflex display that responds to various styli (even a finger) and erases at the touch of a button. Power is required only to erase (provided by an internally-sealed battery rated at 50k erasures), not to retain an image

eNote tablets have many uses in the classroom, office, home and even on the athletic field. They are ideal for student practice exercises (e.g., handwriting, arithmetic), sketching/doodling, game playing (e.g., tic tac toe), list making, play diagramming and general memo writing. Initial market response to the eNote tablet has been strong and includes the inaugural FLEXI product development award for most innovative development in 2009.

The eNote LCD writing tablet has received strong initial response from consumers and industry groups.

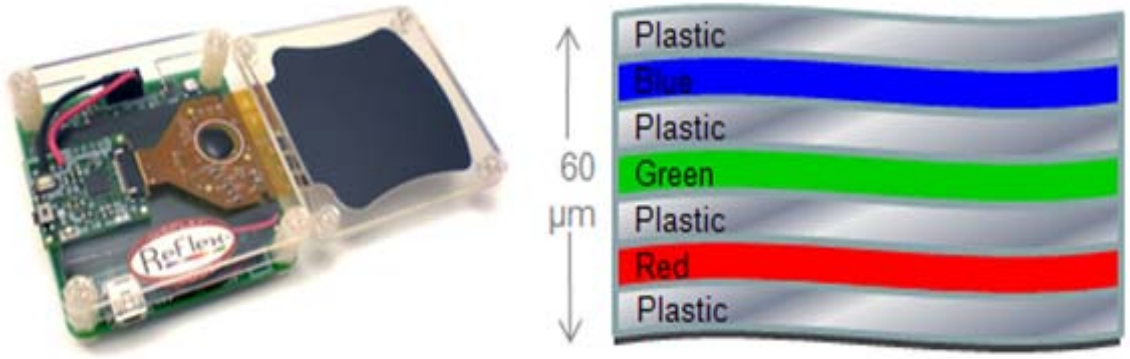
Electronic Skins: Electronic skins are the third initial focus application for flexible Reflex displays. Electronic skins provide a new way to personalize cell phones, media players, notebook computers and other personal electronic products, one that allows the user to dynamically change the product color/appearance to match their mood, clothes, preference or device state (e.g., visual ring tone, visual voice mail indicator). Permanently molded to the outer case of the product, electronic skins offer consumers and product manufacturers numerous advantages over current static personalization options such as plastic cases, adhesive skins and appliqués (beads/stickers).

Artist conception of a cellular phone with an integrated Reflex electronic skin from Kent Displays.

"Following a significant investment of labor and capital in the development and manufacturing of plastic substrate displays, Kent Displays is now realizing the fruits of its labor in the form of mass-produced, flexible Reflex LCDs," states Dr. Albert Green, CEO, Kent Displays. "The display markets have been waiting patiently for products of this type that are conformable, cost effective and rugged. With flexible Reflex displays, Kent Displays is positioned to be a major player in ushering in this era."

For consumers, electronic skins provide a permanent personalization solution that allows

spontaneous appearance changes without the purchase of accessories or a similar product in a different color. As a device status indicator, electronic skins provide a new level of functionality unavailable in similar previous products. Based on general consumer response to other product advances in the past, it is likely this type of new functionality will be highly valued. For product manufacturers, electronic skins represent a paradigm shift in the way they can differentiate their products. Electronic skins also offer the potential for them to increase revenue previously captured by providers of after-market personalization products (through increased incremental sales of products with skins and/or higher prices for them).



An engineering kit for Reflex electronic skins is now available. Reflex electronic skins measure just 60 microns thick and utilize a stacked design for high brightness and optimal color.

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Flexible Displays and Electronics Report

Are flexible displays finally ready for mass adoption?

The 300+-page *Flexible Displays and Electronics Report* contains detailed data and unparalleled analysis on the readiness of various flexible display technologies and their commercial opportunities.

In this new report, DisplaySearch and the FlexTech Alliance forecasts that flexible display revenue will increase from $85M in 2008 at a compounded annual growth rate of 58% to $8.2B in 2018. In addition to market forecasts by technology and application, this comprehensive report covers:

- Market readiness of core technologies, suppliers, and manufacturers
- Market drivers impacting the growth of flexible displays and electronics
- Analysis of electrophoretic, electrochromic, OLED, RFID, flexible substrates, active matrix backplanes and more
- Product roadmaps and capacity by technologies and applications

Contact us today for more information on the *Flexible Displays and Electronics Report* and how you can get a complimentary copy of the 85-page Flex Tech Alliance (with assistance from cintelliq) report *"Flexible Electronics: Government Investment and R&D Programs in the U.S. and European Union"*.

FlexTech Alliance for Displays & Flexible, Printed Electronics

DISPLAYSEARCH AN NPD GROUP COMPANY

Interview with Jim Tassone of Uni-Pixel Displays

James A. Tassone joined Uni-Pixel Displays as chief financial officer in August of 2003. Prior to joining the company, he was the founder, managing director, and CFO of Mindwave Research, Inc. where he remains on the board of directors. Early in his career, he was with IBM, Digital Equipment Corporation and Comdisco, Inc. before joining market research leader DataQuest/Gartner Group. After Gartner Group, Tassone became managing director at IntelliQuest. He left a research company start up he launched under CMP Media (Reality Research) to found Mindwave.

We haven't heard too much lately from Uni-Pixel. Tell us about what the company has been up to. After demonstrating our first TFT and direct drive based TMOS prototype systems during SID last year, we have been optimizing the sub-systems and working on expanding our efforts with our development partners. We have broadly expanded our thin film development efforts which have yielded a number of outstanding results. This includes the first product within our Opcuity Performance Engineered Films family which is ready to enter the market. We have completed a Joint Development Agreement with our first display panel partner and we have developed a unique conductor patterning capability using an inkjet process that has a wide range of applications.

