FlexTech Alliance
for Displays & Flexible, Printed Electronics

FlexTech Trends

News from the world of displays and flexible, printed electronics

Volume 7 – Q2 2010

FlexTech Trends
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Note from the President

by Michael Ciesinski

Printed electronics and smart packaging are making their way onto store shelves, improving the customer experience and driving sales in competitive markets. Smart packaging and flexible electronics have many applications in addition to product promotion. For example, smart pharmaceutical packaging is improving the customer experience for an aging population by helping people adhere to their medication regiments. Printed flexible electronics can also improve the quality of healthcare by enabling unobtrusive long-term health monitoring systems via wearable clothing.

While we are at the verge of realizing the benefits of these technologies, challenges remain with bringing these concepts to mass market. The latest developments to support a world-class, manufacturing capability for flexible, printed electronics and smart packaging were presented at the FlexTech Alliance spring quarterly workshop. Held at the University of North Carolina State University campus, this workshop highlighted unique applications of printed electronics for packaging and the associated challenges of moving from R&D to commercialization. Our invited speakers covered topics such as using nonwoven fabrics for smart sensors, harvesting power with PVs for e-paper displays, and developing media-independent electronics for various package types. For more details, check out the workshop summary on page 9.

The FlexTech Alliance produces workshops, seminars and conferences to advance technology development. These events are held in cooperation with other industry and academic organizations in order to foster networking and to share practical experience. Our fall workshop, scheduled for September 16, 2010 focuses on photovoltaic (PV) nanomanufacturing. Meeting the aggressive goals of the Dept. of Energy to advance energy independence is not a trivial task and PV technology shows much promise in harvesting energy from sources other than fossil fuels. But more than any other disruptive technology, PV nanomanufacturing requires close cooperation between industry, academia and government to transition from concept to manufacturing. At this workshop, industry experts will come together to convey information on lab to fab transfer of nanomaterials and their processes. For registration information, please visit http://www.flextech.org.

The FlexTech Alliance also has exciting and informative events planned at SEMICON West 2010 in San Francisco. Join us on July 15, 2010 as we host a session on flexible and hybrid electronics during the Extreme Electronics presentations. Innovations in making electronics on flexible substrates open up new form factors, price points and performance possibilities for wide-area electronics. IDTechEx will discuss the market outlook, Applied Materials and Aixtron will update on developments in process technology, Kovio will talk about its printed semiconductors, PARC its development of flexible sensors, and the Flexible Display Center at ASU its progress in hybrid process technology for displays.

Also at SEMICON West, the FlexTech Alliance will sponsor a short course taking place on July 14 titled "Fundamentals of Touch Technologies and Applications". The objective of this four-hour short course is to enable attendees to become knowledgeable about all of the 13 transparent touch technologies that are used on top of displays, as well as an introduction to the newest "in cell" touch technologies.

FlexTech is dedicated to fostering the growth, profitability and success of the electronic display and flexible, printed electronics supply chain. Our events are designed with that goal in mind and we invite you to join us at one of our events and take advantage of the opportunity to collaborate and network.

Market Update: Fame or Fortune
The Need for Flexible Thinking

by David Barnes

David Barnes brings more than forty years of experience in the capital equipment, semiconductor and TFT LCD markets to bear on client concerns. He introduced market-leading test-repair systems for TFT manufacture (ArrayChecker and ArraySaver lines) in the mid 1990's. Later that decade, he negotiated joint ventures between Philips Electronics and LG Electronics through due diligence, then stayed in Seoul to support the board from conception through the IPO in 2004. After the first dual listing on NYSE and KSE, he provided similar services to more clients as VP of Strategic Analysis for DisplaySearch. Assignments in recent years include IPO, project funding, underwriting, due diligence and debt restructuring. He now provides services through BizWitz, LLC. He attended the University of California at Santa Cruz.

After interviewing more than fifty marketing and engineering professionals involved with flexible electronics for corporate clients in recent months, my confidence in prospects for the industry has increased. A few things continue to worry me, however.

- Conventional technologies will dominate the display market for years to come and the locus of activity will shift to China.
- Materials companies in Europe or North America may realize profitable returns on their technologies but manufacturers in Asia may dominate product markets.

> *As a result, I posit a choice for many firms in this emerging industry: fame or fortune?*

Companies in Asia tend to favor fame over fortune. A few managers or owners at the top may become rich but few Asian manufacturers generate dividends or profits for stakeholders in general. This seems a natural consequence of striving for market share (fame) and a plausible cause of low profit margins.

Companies in Europe and North America tend favor fortune over fame. In some cases they might see fame as a consequence of fortune but the goal is to raise share prices. The success of leading materials companies such as 3M, Corning, DuPont, and Merck seems a natural consequence of managing margins and a plausible cause for more success in materials than in electronics.

> *Companies in Asia tend to favor fame over fortune. Companies in Europe and North America tend to favor fortune over fame.*

Nevertheless, Apple's introduction of the iPhone 4 is a reminder that markets have room for one leader in creative destruction, at least. A generation ago, Sony was the company that wowed consumers and redefined market segments with the Walkman and other innovations. Today, Apple has redefined market segments and relegated some brands to commodity status. The point is that there is room for few such leaders at any point in time. Most companies compete in commodity markets most of the time.

The remainder of this article will describe some of the factors affecting commodity markets. We leave detailed forecasts to others; we assume that history illuminates the present and indicates the future.

Incumbents:

Flexible displays have been a dream for many decades. Almost all displays were built with glass in 1960 and that remains true fifty years later. Indeed, the few consumer products with displays fabricated on plastic are made with glass carriers.

The display area shipped by active-matrix LCD (AMLCD) producers has increased at an annual rate of 28% since 2005. AMLCD makers will ship four times more display area in 2010 than they did in 2005. All of that will be on glass substrates.

If we take two of leading producers as representatives of the AMLCD industry, we can see that cash costs (cost of product less depreciation and amortization, which vary by company policy) fall two percentage points slower than panel prices do. This means that increasing capacity leads to decreasing profit margin. Economists call this diminishing return to scale.

One of the few countermeasures for companies in such predicament is to reduce the cost of capital. That leaves them with one less factor to manage and the potential for managing their supply chain so that their suppliers fund their customers. If producers accomplish that, they can sustain operations at low profits.

From this, we see why AU Optronics keeps pleading for permission (from the Taiwanese government) to form joint ventures with Chinese companies and reduce their capital domestic requirements. LG Display and Samsung have already received such permission. Chinese companies and provinces are eager to invest in high-tech infrastructure and in capacity for AMLCD to serve rising middle class consumers.

Indeed, classical market evolution theories from A.T. Kearney and others predict that AMLCD producers would seek alternative means of investment and alternative market segments about now. DisplaySearch presented data at the USFPD Conference this year that indicates producer concentration has peaked.

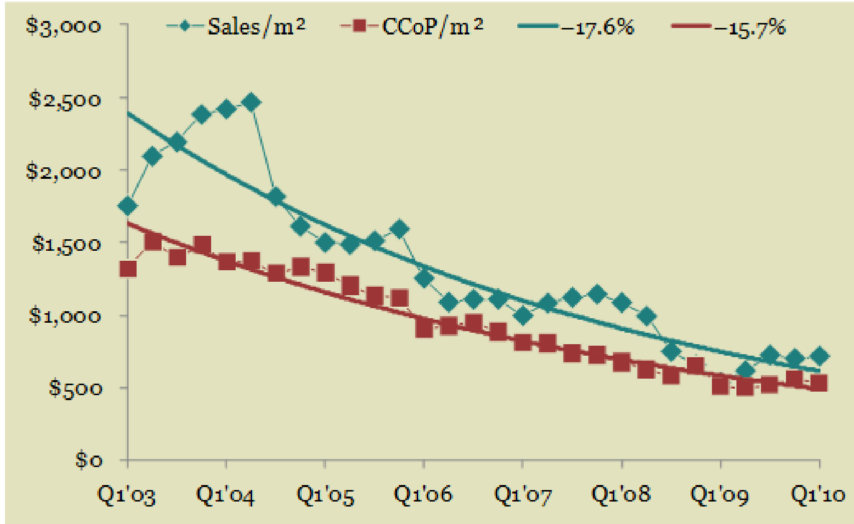


Figure 1: Dollars per square meter of display for AU Optronics and LG Display. Their native currencies have moved against the U.S. dollar at different rates over recent years, so there combined consolidated results represent the AMLCD industry as a whole.
Source: BizWitz analysis of AU Optronics and LG Display disclosures, Apr '10

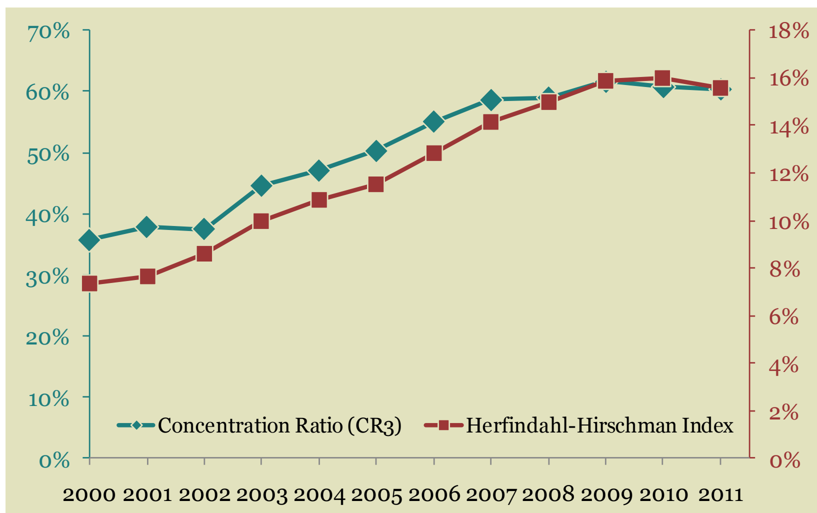


Figure 2: AMLCD Producer Concentration, 2000-2011
Source: Biz Witz analysis of DisplaySearch data, Mar '10

> ***From here on, there will be more rivalry in AMLCD markets, not less, according to Kearney's CR3 and Herfindahl's indices.***

Entrants:

Companies seeking positions in the emerging market for flexible electronics jostle with intrapeneurs inside incumbent suppliers and with entrepreneurs in new ventures. All make bold claims in their efforts to gain investors, suppliers and customers; most entrants do so in good faith but bad visibility. All entrants must manage internal risks and manage through uncontrollable external risks. External developments can be like wild cards in play. They can strengthen a weak hand and win the pot, upsetting players who thought they had the upper hand. Government decisions to change feed-in tariffs for solar power are a good example of uncontrollable factors affecting the fortunes of photovoltaic companies.

Even intrapeneurs in powerful incumbents such as Dr. Kim of Samsung Mobile Display hedge their bets. During his keynote address to SID 2010, he described a future in which AMOLED were fabricated on metal foil or on glass with LTPS or IGZO materials. Few in the display industry would bet against Samsung. We expect this incumbent will produce novel displays by mid decade but we are less certain how they will do so.

The point is that a new technology market cannot achieve economies of scale until there has been a shake-out among early entrants.

Industry Snapshot:

At the opening of a new industry, there is room for many technologies and business models.

-The OELamp (OLED lighting) industry is populated by ventures of mature companies such as GE or Philips plus ventures such as ModisTech or LOMOX.

-More OELighting companies will form in Asia and elsewhere to explore various technologies and business models. Not all will succeed.

-Hanwang Technology, a Chinese company challenges the likes of Amazon for leadership in the e-Reader market. The firm captured more than 60% of the market in China so far this year according to some observers.

-While Asian entrants commoditize the monochrome reader market segment, Bridgestone, E Ink and Liquavista prepare color displays for low-power reader applications. We expect a conflagration of color competition in 2011–2012 that will lead to another shake-out.

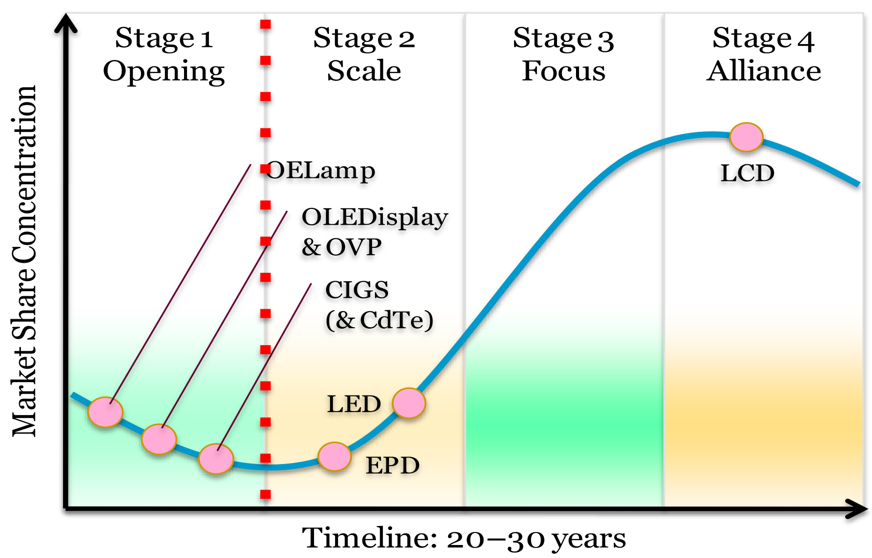


Figure 3: Some Positions on the Merger Endgame Curve
Source: BizWitz (conceptual) analysis, Apr '10

-Inorganic LED producers are well on their way to industrial scale. Indeed, the learning they obtain from serving the LCD backlight market may lead to area illumination products that cost less than any OLED technology at present.