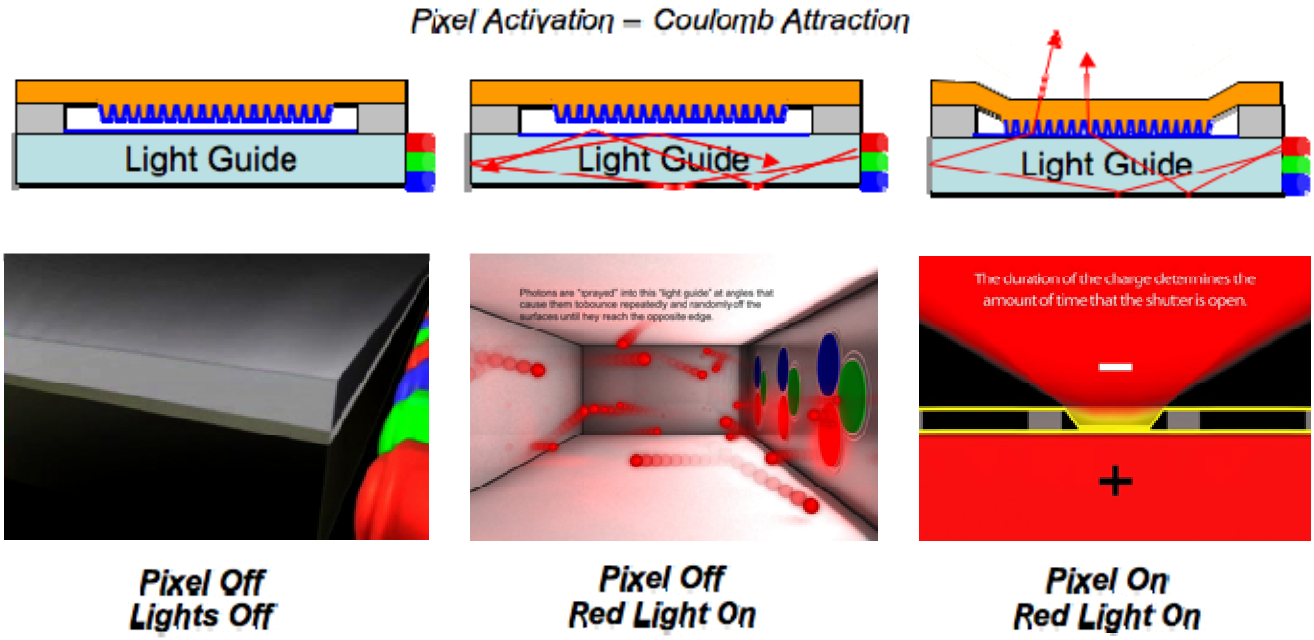
Can you describe these technologies in more detail? The core technology is our display architecture which we call "TMOS" which stands for Time Multiplexed Optical Shutter. It is a polymer MEMS system that leverages the frustration of Total Internally Reflected (TIR) light as the means to transmit light from edge mounted LEDs through a light guide to the viewer. In summary, we sandwich a polymer membrane between two sheets of panel glass to form individual drum like structures as pixels. When the drum head oscillates into contact with the light guide glass, light is coupled out to the viewer. As a unicellular "unipixel" system, each pixel emits the full color spectrum through field sequential (time multiplexed) color. This eliminates the need for color filters and reduces the TFT count by 2/3 as there are no sub-pixels in the panel. We also eliminate liquid crystal, both vertical and horizontal polarizers, and replace the backlight unit with our edge light assembly which injects light directly into the panel glass.

Our Opcuity Performance Engineered Films leverage a common set of unique capabilities that we have developed. The first of these is the ability to pattern precision geometric microstructures on the surface of a thin film. These optical microstructures are between 2 and 10 microns tall with precision edges and faces. We have developed an inkjet process that allows us to pattern conductors around these structures on the film. We have also developed unique capabilities to modify the surface energy properties of the films to accomplish various beneficial results. When these three capabilities are combined with our optical expertise and engineering the result has been a family of film products that are truly unique and can support unique applications.

Are your development efforts focused on flexible display solutions, or do you plan to transition from fixed substrates to flexible substrates over time? We plan to transition over time. We feel very comfortable that once we have optimized our solution on a fixed substrate, it will transition to flexible substrates. We are tracking the work being done today in flexible displays to determine if it may benefit our efforts immediately. That being said, both of our unique thin film capabilities were developed for roll to roll processing. So our model is to produce rolls of our Opcuity films for the specific applications which can include flexible display implementations. One very interesting aspect of our work that we developed for our TMOS specific films is the conductor patterning technique that we use for our Opcuity Active Layer film. Using our unique approach we can pattern conductors on thin films at trace widths of 3 to 5 microns using an inkjet processing technique. In a recent planning session with a number of industry experts, a roadmap was presented that showed the industry attempting to reach this goal for a roll to roll processing environment in the next 5 to 7 years. We stood up and said, "We can do that today". As a result we are now pursuing a project to bring this capability to broader industry applications such as multi-layered printed flexible circuitry and micro-fluidics. This also will allow us to

be able to use it to produce our Opcuity Active Layer Film for TMOS in a roll to roll production environment. Beyond that I believe that it may also find its way into other flexible display applications.

You have claimed "that TMOS will outperform OLED, plasma and LCD technology in every measurable dimension". That's a pretty bold claim! Can you back it up? When we first made this claim, we relied on our models to support the performance that we believe could be achieved. We have since built prototypes and conducted detailed empirical testing on every aspect and are still confident that TMOS will be the best performing display architecture in the industry in brightness and the lowest in power consumption. We have also physically demonstrated frame rates of over 650 frames per second, which we are absolutely sure will allow image quality beyond all others.



Display cross-section: pixel off represents no charge differential between conductors; pixel on represents a charge differential between conductors (+/+, +/-, -/-). Note that layers and deformation are not to scale. The combined layers on the light guide are less than 15 microns thick.

You also claim that "Uni-Pixel technology will work in something as small as a pocket calculator with displays less than an inch... and will also fill a family room with TV images as large as 110 inches." What markets are you targeting as the most likely initial adopters of your technology? We have aligned TMOS manufacturing processes to be completely compatible with existing LCD fabs so our panel sizes will be governed by the generation of LCD fab we are implemented into and its glass handling. Eventually we would hope that we can transition the largest fabs to TMOS from LCD to achieve very large panels. Initially we are working on smaller size panels where our low power consumption attribute can extend battery life in hand held devices while providing much brighter output making them direct sunlight readable.

What are the biggest challenges facing Uni-Pixel Display in terms of developing solutions appropriate for the flexible display market? Time and resources.

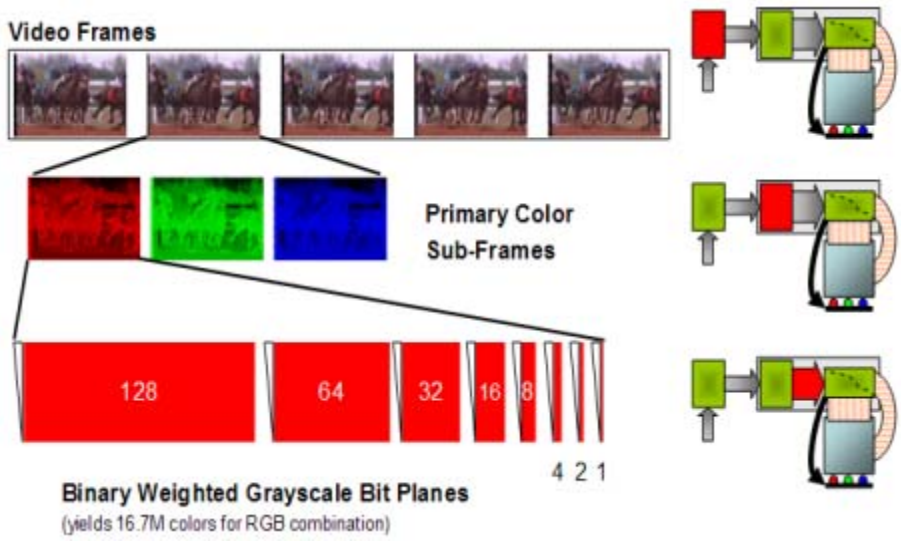
Field sequential color is sometimes criticized due to color break-up issues. What are you doing to minimize such concerns? First and foremost our extremely high pixel speed (less than 2 micro-seconds) allows us to burst mode our sub-frames at rates that overcome breakup. Secondly we have filed patents on methods and algorithms that allow us to take full advantage of this speed.

Tell us about your intellectual property position. We have surpassed 118 patents issued or filed and still have a backlog of over 50 new innovations that we are processing our way through. Again, time and money are the limiting factor for us to continue this ramp.

Does your business model assume licensing to established display companies, or are you hoping to manufacture display systems yourselves? We will license our display architectures, designs, and IP to existing panel manufacturers and eco-system partners in various sub-systems like light injection and drive control circuitry, and to supply the Opcuity Performance Engineered Film that makes TMOS work.

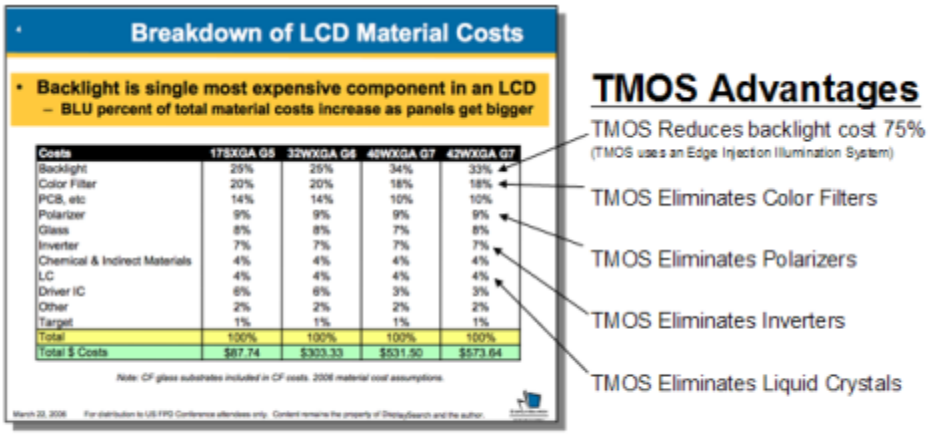
When can we expect to see further public demonstration of your technologies? We expect to make announcements in the near future specific to TMOS but do not have firm dates to announce at this time. We are in the process of distributing test samples of our Opcuity Finger Print Resistant (FPR) Film for Touch Screen panels with its expected entry into the market in the next few months. Opcuity FPR serves as a protective cover for touch screen panel devices that also prevents fingerprinting and smudging. Beyond that we have a few other Opcuity film designs that we expect to announce and demonstrate over the next year.

Your technology also relies on field sequential color. Any interesting breakthroughs in this area? The speed of the LEDs and the TMOS pixels gives us the ability to overcome ghosting and rainbow effects that other field sequential color (FSC) architectures have had trouble resolving. The TMOS architecture provides many differing methods for achieving both billions of colors and an extended color gamut while at the same time eliminating typical FSC artifacts. Uni-Pixel has several patents, filed and issued, that are specific to FSC generation in a TMOS system.



What are the practical limits of your technology in terms of resolution? We anticipate meeting 300-400 ppi and will be able to push the resolution higher if required. TMOS, which has a single pixel architecture generating the entire color spectrum, holds a distinct advantage over LCD, OLED, and plasma displays which require three or more sub-pixels for each pixel.

You characterized your TMOS solution as a way the TFT LCD industry can reduce costs. Please be more specific. The TMOS display panel manufacturing requirements are a subset of LCD panel manufacturing requirements. TMOS has a reduced Bill of Materials (up to 50% materials reduction for the foreseeable future) and provides a significant reduction in LCD manufacturing process steps. The LCD manufacturing industry can reduce costs as well as increase the performance levels of the flat panels they produce by building TMOS displays.



(LCD panel manufacturers can achieve a > 50% reduction in materials cost by switching to a TMOS manufacturing approach)

Cost reduction advances for manufacturing flexible displays and electronics

by Abbie Gregg

Abbie Gregg has spent the last twenty years as an engineering consultant, specializing in microelectronics process analysis and startup / restructuring of laboratories and manufacturing facilities. Abbie Gregg, Inc. (AGI) is her consulting firm, specializing in programming and design of cleanrooms and advanced technology laboratories. Layout, Room Conditions, Utility Matrix, and Specialty Systems design have been provided for Industrial and University Clients. Her previous experience is in process engineering, operations management, and technical strategic planning for major semiconductor device manufacturers. Her areas of specialization include Integrated Circuits, Flat Panel Displays, TVS Devices, and Multichip Modules. Consulting projects have included yield enhancement, improved operations effectiveness, systems and programs for computer aided layout and design of Cleanrooms. Abbie's team also developed software models for semiconductor and FPD product cost, outsourcing analysis, cost of ownership and factory modeling. Abbie holds a Bachelor of Science in Metallurgy and Material Science from the Massachusetts Institute of Technology, and studied Electrical Engineering at the University of Maine.

Note: A more thorough article about opportunities to reduce costs associated with automation will appear in the next edition of the Flexible Substrate newsletter from Veritas et Visus.

Recently, AGI has found our clients are interested in a better understanding of costs of the widely diverging technologies using flexible microelectronics manufacturing techniques. These needs can be broken down into 4 areas:

- What are the Current Cost Drivers in Flexible Displays and Electronics?
- What are the Key Equipment Advances in Process and Automation that can help reduce costs?
- How does the scale of Operations and Geographic location affect cost?
- Where are the best Future Opportunities for Cost Reduction?

AGI has recently reviewed the key cost drivers in Flex Displays and Electronics using our cost models for a variety of clients and products. Some of the recent applications we have studied include manufacturing of test strips for diabetes, and comparing two techniques: printed with ink OR laser-ablated metal. We have also compared photovoltaic devices: CIGS and organic materials. In touch screens we modeled waveguide based touch screens and PC board type that uses a pen and includes a digitizer as well as touch. In displays we have looked at TFT displays as well as simple dye photo-chromic displays and LED displays on flex for credit card applications. We also analyzed manufacturing for batteries in a cosmetic patch or RFID product looking at an ink-based manufacturing approach.

Two areas emerged as key cost drivers:

- Materials
- Product packing density

We find that Materials for flexible electronics continue to be expensive, although inexpensive materials in roll format are one of the dreams of flexible electronics, so the high cost of silicon and glass can be eliminated. Organics are now popular because electronically/optically active materials and substrates have been developed in research. Many have inexpensive base formulas which should eventually lead to low cost process materials. However, most electrically or optically active materials are still moisture susceptible, and have a relatively short shelf life before a baking or curing step. Organic materials also suffer from a lack of precision in chemical formulations causing waste, and unpredictable yield, although testing and mixing are

becoming more rigorous. Improvements in chemical formulation consistency will be very important in yielding lower costs and economies of scale.

The second big problem with materials causing waste and high cost, continues to be lack of precision in physical dimensions and retention of dimensions of substrates during processing, causing misalignment of multiple layer patterns and lack of tolerance in these patterns, ultimately leading to scrap.

One big recent advance is, finally, a "display ready" planarized PEN substrate from DuPont Teijin Films. Teonex PEN films are a high performance extension to the existing range of Melinex and Mylar polyester film products and bridges the gap between price and performance for polyester and other films.

Metal foils are also enjoying wider use due to improvement in surfaces, and reduction in defects. A recent announcement from Lehigh is one of several pointing to improvement in the analysis and implementation of metal foils for a variety of photovoltaic and display applications.

- Lehigh University's Display Research Laboratory, which will investigate the suitability of a number of different metal foils for use in the manufacture of flexible display backplanes. The $270,000 cost-shared award will be the first-ever systematic study of metal foils with the goal of yielding alternative substrates to today's commonly used stainless steel.
- Specifically, Lehigh University will work cooperatively with Hamilton Precision Metals (HPM), a business unit of the Specialty Metal Products Division of AMETEK, Inc. to identify promising material candidates with parameters for improving yields on metal backplanes for flexible displays. Important factors in creating displays include good thermal coefficient matching and smooth substrate surfaces for minimal display defects, both of which are current issues with using stainless steel as a substrate. In addition, this study will assess the costs associated with each foil in a high-volume manufacturing environment – enabling selection of more cost-effective approaches to producing displays. The year-long project will be led by Dr. Miltiadis Hatalis, professor of electrical engineering and computer science at Lehigh.
- Dr. Mark Robinson, vice president of technology at Hamilton Precision Metals, noted, that the metal foils being characterized by Lehigh will have all been prepared by the same cold rolling process, using the same equipment."
- Once the film characterization has been completed and the most promising materials identified, additional samples of the selected foils will be made available to the US Army-sponsored Flexible Display Center (FDC) at Arizona State University to further test its capabilities.