After the Shake-out:

The post shake-out phase of industrial development is not without its problems - price is a chief issue. When clients ask us what price they can get for new products, we answer, "That depends on how much you want to sell." Price is nature's way of balancing supply and demand. The faster supply increases, the faster prices must decrease to balance demand. The balance is seldom perfect but over long periods we can see markets seek a balance.

The LCD TV market provides an example of how new technologies come into supply-demand balance. In Figure 4, we plot the area prices for AMLCD modules and for LCD TV sets. Both time series decline 21% a year. This illustrates two factors at work in many markets: contribution and commoditization. The contribution of AMLCD module prices to LCD TV prices tends to rise as set designs become more standardized and other component suppliers achieve economy of scale. It seems reasonable that the average price per square-foot of TV sets would track the average area price of displays.

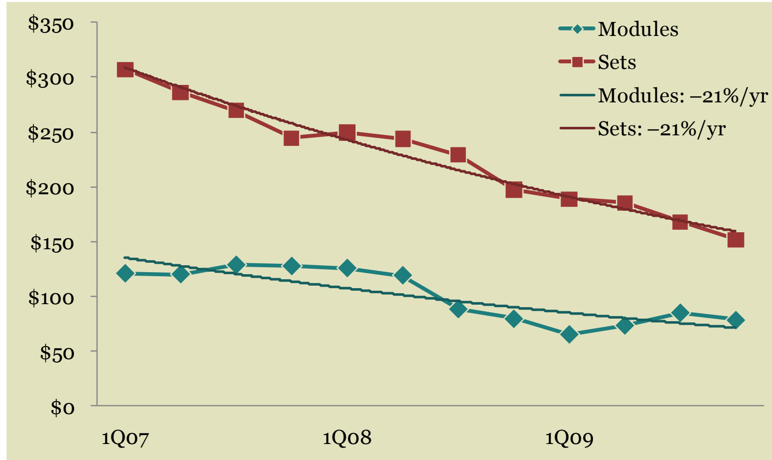


Figure 4: ASP per sq. ft. of AMLCD modules and LCED TV sets
Source: BizWitz analysis of DisplaySearch data, May '10

In addition to commodity price pressures on AMLCD modules, there are commodity price pressures on TV sets. The more picture real estate the industry wants to sell, the more it must discount the price per acre.

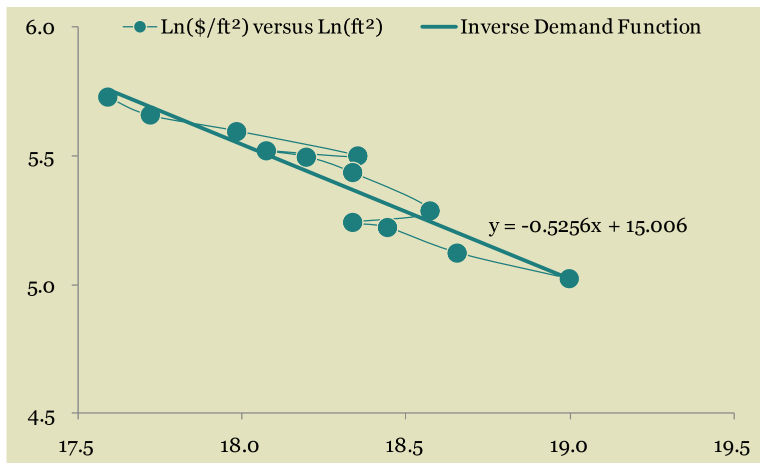


Figure 5: Inverse demand function for LCD TV sets, 2007-2009
Source: BizWitz analysis of DisplaySearch data, May '10

Such market dynamics should not be ignored in the rush to bring new technologies to market. Incumbents in the AMLCD industry have survived many business cycles and a 21% annual rate of area price decline for decades. One way to consider that challenge is to realize that 21% a year means prices get cut in half every three years.

> *The implication for entrants planning to compete with incumbents in such a market is that entrants should plan on product prices one-half of today's level if they enter the market in 2013 and one-quarter of today's price if they enter in 2016.*

In addition, the pace of cost reduction depends on scale economies. If we use the same data but separate it from time, we see strong correlation between price and demand. Economists call this the inverse demand function. The classic approach is to plot the natural logarithm of price against the natural logarithm of demand. In the case of LCD TV sets, this would be the price per square foot versus the amount of square feet sold. Classic economics predicts a straight line relationship between them, as revealed in figure 5. The implication is that competitors in the LCD TV market can predict future prices by estimating future supply. The more they want to sell, the more they must reduce prices and the faster they increase supply the faster they must decrease price.

Asian producers tend to accept such conditions more readily than others might because they look more toward fame than fortune. That is one reason why we see repeated pile-in behavior. Examples from displays include the spoiling of the digital picture frame and portable navigation product categories. Producers rush to supply each new product then discover that there is no such thing as a mass market for niche products.

Even more disciplined producers can discover declining profit opportunities when new products create more value for others in the market. The rise of e-Reader and Tablet product categories illustrate such risks. Much of their value to consumers stems from gesture interfaces, wireless services, on-line storefronts and other services not provided by the display hardware itself. As more and more products become thin clients of services in the clouds, less and less value will be created by hardware.

The seeming contradiction is that building advanced hardware will depend on advanced materials that embody a great deal of intellectual property. Here is where companies in Europe and North America shine. The problem of course is selecting the right amount of capacity/capability to bring on-line without spoiling prices. It is like the chicken and egg problem. Once you have one, you can get the other, but how do you start? Enough for now… the point is that regional industry structures depend on the choices participants make between fame and fortune.

Mission of the FlexTech Alliance

The FlexTech Alliance is the only organization headquartered in North America exclusively devoted to fostering the growth, profitability and success of the electronic display and flexible, printed electronics supply chain. Leveraging its rich history in promoting the display industry as the U.S. Display Consortium, the FlexTech Alliance offers expanded collaboration between and among industry, academia, and research organizations for advancing displays and flexible, printed electronics from R&D to commercialization.

1. To advance the growth, profitability and success throughout the flexible, printed electronics and displays manufacturing and distribution chain
2. To facilitate collaboration between and among industry, academia, and research organizations to share practical experience and develop solutions for advancing flexible, printed electronics and displays from R&D to commercialization
3. To foster development of the supply chain required to support a world-class, manufacturing capability for flexible, printed electronics and displays

FlexTech Alliance
for Displays & Flexible, Printed Electronics

Summary of FlexTech's Quarterly Workshop
on Flexible, Printed Electronics
Raleigh, North Carolina
June 2-3, 2010

At the FlexTech Alliance 2010 Flex Conference, a presentation by Dave Knox from the Center of Packaging Innovation at MeadWestvaco, entitled *Printed Electronics and Packaging Opportunities,* was very well received. The interest generated by this presentation was the motivation to hold a workshop on "Smart Packaging Enhancing the Customer Experience". The workshop was jointly hosted by MeadWestvaco and The Nonwovens Institute at North Carolina State University.

The objective of this workshop was to identify technical challenges, increasing the functionality of "smart packaging" without substantially increasing cost by utilizing flexible printed electronics. The morning session focused on presentations to identify the major factors impacting smart packaging performance, power requirements, and manufacturing costs by:

- "Overview of the Centennial Campus at NCSU", Behnam Pourdeyhimi, Director of the NCRC
- "Smart Packaging Market Overview", Harry Zervos, Technology Analyst, IDTechEx
- "Case Study Review", Professor Behnam Pourdeyhimi
- "The Nonwovens Institute at NCSU", Professor Behnam Pourdeyhimi,
- "Printed Electronics and Smart Packaging Opportunities", Dave Knox, MeadWestvaco
- "Smart Adherence Packaging for the Health Care Industry", John Musaus, MWV Healthcare
- "Flexible Electronics & Path to Smart Packaging", Jim Stasiak, Hewlett Packard
- "New Solar Inks and Applications: Organic Photovoltaics – The perfect power solution for e-paper Displays", Mark Storch, Program Coordinator, Inks at Plextronics

A common issue of the work shop presentations and discussion was targeting the right level of functionality in a smart package without prohibitively increasing cost. To the extent that flexible electronics adds expense, how does that get assimilated in the supply chain?

A clear application for cost-effective, smart packaging is in health care, in which the cost of smart packaging can be reasonably incorporated into the price of the product. Value is clearly added and understood by the consumer with respect to adherence to treatment, which ultimately lowers overall health care industry costs through reliable preventative treatment. Several innovative, smart packaging product concepts, wired to the internet for patient monitoring, were discussed.

An interesting discussion and demonstration involving nonwoven substrates to accommodate flexible electronics to enable smart fabrics and smart packaging was provided by Professor Behnam Pourdeyhimi.

Panel Discussion: "Do we need to add more functionality to packaging?" The afternoon session involved a panel discussion addressing the challenges facing smart packaging innovation to increase performance without severely impacting cost.

Three key issues were addressed between panel members and the attendees:

1. When is performance "good enough" from a packaging perspective?
2. Graphics (displays) alone may not be sufficient to meet customer/ consumer needs. What increase in functionality is required and at what cost?
3. How can flexible, printed electronics address these issues and further the customer experience? What about disposability and environmental hazards?

Mike Londo from MeadWestvaco joined the morning presenters on the panel and brought an informative perspective on customer/consumer needs and tradeoffs. Customers include manufacturers of products as well as retailers who sell those products; product branding and shelf space differentiation to draw the customer to the product.

Other than health care and novelty packaging applications (which have limited volume potential to yield reasonable break even time and acceptable ROI business models), the smart packaging industry is just emerging and in search of the right technology, such as flexible printed electronics, to increase performance and functionality beyond graphics with the required form factors and cost/pricing structure. Another trend for smart packaging is providing more "active" functionality; examples include compensating for high temperature exposure by active cooling or indicating food spoilage by detecting bacteria leading to packaging color change.

Flexible Electronics & Path to Smart Packaging

adapted from a presentation made by Jim Stasiak from HP

This article is adapted from a presentation made by Jim Stasiak at the recent FlexTech Alliance Quarterly Workshop on Flexible, Printed Electronics in Raleigh, North Carolina. Stasiak works in the Emerging Technologies Group in HP's Technology Development Operations Engineering group in Corvallis, Oregon.

Significant innovations, advances and improvements have occurred in last decade with regard to new materials and substrates, organic and inorganic devices and circuits, roll-to-roll processing, digital fabrication methods including inkjet deposition, and commercialization of the technology.

However, significant challenges remain, particularly in areas related to the building of electronics and MEMS on non-rigid media (dealing with distortion and mis-registration of stacked features), low temperature fabrication processes and lithography, and device stability, performance, and reproducibility. And, of course, no "killer app" for flexible circuits has emerged yet to create substantial demand.

A very simple taxonomy of active and smart packaging/label printing technologies

- *Active packaging for foods and beverages*: freshness/expiration labels, oxygen scavengers, moisture absorbers, temperature control packaging, and flavor/odor absorbers.
- *Active packaging for security and brand protection:* RFID (inventory control and tracking), authentication, security marking and coding, anti-counterfeiting features, branding and attention-grabbing features, and anti-tamper features.
- *Smart packaging for pharma and health:* Patient compliance and interaction with providers, wireless communication, date and time stamping, alarms and alerts, thin flexible displays, and anti-tamper features.

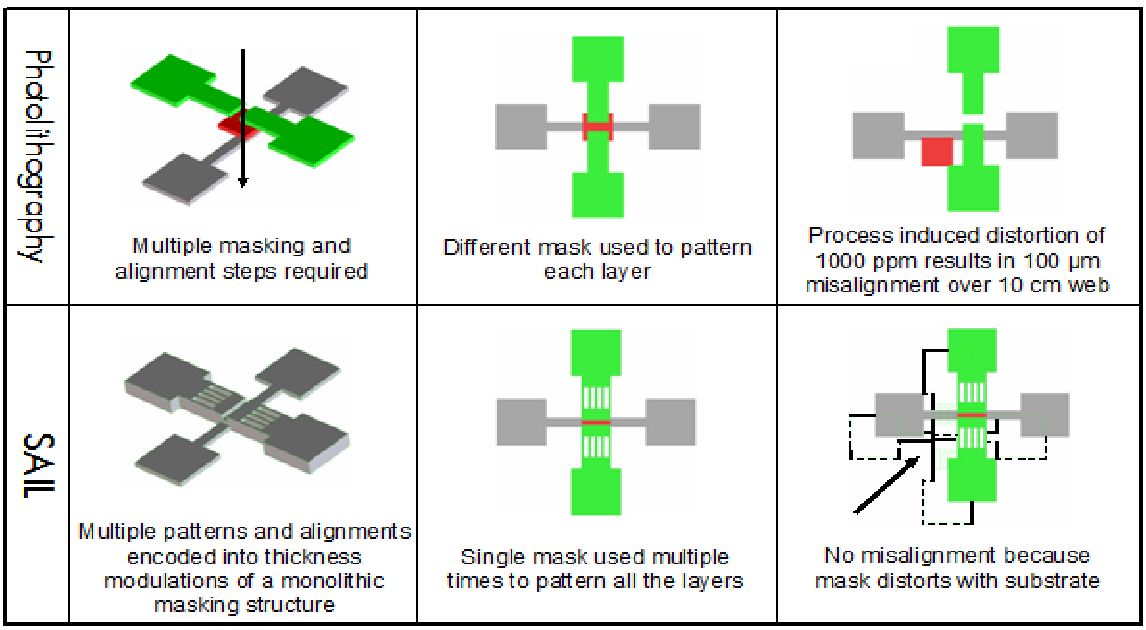
A next generation "Smart Package" might be viewed as a digitally fabricated flexible package "backplane"… To achieve this vision requires that manufacturers minimize pick-and-place of physical and discrete components. The technology must enable the integration of high performance analog and digital circuitry and MEMS on packaging media (e.g. blister pack foil) providing: date and time stamping, memory, alarm/alert, moisture/temperature monitor, compliance sensor/transducer, on-package diagnostics (bio sensors), "Lab-on-a-chip" functions, wireless communication, real-time feedback and diagnostics, flexible display, GPS, and cloud-based information management. Such "smart packages" combine the package and backplane into a "wireless node" that links, for example, the health care team with patients and clients.