Product packing density is the second area with a large impact on product cost. The basic rule of product packing density is that high device packing density is needed to achieve low cost. However, as many clients come to us with overly aggressive packing density as come with far too loose packing density. Those with overly aggressive packing density lose out on yield. Those with tool loose packing density lose out on throughput. The role of product engineering in accounting for and carefully analyzing the following parameters is critical:

A – Alignment tolerances of multilayer devices
B – Processing tolerances of line-width

Design rules for new flex devices in all applications are still evolving and vary by type of material and equipment. For example, a waveguide made of a thick proprietary polymer will not have the same line width tolerances when exposed on a Tamarack aligner with broad spectrum UV light as does a classic UV sensitive photo-resist.

Mechanical, electrical, and process engineers must work together and create test patterns and metrics for new device types. It is very important to characterize the limits of any pattern and overlay tolerances in order to provide better design guidelines for the next generation of devices one plans to produce. As an example, on large area Photovoltaic devices on flex, maximizing area open to sunlight is critical in device layout. This open to sunlight area is the biggest cost driver!

PV Design Rules Impact is shown in the table below where the variation in fill factor between 75% and 95% of this device changes the cost per watt from $35.78 to $30.85 for the same cell efficiency, volume and substrate cost.

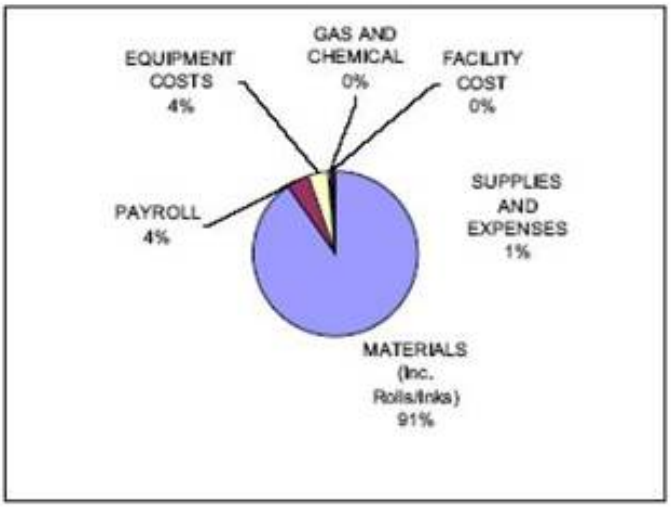
Variation	Module Efficiency		Design						
Module Eff.	FT^2/wk	$/watt	$/sq m	Tools ($M)	MW/yr	($/ml)	(ml/sub)	Incoming sub ($)	Filling factor
4.6% - BASE	2,311	$35.78	$1,154	$11.8	0.36	$5.00	3	$50.00	75%
5.6%	1,897	$31.57	$1,240	$11.8	0.36	$5.00	3	$50.00	75%
6.6%	1,610	$28.75	$1,331	$11.8	0.36	$5.00	3	$50.00	75%

Variation	Filling Factor		Design						
Filling Factor	FT^2/wk	$/watt	$/sq m	Tools ($M)	MW/yr	($/ml)	(ml/sub)	Incoming sub ($)	Filling factor
75%- BASE	2,311	$35.78	$1,154	$11.8	0.36	$5.00	3	$50.00	75%
85.0%	2,028	$32.95	$1,205	$11.8	0.36	$5.00	3	$50.00	85%
95.0%	1,823	$30.85	$1,260	$11.8	0.36	$5.00	3	$50.00	95%

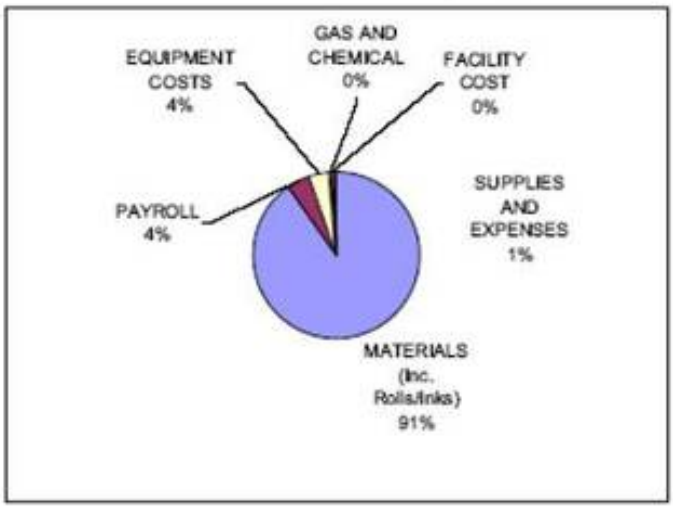
Here are some other examples of Flexible Electronics devices where materials were the major cost drivers.

This flexible medical device fabricated using a Metal Sputter/ Laser Ablation Process had 91% of its costs attributable to the materials. The precious metal ablation and recovery was not only the largest cost by far, but also would fluctuate with market price of this precious metal, although the product price to the customer could not vary accordingly, it was highly regulated.

Year 1 Costs			
MATERIALS (Inc. Rolls/Inks)	$	13,773,455	90.2%
PAYROLL	$	670,350	4.4%
EQUIPMENT COSTS	$	617,220	4.0%
GAS AND CHEMICAL	$	75,000	0.5%
FACILITY COST	$	49,000	0.3%
SUPPLIES AND EXPENSES	$	80,000	0.5%
	$	15,265,025	



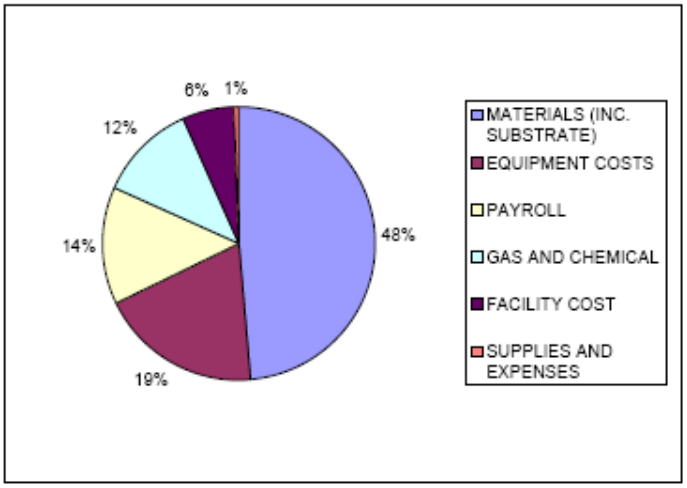
Year 5 Costs			
MATERIALS (Inc. Rolls/Inks)	$	15,502,145	90.2%
PAYROLL	$	754,485	4.4%
EQUIPMENT COSTS	$	701,296	4.1%
GAS AND CHEMICAL	$	84,413	0.5%
FACILITY COST	$	55,150	0.3%
SUPPLIES AND EXPENSES	$	90,041	0.5%
	$	17,187,529	

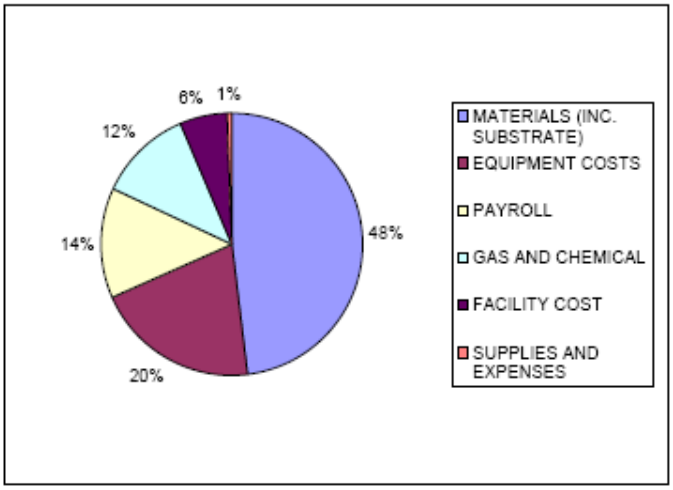


In this PV device the materials including the substrate make up 48% of the cost.