Requirements and challenges for next generation smart package technologies:

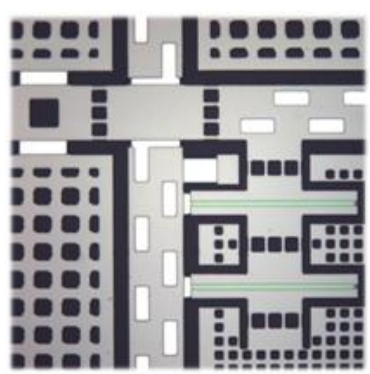
- Merging digital printing and digital fabrication
  - Minimize pick-and-place, bonding and attaching processes.
  - Use "variable data" to customize, personalize and uniquely identify items.
- Developing media-independent electronics and MEMS fabrication materials and processes
  - Plastics, cardboard, foils, paper, metal
  - Pre-coating of surfaces
  - Overcoming substrate distortion and imperfections – a new lithography approach is required
  - Low temperature device fabrication, patterning and post processing
  - Integration of MEMS and sensors onto unconventional surfaces (MEMS-on-plastic and Plastic MEMS)
- Develop active and passive, analog and digital electronics capable of robust, stable, predictable, reproducible, high performance operation and new functions:
  - Low temperature (<175C) device processes
  - High mobility and narrow channels to achieve reasonable fmax and current densities
  - Wireless technologies

- Develop roll-to-roll fabrication processes to achieve scale, lower costs and integrate into digital and analog printing work-streams (plug-and-play?)
  - Embossing and imprinting
  - Plating of metals
  - Solution processing of electronic materials
- Develop functional inks to enable the "printing of things"
  - Functionalization for chemical and bio-sensors
  - Nanomaterials (CNTS, nanowires, nanoparticles, Qdots)
- Develop new "printable" sensing, actuation and transduction functions for packaging and labels
  - Ceramics and piezoelectrics
  - Microfluidic and fluidic functions

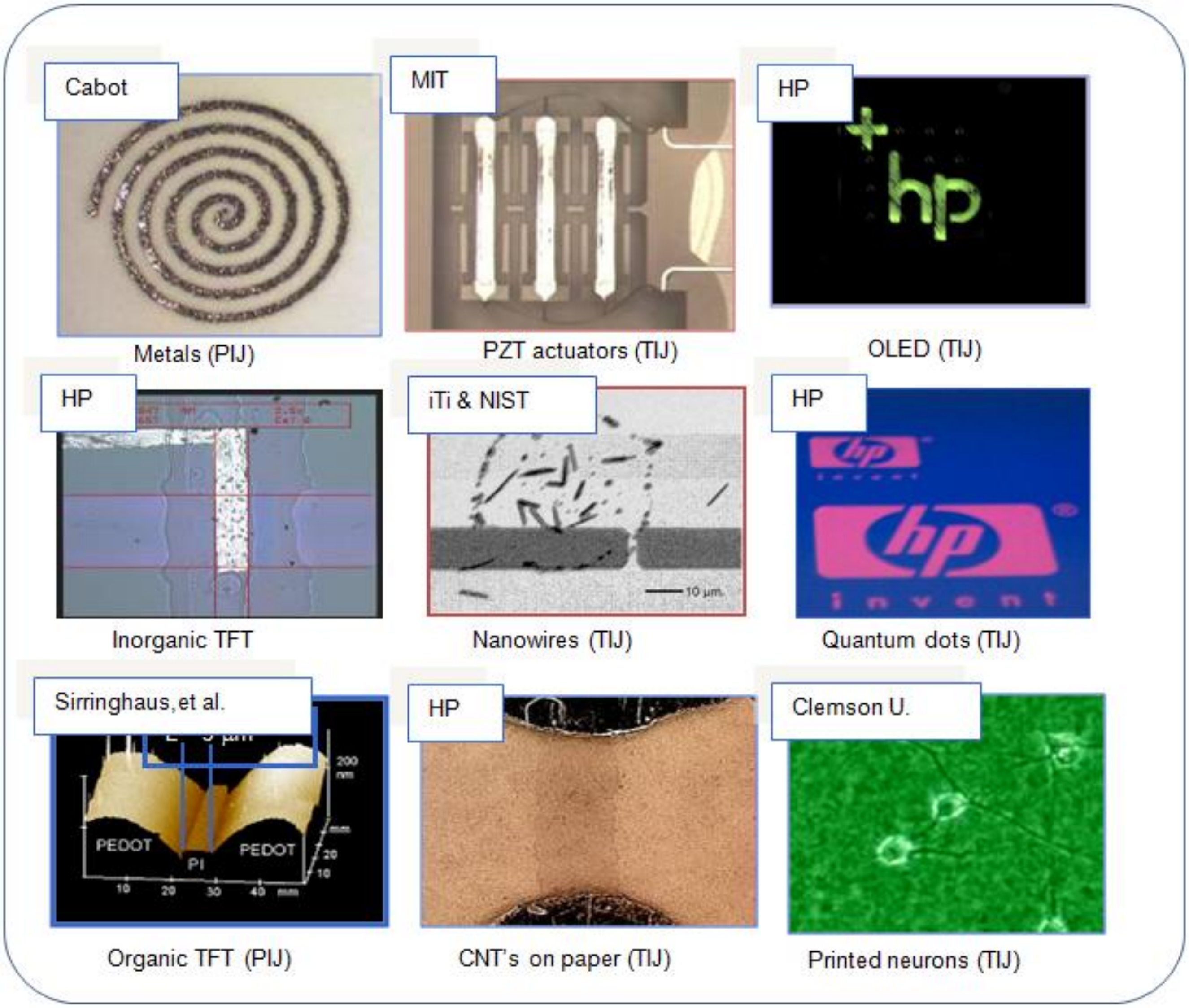
One of the biggest challenges remaining relates to alignment and registration tolerant lithography. Media independence will be a key requirement for integrating electronics, MEMS, and microfluidics with Smart Packaging applications, including plastics, paper, cardboard, foils, and other substrates. Significant challenges arise due to substrate distortion (esp. multi-masking demands for TFTs, etc.), temperature limitations, surface quality of media, and thermal mismatches. By "trading" lithography and masking operations for etching challenges, HP Labs' R2R compatible SAIL lithography process solves layer-to-layer alignment and distortion problems for flexible substrates.



HP developed the world's first R2R active matrix display. On the left below is an image of an E Ink frontplane and backplane each made with HP's R2R process; on the right is pixel detail of HP's SAIL backplane on flexible substrate.