Year 1 Costs			
MATERIALS (INC. SUBSTRATE)	$	6,139,529	48%
EQUIPMENT COSTS	$	2,452,813	19%
PAYROLL	$	1,746,600	14%
GAS AND CHEMICAL	$	1,493,684	12%
FACILITY COST	$	761,600	6%
SUPPLIES AND EXPENSES	$	69,500	1%
	$	12,663,726	

Year 5 Costs			
MATERIALS (INC. SUBSTRATE)	$	6,910,095	48%
EQUIPMENT COSTS	$	2,917,179	20%
PAYROLL	$	1,965,814	14%
GAS AND CHEMICAL	$	1,681,155	12%
FACILITY COST	$	857,188	6%
SUPPLIES AND EXPENSES	$	78,223	1%
	$	14,409,652	





Another typical flexible electronics cost model for a semi automated line showed the percent of costs due to materials increased as volume went up because while the labor and equipment efficiency increased with volume, the absolute value of material costs per unit remained the same.

Semi-automated line showing % of costs due to material as volume increases and labor cost decreases

Lower Labor Rate →

819.7 panels/wk
U.S. Labor Rates
$1.45 / WG set

Materials	38%
Equipment	27%
Labor (Direct)	20%
Salary and Fringe (O/H)	8%
Equipment Maintenance	5%
Facility (Manufacturing Space)	1%
Facilities Maintenance	1%
Shipping	0%
Storage	0%

819.7 panels/wk
China Labor Rates
$1.17 / WG set

Materials	47%
Equipment	33%
Labor (Direct)	6%
Salary and Fringe (O/H)	4%
Equipment Maintenance	6%
Facility (Manufacturing Space)	2%
Facilities Maintenance	1%
Shipping	0%
Storage	0%

Higher Volume ↓

8,197 panels/wk
U.S. Labor Rates
$1.05 / WG set

Materials	52%
Equipment	20%
Labor (Direct)	19%
Salary and Fringe (O/H)	4%
Equipment Maintenance	3%
Facility (Manufacturing Space)	1%
Facilities Maintenance	1%
Shipping	0%
Storage	0%

8,197 panels/wk
China Labor Rates
$0.88 / WG set

Materials	62%
Equipment	24%
Labor (Direct)	6%
Salary and Fringe (O/H)	2%
Equipment Maintenance	4%
Facility (Manufacturing Space)	1%
Facilities Maintenance	1%
Shipping	0%
Storage	0%

Summary of FlexTech's Quarterly Workshop on Flexible, Printed Electronics

February 6, 2009

The FlexTech Alliance hosted a quarterly Printed Electronics Workshop as part of the Flexible Electronics and Displays Conference in Phoenix in early February. The Workshop focused on Market and Technology Updates: Government Programs. An overview of technology funding opportunities for 2009 was reviewed, including the NIST TIP Program, FlexTech Programs, and other government programs. The workshop also included two breakout groups focused around demonstrators for consumer packaging and medical applications.

The Consumer Packaging demonstrator is focused around building a product demonstrator using a fresh produce flexible package as a media for communicating future of functional and electronic applications in packaging. The conceptual approach is to design packaging to "look and feel" like a spinach bag and be easily transported. The functionality of the package is to include a variable price/expiration date, activated/switched by the user, based on temperature/humidity/time detected by an exterior sensor.

The Medical Applications demonstrator is to showcase printed, flexible electronics as a viable method to fabricate functional electronics based on a platform technology to serve as a model for other applications, including security sensors, structural health monitoring, and eventually active control of surfaces in response to stimuli. The demonstrator should utilize flexible printed electronics methods that offer a potential for a low cost, manufacturable, disposable "patch" to monitor vital health-status signatures.

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Save the Date: May 14, 2009

FlexTech Alliance

THE SONOCO INSTITUTE OF PACKAGING DESIGN AND GRAPHICS at Clemson University

The next FlexTech quarterly workshop on flexible, printed electronics will be held on May 14, 2009 at Clemson University in Clemson, So. Carolina. Included will be a **tour of Clemson's new Sonoco Institute of Packaging Design and Graphics, including live demonstrations of printed electronic initiatives.**

Please join leading technologists from producers, materials and tool manufacturers, as well as prominent universities and laboratories for a great networking event, a chance to collaborate with other experts in your field, and the opportunity to make a significant contribution towards moving the emerging printed electronics industry closer to commercialization.

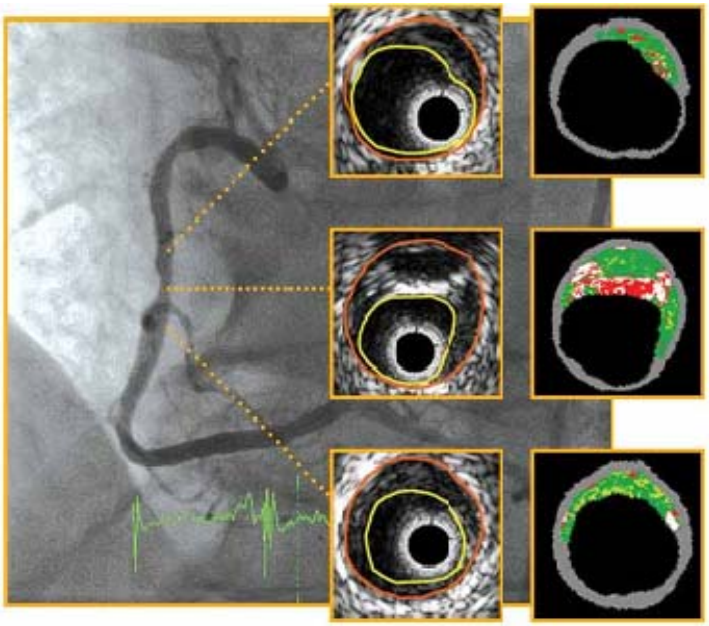
On Wednesday, May 13th, there will be will be a networking dinner at Clemson University, starting at 6:30 pm.

Attendance at the workshop is limited, so please contact Kay Mascoli (kay.mascoli@flextech.org) to confirm your attendance. Hotel accommodations are available on-site at the Clemson University Martin Inn, located on Lake Hartwell and the Walker Golf Course.