The development of new “functional inks” and drop-on-demand (both thermal and piezo inkjet) printing processes – are enabling the “printing of things”.



Current state of flexible electronics and future

- Smart Packaging and labeling technologies are redefining the packaging business – especially in pharma and beauty product markets.
- Advances in flexible electronics, MEMS, and R2R manufacturing will enable “smarter packaging” and establish new user paradigms especially in healthcare, security, inventory management and track-and-trace.
- Integrating conventional printing with new foundational capabilities in materials, processes, devices and scaling will provide a path to smart, active and intelligent packaging and labeling.
- Challenges: media independence, low temperature processing and materials, new devices, circuits and MEMS, alignment tolerant patterning, work-stream integration.
- HP’s current focus on developing solutions and innovations addressing a broad range of flexible electronics and MEMS.

HP’s Vision: “Transform every surface into an information surface”.

Case Study

Utility of Nonwovens in the Production of Integrated Electrical Circuits via Printing Conductive Inks

by B. Karaguzel, C. R. Merritt, T. Kang, J.M. Wilson, H. T. Nagle, E. Grant and B. Pourdeyhimi
North Carolina State University, Raleigh

INTRODUCTION

Wearable electronics or so-called “smart clothes” introduce microelectronic circuits and systems into innovative textiles or garments, which are not only flexible but also conformable to the human body. Applications of wearable electronics vary from musical jackets to vital signal monitoring devices. A wearable garment can collect, process, store and transmit information to any remote location. A garment intended for vital sign monitoring should be able to collect, process, store and transmit vital signals (heart rate, respiration rate, electrocardiogram, body temperature) information about the wearer continuously and remotely.

Textiles are flexible, soft, lightweight, breathable, durable and washable and with these characteristics they are incompatible with conventional electronics. Open issues remain with the manufacture of wearable computing. How do we transmit signals and create a conductive pathway? How do we provide power? How do we deal with the interconnect? How do we handle flex, abrasion, bending, shear, and exposure to water?

Screen printing can be a viable alternative for creating structures with electrical properties and nonwovens can offer advantages over traditional fabrics. Nonwovens offer excellent printability, washability and are lightweight. Nonwovens can be produced at much lower cost and at higher speed than weaving. Nonwoven fabrics are formed by mechanically, thermally or chemically bonding a web of loose fibers. Unlike woven fabrics, nonwovens provide the opportunity to control surface texture by selecting the fibers and the process. Heavy weight fabrics can be produced using very fine fibers.

Research was recently conducted which employed polymer thick film (PTF) processing technologies to directly deposit conductors onto compliant, flexible substrates. This technique utilizes screen-printing to deliver the PTF conductive inks onto nonwoven substrates.

EXPERIMENTAL PROCEDURES

Materials

Three nonwoven substrates were selected for screen printing.

Nonwoven 1: Freudenberg’s Evolon®, Freudenberg’s Evolon is a spun-bonded and hydroentangled substrate made of PET/Nylon splittable fibers of roughly 1.5 micron in diameter.

Nonwoven 2: DuPont’s Tyvek®, DuPont’s Tyvek is made of high density polyethylene fibers produced through flash spinning process. Tyvek is a highly calendered (and therefore dense) substrate providing a smooth medium for the conductive ink to bond. The Tyvek used was plasma treated, making it suitable for printing through the ink being able to adhere to the substrate.

Nonwoven 3: BBA FiberWeb’s Resolution Print Media® (RPM).
BBA FiberWeb’s RPM is a spunbonded substrate made of trilobal polyester fibers which provides increased surface area for better print definition. The fiber size of RPM, which is around 25 to 30 microns, is much larger than that of Evolon.

RESULTS AND DISCUSSION

Printability:

A series of scanning electron microscope (SEM) micrographs were obtained to determine the height of the printed lines and thickness of the substrates. The results showed that the printed conductive inks remained on the surface of Nonwoven 2 (Figure 1b), while they penetrated Nonwoven 1 (Figure 1a); both in plane and through the plane. The low ink height on Nonwoven 3 can be seen (Figure 1c).

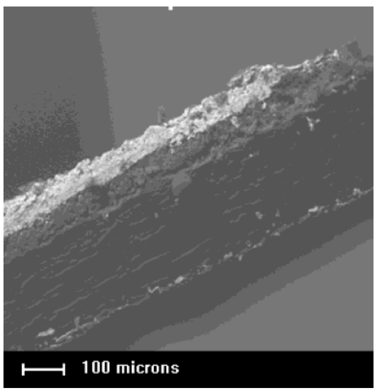


Figure 1a

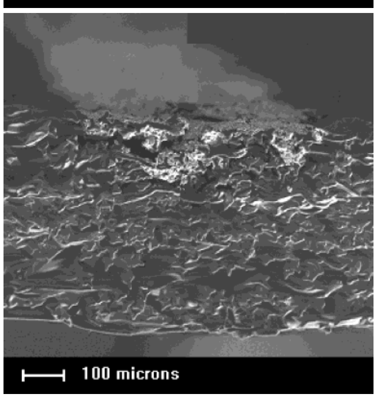


Figure 1b

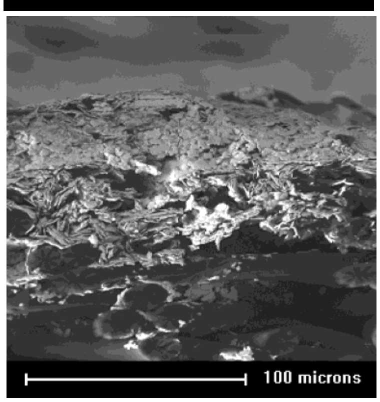


Figure 1c

Figure 1: SEM cross-sectional images of printed substrates (a) Evolon (b) Tyvek (c) Resolution Print Media

EXPERIMENTAL PROCEDURES

Inks

Two different silver conductive inks were chosen. The inks had different viscosities and carry different percentages of silver particles as the conductor.

Screen Printing

Screen printing parameters such as screen mesh count, squeegee durometer, snap-off distance, and print speed were altered in order to achieve an even coverage of ink over the entire image. The printed samples were cured in a convection oven where the curing temperatures were chosen to minimize any adverse effects on the nonwovens substrates.

Textile Transmission Line Design: Coplanar Waveguides (CPW)

Screen printed coplanar wave-guide lines chosen for electrical characterization consisted of a center conductor that acted as the signal while being surrounded by two ground planes.

Ink Viscosity and Drop Testing

The viscosity measurements of two different silver conductive inks were performed. Dynamic contact angle measurements of conductive inks on different substrates were measured by using a high speed camera.

Substrate Characteristics: The characteristics of different substrates are given in Table I.