Partner update from the CAMM

by Mark D. Poliks, Director of R&D at Endicott Interconnect Technologies, mpoliks@eitny.com

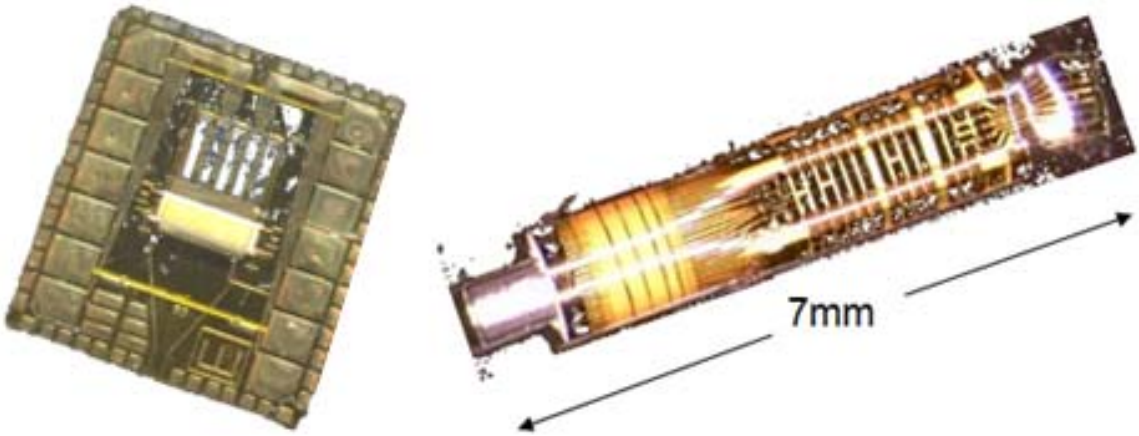
Endicott Interconnect Technologies and the Binghamton University Center for Advanced Microelectronics Manufacturing (CAMM) have teamed up to explore materials, processing and tooling for roll-to-roll manufacturing of advanced flexible substrates. Endicott Interconnect R&D staff are using vacuum deposition, photolithography and wet processing tools to fabricate flexible substrates for an Intravascular Ultrasound (IVUS) catheter application in the CAMM. The IVUS is a catheter-based system that allows physicians to acquire images of diseased vessels from inside the artery. IVUS provides detailed and accurate measurements of lumen and vessel size, plaque area and volume, and the location of key anatomical landmarks.



The CAMM and Endicott Interconnect are fabricating flexible substrates for use in Intravascular Ultrasound catheters.

Flip chip components are mounted on a state-of-the-art circuitized flexible substrate. The assembly becomes part of an intravascular ultrasound (IVUS) catheter device that provides an ultrasound image from inside a coronary artery and is used to diagnose and assess vascular and structural heart disease. It is comprised of a miniature polyimide flexible substrate featuring extremely fine pitch circuitry, 14 micron lines and spaces, and specialized plating and metallization features to facilitate assembly and provide the highest levels of interconnect quality and reliability. The polyimide film on which the device is fabricated is 12.5 microns thick. Assembled to this flexible substrate is a PZT (receiver/transmitter), and multiple flip chip die having 22 micron bumps on a 70 micron pitch, among the finest pitched, soldered interconnect flip chips in production anywhere in the world today. Specialized fixtures and handling are required to accommodate assembly processes on the thin polymer film.

The devices are fabricated on a flexible polyimide substrate with transducer (receiver/transmitter). The dielectric is a 12.5 µm polyimide, LW/LS is 14µm / 14µm, and the Flip Chip measures 22µm bumps at a 70µm pitch.



The end application is for medical assembly which provides an ultrasound image from inside a coronary artery and is used to diagnose and assess vascular and structural heart disease.

Partner update from the FDC

by Nick Colaneri, Center Director, Flexible Display Center

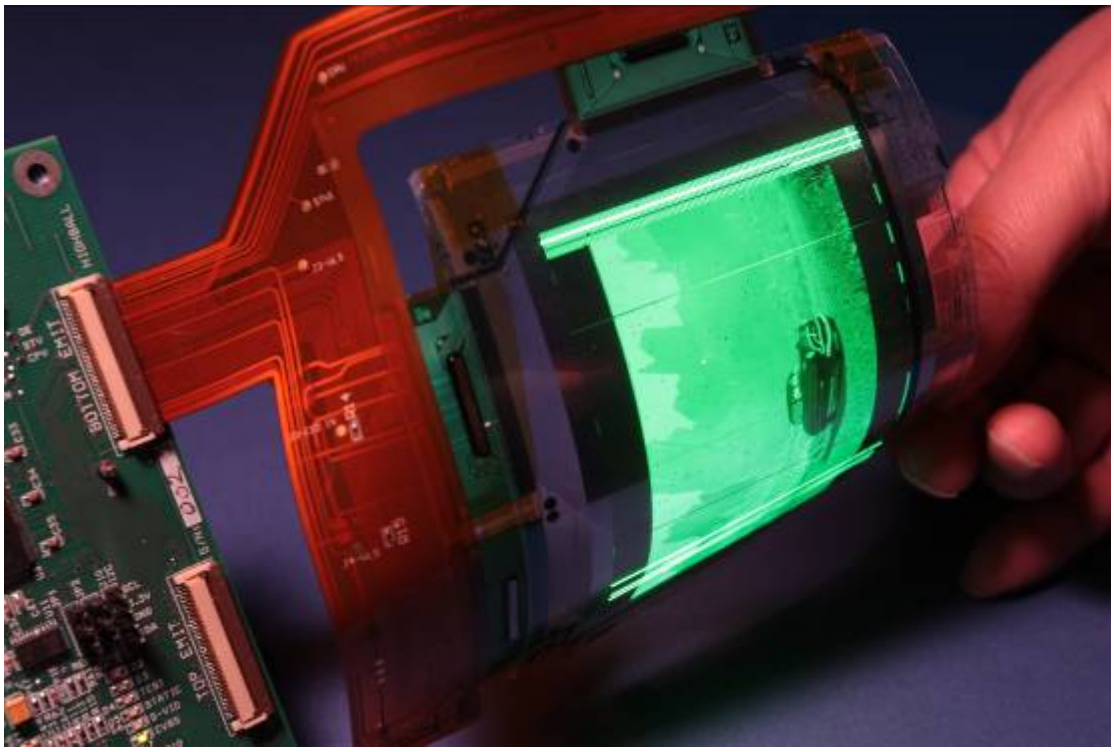
The newest industry members at the FDC this year are Lockheed Martin Corp., Cytec Specialty Chemicals, and MOCON Inc.

- The FDC anticipates that they will collaborate with Lockheed Martin on integration of larger form factor displays for aircraft and vehicle applications.
- We will be working with Cytec's newly formed Flexible Electronics group on UV curable formulations and other low temperature coatings and sealants for flexible display development.
- MOCON will install its state-of-the art AQUATRAN unit, an ultra high-barrier water vapor permeation test instrument at the FDC. The AQUATRAN makes it possible to accurately measure water vapor transmission rates down to 0.0005 g/m2 per day under varying temperature conditions. (Conventional units typically only measure to 0.005 g/m2 per day.)

Vitex has announced that they intend to provide their Barix barrier layer and encapsulation tool developed with funding from the FlexTech Alliance to the FDC.

The Center is making steady progress in GEN II (370x470mm) scale-up of their proprietary bond/debond process and has completed development of display characterization systems for reflective and emissive displays. This progress, along with member collaborations and donations are key to ramping up the flexible OLED development capabilities.