Fabric type	Evolon®			Tyvek®	Resolution Print Media®		
Process	Spunbonded/ Hydroentangled			Flashspun/ Calendered	Spunbonded/ Calendered		
Fiber type	PET/Nylon			PE	PET		
Fiber size (µm)	1.5			4	25-30		
Thickness (mm)	0.4			0.3	0.4		
Basis Weight (g/m^2)	100			150	260		
Pore Size (µm)	Mean (Std)	Min.	Max.	No pores detected	Mean (Std)	Min.	Max.
	18 (16)	9	91		18 (11.7)	5.8	47
Porosity (%)	83%			50%	63%		
Bending stiffness (µN.m)	1300			4764	Too stiff for testing		

Table I: Characteristics of Different Substrates

Naturally, the structure of the nonwoven dictates how the ink disperses onto and into the substrate. The ink must penetrate into the structure in order to prevent the ink from washing off during laundering. This was achieved by controlling the geometry of the fabric or the squeegee pressure.

Data summarizing various properties related to ink height and fabric thickness are given in Table II. The relatively low ink height for RPM is the result of the penetration of the ink in x-y plane of the structure. Ink spreads more in Evolon than Tyvek because of the structural differences that exist between the two. Tyvek has very small and very few capillaries available on the surface and consequently, the printing is a surface phenomenon.

Fabric Type	Evolon			Resolution Print Media	Tyvek
	80 gsm	100 gsm	130 gsm		
FabricThickness (µm) (Std Dev)	**320.22** (17.43)	**391.22** (16.84)	**416.91** (25.53)	**398.72** (13.15)	**241.9** (9.07)
Ink Height (µm) (Std Dev)	**36.27** (12.05)	**40.48** (8.13)	**41.17** (12.01)	**21.02** (13.02)	**43.51** (4.94)

Table II. Mean Fabric Thickness and Ink Height extracted from SEM Cross-sectional images

Ink Viscosity:
Viscosity measurements were performed using a Brookfield Cone/Plate Viscometer. The results are summarized in Figure 2. It may be noted that Creative Materials ink shows higher viscosity value. Both inks however, show non-Newtonian and shear thinning behavior.

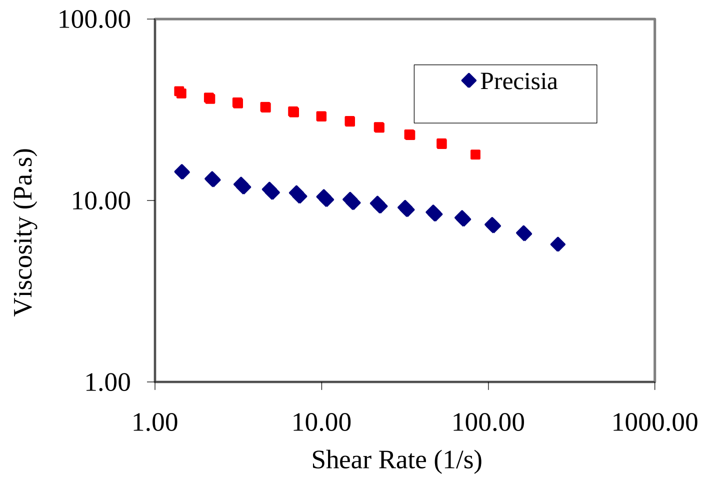


Figure 2: Effect of shear rate on ink viscosity

Ink Droplet Testing:
A high speed camera was used to determine the interaction of single droplets with the substrates. The results are shown in Figure 3. The higher viscosity ink, Creative Materials ink, tends to remain on the substrate while the lower viscosity ink, Precisia, penetrates through the nonwoven. Tyvek behaves almost like a film where the ink droplets don't penetrate into the structure due to very few and small capillaries on the surface. However, both in plane and through the plane penetration of ink droplets is observed on Evolon due to its three dimensional structure with very fine fibers. RPM absorbs the ink droplets the most due to larger capillaries on its surface.

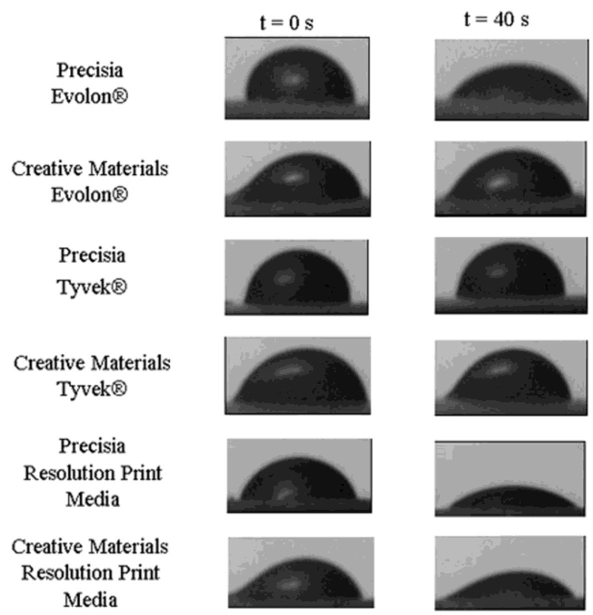


Figure 3 Droplets on Evolon, Tyvek, and Resolution Print Media

Dynamic contact angle measurement results are shown in Figure 4. These indicate that the largest contact angle was observed for Tyvek and lowest for RPM.

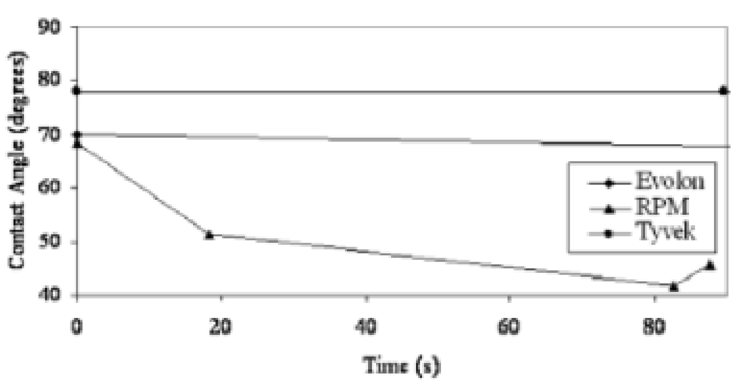


Figure 4: Dynamic contact angle with Creative Materials Ink

Printing Results:

Figure 5 shows the screen printed 10cm long transmission lines with varying signal line widths for CPW line characterization on Tyvek and Evolon. Visually, the printed lines appear to be continuous and complete coverage is obtained for the ink.