The FDC will be exhibiting various electrophoretic flexible display technology and applications demonstrators, as well as their 4.0-inch diagonal PHOLED display on PEN, integrated under collaboration with UDC at SID 2009 in booth 523. We will also be presenting two talks: "*Flexible CMOS and Electrophoretic Displays",* as presented by D. Allee in collaboration with B. Gnade from *UT-Dallas,* and "*AM PHOLED Displays on Temporary Bonded Polyethylene Naphthalate Substrates with 180°C a-Si:H TFTs", as presented by* Doug Loy



The FDC's 4.0-inch diagonal PHOLED display on PEN, integrated under collaboration with UDC, will be shown at SID San Antonio in June

Flexible Electronics and Displays Conference

Significant Progress in R&D, Manufacturing and Product Applications

8th Annual

2009 Flexible Electronics & Displays Conference & Exhibition

Pointe Hilton Squaw Peak Conference Center
Phoenix, Arizona, USA
February 2-5, 2009

Recap

The Flex Conference, held February 2-6, 2009 in Phoenix, Ariz., included a business & investment summit, three-day market analysis & technical conference, short courses, product exhibitions, poster sessions, and a half-day workshop. This conference is the leading North American event for announcing new products and R&D outcomes. Despite a challenging business environment, the conference drew 375 registrants, equal to 2008 levels. 151 presentations were given, exhibits increased, and short course offerings expanded.

Keynote speakers at the inaugural Business & Investment Summit included Maurice Gunderson of CMEA Ventures, Subhendu Guha of of UniSolar, and John Parmentola of the US Army Research Lab. They described everyday applications for conformal electronics, including energy, displays, lighting, and military systems.

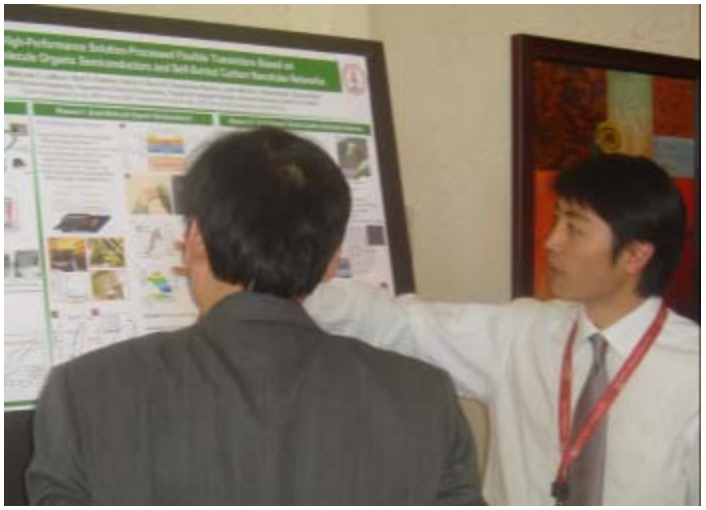
Due to the event's expanded scope with 21 tracks, there was a remarkable level of product announcements and innovations from industry segments in solid state lighting, graphics printing, medical applications, sensors, smart cards, RFIDs, solar and photovoltaic, novel printing tools, and functional inks. Dr. Mark Pinto, senior vice president of Applied Materials, opened the conference with the keynote address. Several notable topics were highlighted: e-books and other new display technologies by Sony, LG Philips, E Ink, PVI and Plastic Logic, market opportunities for conformal electronics via electronic skins by Kent Displays, medical applications using OLED displays and lighting in ambulatory on-body displays and in-vitro diagnostics, and printed sensors to measure acceleration, acoustics, pressure and temperature from Palo Alto Research Center's new project.

Proceedings of the Flex Conference 2009 can be purchased at http://www.flextech.org/.

SPONSORS

Panelists at the inaugural Business & Investment conference: Craig Cruickshank from cintelliq, Jim Richiutti from Needham & Co, Jacob Grose from Lux Research, and Norbert Hildebrand from Insight Media

The technical conference attracted an outstanding turnout despite the economy; attendees enjoyed a broad range of exhibits and networking opportunities



Jay Sperry from Clemson demonstrates some fine points about printing technologies during one of the short courses; Zhong Liu from Stanford explains the details of his student poster to an attendee

News and news links from the FlexTech Alliance

excerpted from Veritas et Visus newsletters

FlexTech Alliance inaugurates FLEXI awards program

The FlexTech Alliance announced the FLEXI awards and the student poster awards given out at the 8th annual Flexible Electronics & Displays Conference and Exhibition held February 2-5, 2009 in Phoenix, Arizona. The new FLEXI awards recognize significant accomplishments in R&D, product development, and leadership in education and training. DuPont Teijin Films won the award for development of its PET and PEN polyester films. Kent Displays won the product development award for development of the eNote liquid crystal writing tablet. For leadership in education and training, awards were presented to Binghamton University, Cornell University, Endicott Interconnect, and Princeton University. http://www.flextech.org

Detroit newspapers partner with Plastic Logic on new e-reader

Plastic Logic announced a strategic partnership agreement with the Detroit Free Press and The Detroit News, Michigan's largest metro daily newspapers, to offer digital content delivery and distribution program with its forthcoming Plastic Logic Reader. http://www.plasticlogic.com

Novaled showcases ultra stable OLEDs

Novaled introduced a novel defect tolerant OLED structure in mid-April. The defect-tolerant OLEDs maintain the appearance of a homogeneously lighted-up surface even in the case of electrical shorts, thanks to the use of its proprietary electrode design. http://www.novaled.com

NovaCentrix launches new conductive ink product line

NovaCentrix announced the launch of a new offering in the Metalon family of high-performance conductive inks: the ICI copper-based ink platform. The first example of this new line is ICI-001, formulated specifically for inkjet application and available for immediate shipment. http://www.novacentrix.com

OMET and Sonoco Institute establish partnership related to printed electronics

OMET S.r.l of Lecco, Italy, has formed a partnership with Clemson Universities' new Sonoco Institute of Packaging Design and Graphics. The emphasis will be on printed electronics and the hope is that Clemson will be able to break new ground in this emerging market. An OMET narrow web press features seven printing stations that can be configured with rotary screen, flexography or gravure with a variety of solvent based, water based and UV curable ink systems. http://www.omet.it/

Plextronics debuts new manufacturing line for flexible lighting

A new $6 million manufacturing line at Plextronics is designed to provide a link between the laboratories where that technology is being perfected and the manufacturers that eventually will produce it for consumers. The company is using the line to learn about and fine-tune the processes needed to translate its products to commercial applications. http://www.plextronics.com

Polyera and BASF develop ink for flexible PC screens

Developed by researchers at Polyera and BASF Future Business, a new semiconductor ink carries an n-type negative charge. Up until now, semiconductor inks have only been able to carry a positive charge, such as that developed by Xerox in 2004. This new form of n-type ink is made by dissolving a specific molecule in a certain solvent, can be printed on to any flexible material, including plastic and paper, using only a modified ink-jet printer. Polyera plans to market the n-type ink under the brand name ActivInk. http://www.polyera.com

HP joins with Arizona State University to prototype an affordable flexible electronic display

HP and the Flexible Display Center (FDC) at Arizona State University along with FDC partners DuPont Teijin Films and E Ink, have created the first prototype of an affordable, flexible computer screen by employing a manufacturing process developed by HP Labs called Self-Aligned Imprint Lithography (SAIL). Flexible screens are made by layering stacks of semi-conductor materials and metals between pliable plastic sheets. The technique also allows the screens to be manufactured in a roll-to-roll process. http://www.hp.com

Sencera demonstrates 8.7% efficient thin-film silicon solar cell

Sencera successfully deposited single-junction silicon solar cells with an initial 8.7% sunlight to electricity conversion efficiency under standard test conditions. As a result, the company has secured the final $5.2 million of a $15.6 million investment from the California-based investor Quercus Trust. http://www.sencera.com

UDC shows off flexible wrist-mounted OLED display concept

Universal Display revealed a flexible 4-inch OLED prototype. The company says the OLED "watch" display is made out of a one-sheet metal foil, and that its malleability will allow it to be quite comfortable. It will be a direct communications device, which means it will likely also include 3G, HSDPA capability. LG's GD910 will have a smaller touch screen, 7.2 Mbps HSDPA and a camera for taking pictures and video. Universal Displays has developed its OLED display in collaboration with the LG Display division, but the larger showcase display shows the possibilities of the technology.

The US Department of Energy honors UDC for advances in white OLED lighting

UDC announced that the company was honored by the US Department of Energy (DOE) for its research advances in white OLED lighting performance. In 2008 UDC demonstrated a white OLED light source with record luminous efficiency of 102 lumens per Watt (lm/W), a significant leap forward in OLED efficiency. That milestone placed OLED development well on the way to achieving the DOE's target of a 150lm/W OLED lighting device by 2015. http://www.universaldisplay.com

CMEL and UDC renew their material supply agreement

UDC announced that CMEL has renewed their "commercial supply" agreement. UDC is providing CMEL with materials to use in their AMOLED displays. The new agreement will run through December 2009. CMEL is making the AMOLED displays, and is currently shipping the largest display available (beside Sony's XEL-1 11-inch TV) - a 7.6-inch OLED panel, as used in Kodak's digital photo frame. http://www.udc.com

Sumitomo, Cambrios, and Chisso expand commercialization of transparent conductive material

Sumitomo, Cambrios, and Chisso have agreed to jointly promote and commercialize "wet-coatable" transparent conductive ink as a replacement of for ITO in the field of TFT-LCD. The companies plan to create a product based on Cambrios proprietary ClearOhm coating material. http://www.cambrios.com

Optomec fully prints ultrahigh frequency carbon nanotube transistors

Optomec announced that its Aerosol Jet system has been used to fully print carbon nanotube (CNT) based TFTs with operating frequencies over 5GHz. The work was conducted in collaboration with the University of Massachusetts and Brewer Science, Inc. Printing TFTs on flexible substrates at room temperature offers a cost-effective way to achieve mass production of large-area electronic circuits without using special lithography equipment. This is important for many emerging applications such as flexible displays, RFID tags, electronic paper, and smart skins. The Aerosol Jet deposition process was used to completely print all four layers of the TFT including materials with a wide spectrum of viscosities, making it an ideal solution for this type of multi-layer device. http://www.optomec.com

NIST finds insights into polymer film instability

While exploring the properties of polymer formation, a team of scientists at the National Institute for Standards and Technology (NIST) made a fundamental discovery about these materials that could improve methods of creating the stable crystalline films that are widely used in electronics applications, and also offer insight into a range of other phenomena. The team determined that temperature can play a decisive role in determining which of two competing processes-called crystallization and de-wetting-will "take the lead" when a semi-crystalline polymer film hardens. The findings could lead to better control of these two processes, which can cause imperfections in polymer films during their formation. http://www.nist.gov

NanoGram and Teijin enter printed silicon agreement

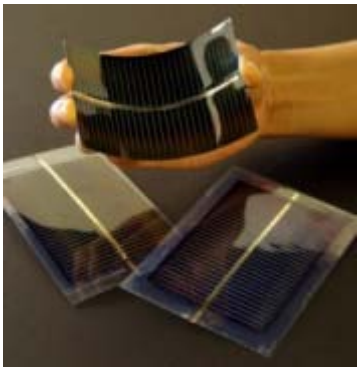
NanoGram announced that it has entered into a technology development agreement (TDA) with Teijin Limited to further develop NanoGram's printed silicon ink. The TDA will focus on extending NanoGram's printed silicon ink technology for use with Teijin's flexible substrates. The ink-substrate package targets light, flexible and printed electronics applications. http://www.nanogram.com

Philips Research develops flexible, moldable OLED lighting panels

Scientists at Philips Research are working on flexible and moldable OLED lighting panels. In collaboration with the Holst Centre, Philips is developing the technology ingredients for flexible OLEDs. Philips is now offering an OLED technology kit to lighting designers, architects and creatives from all disciplines. This kit includes an information pack and DVD explaining the technology behind OLEDs and outlining possible future applications. It also contains several OLEDs of various shapes, structures and colors, enabling people to experiment with and experience the effects of OLEDs for themselves. http://www.research.philips.com

Vitex Systems expands license agreement with Advanced Neotech Systems

Vitex Systems announced that it has expanded its license agreement with Korea-based Advanced Neotech Systems (ANS), granting ANS rights to develop and manufacture roll-to-roll coating equipment used in the production of Barix Barrier Film. Multiple companies have been able to verify that, when protected by Vitex's Barix Barrier Film, their thin film photovoltaic (PV) cells fabricated using either CIGS or CdTe can pass the damp heat test required by the IEC 61646 standard. Vitex entered the first equipment license agreement with ANS in 2006, allowing ANS to make Barix encapsulation equipment. ANS has successfully sold eight systems, including: a pilot system being used by Samsung SDI to make the world's first foldable OLED and the thinnest OLED display; the first mass production system; and the first Gen 2 system. http://www.vitexsys.com



Merck KGaA and Yissum sign R&D collaboration agreement

Merck KGaA of Germany, and Yissum Research Development Company, the technology transfer company of the Hebrew University of Jerusalem, announced a research and development agreement between Merck and Yissum's spin-off, QLight Nanotech Ltd., for the joint development of a semiconductor nano-particle technology for a novel display application invented by Professor Uri Banin from the Institute of Chemistry and the Center for Nanoscience and Nanotechnology at the Hebrew University of Jerusalem. http://www.merck-chemicals.com

Merck presents itself as an innovative partner to the international solar industry

Merck KGaA showcased the many advantages of isishape technology. The brand stands for printable etching pastes that can selectively etch antireflective coatings (e.g. SiNx) and passivation layers (e.g. SiO2) on solar cells as well as on transparent conductive materials (e.g. ITO). The concept offers environmentally friendly and extremely efficient materials for smart and simple structuring in the photovoltaic industry. http://www.merck.de

Cymbet and Konarka demonstrate flexible solar energy harvesting for autonomous sensors

Cymbet and Konarka are combining their unique solar energy capture, energy conversion and energy storage technologies to demonstrate advanced solar energy harvesting techniques. These techniques enable new applications such as zero power intelligent building energy management wireless sensors, agricultural field monitoring/reporting devices and shipment status data loggers. http://www.konarka.com

FlexTech Alliance
for Displays & Flexible, Printed Electronics

Join the FlexTech Alliance Today and Benefit from Services Focused on Your Company's Success!

Industry Research – FlexTech research reports provide valuable insights into economic and technology trends of the electronic displays and flexible electronics industries and its primary markets. Providers include DisplaySearch, Fuji Chimera, Insight Media, Toray Research Council, and Veritas et Visus. *Collectively, the reports are a $27,000 value!*

R&D Program – FlexTech's R&D has two elements for members:

- Gap analysis and technical roadmapping that identifies and resolves key technical challenges
- Pre-competitive R&D funding to provide funds for projects defined by member interests.

Networking & Partnering

- Technical Conferences & Workshops – led by our flagship event, the *Flex Conference*
- Regional Meetings – great networking events at member locations
- Business Conference – connection with potential investor and partners

Member Marketing

- On-line Resources – www.flextech.org is a portal for members' corporate information
- Advocacy – industry voice with the media and federal and state governments
- Demo Creation – FlexTech facilitates the development of product demonstrators

To Schedule a Company Meeting, Call Kay Mascoli at 1-408-993-8111
For More Information and Membership Forms, visit
www.flextech.org