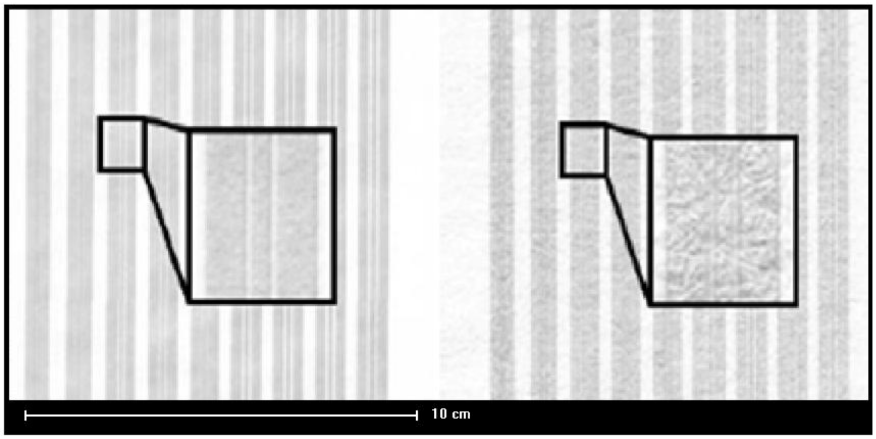


Figure 5: Screen Printed Coplanar Waveguide lines on (left) Tyvek (right) Evolon

DC Characteristics:

The results for DC measurements show that the Creative Materials ink performed better than the Precisia ink due to its higher viscosity and larger percentage of silver particles. The Creative Materials ink tends stay on the surface, due to its higher viscosity, which results in a more continuous coverage of ink while the Precisia ink is broken up slightly by absorbing into the fabric.

It is evident that the Creative Materials ink printed on Tyvek produces the best results in terms of DC resistance (Figure 6). The higher DC resistance results of RPM than Evolon is the result of the penetration of the ink in x-y plane of the structure, which results in less conductive medium for the flow of electrons.

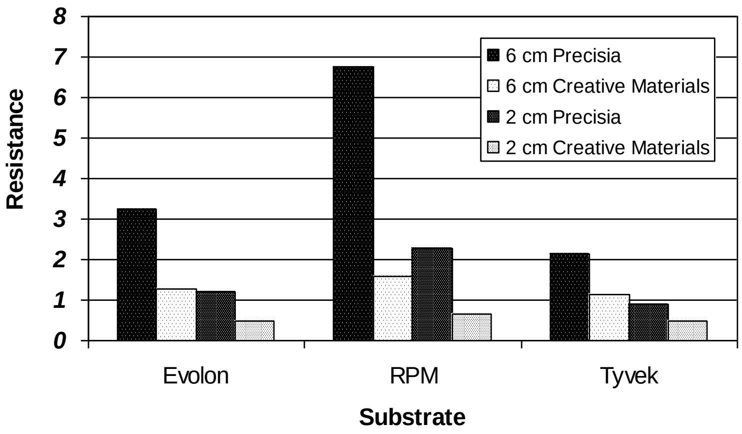


Figure 6: Average DC resistance for 2 cm and 6 cm lines

Characteristic Impedance:

Characteristic impedance measurements of four different line geometries printed on Evolon and Tyvek with Precisia and Creative Materials inks were taken. The measurements indicate that the line impedance decreased from approximately 130 Ω to 95 Ω as the signal line width was increased from 600 µm to 1200 µm. These TDR measurements demonstrate that these geometrical techniques can be used to produce controlled impedance CPW lines.

Conclusion:

Nonwovens provide the opportunity to manipulate pore size, pore geometry and surface texture by selecting the fibers and the process. The penetration of the ink through the nonwoven can be controlled by manipulating fabric porosity, fiber size, fiber orientation distribution and arrangement of fibers in xyz plane.

The best structure is the one that has small fibers and randomly distributed pores that allow ink to penetrate somewhat into the fabric. The contact angle of the ink, relative to the surface of the nonwoven structure, dictates how the ink disperses onto and into the various substrates. The competition between inplane versus through-the-plane ink distribution was ultimately responsible for the quality of the printed media.

The results indicate that nonwovens show promise towards becoming an electronic textile solution for embedding electrical circuits. Large surface area electronics built on the backbone of flexible substrates such as nonwovens are possible. Printing is the shortest path to success.

A FlexTech Alliance Special Report

Flexible Solid State Lighting:

Technology, Manufacturing and Market Assessment

Summary:

This report is a complete overview of the technologies and market opportunities for print-based, flexible, solid state lighting (SSL). With new SSL technologies, novel form factors can extend and expand lighting applications. It is in this space that print-based, flexible, SSL technologies are poised to enter and change the market place.

Experts agree that new lighting technologies are needed to promote energy efficiency and help reduce the emission of green house gases. Introduction of light emitting diode (LED) and organic LED (OLED) light sources can contribute to accomplishing these goals because of their high conversion efficiency of electricity to visible light.

The 329 page report contains charts, graphs, cost of ownership analyses and many other means to visually depict the flexible SSL market's characteristics and dynamics. Interestsed in the market for OLED lamps? Device architectures? Materials? Manufacturing, and conversion processes? Then this is the report for you.

Member Price: $1995
Non-Member Price: $2,495

Visit www.flextech.org to download the executive summary and table of contents.

Report Features:

- The market opportunities for print-based lighting systems.
- How OLED devices manufactured for display applications need to be adapted for lighting applications.
- Identification and assessments of specific materials that meet the requirements for fabricating white OLEDs with high efficiency and long lifetimes.
- The manufacturing issues associated with producing cost effective light-emitting printed devices.
- Conversion operations required to turn a printed light-emitting structure into a product that can be sold to a consumer.

Produced and Distributed by:

FlexTech Alliance™
for Displays & Flexible, Printed Electronics

Partner Update from the CAMM

Summary of CAMM activities

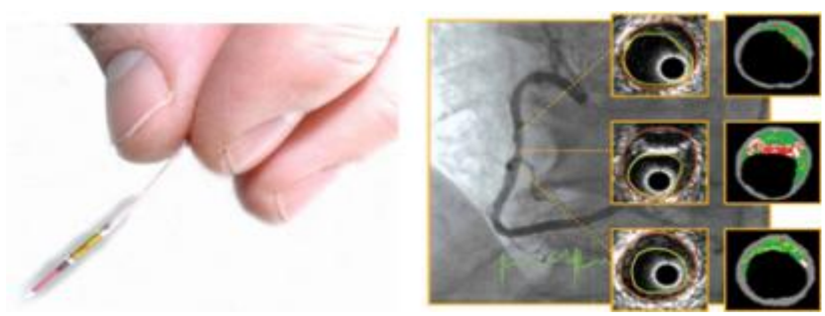
by Mark Poliks

Mark Poliks is the Electronic Components and Technology Conference (ECTC) Materials/Processing Section Co-Chair, a Research Associate Professor at Binghamton University, Northeast Regional Program Chair for the American Chemical Society, Advisory Board Member of the Integrated Electronics Engineering Center (IEEC) and Technical Director of the Center for Advanced Microelectronics Manufacturing (CAMM). The CAMM was sponsored by the FlexTech Alliance and the ARL.

The Center for Microelectronics Manufacturing (CAMM) is a microelectronics manufacturing R&D center focused on the development of manufacturing technologies in a flexible, cost-reduced, roll-to-roll format. The CAMM is an integral part of Binghamton University's New York State Center of Excellence in Small Scale Systems Integration and Packaging (S^3IP).

The CAMM collaborates with government, academia and industry to develop new flexible elecronic technologies. One exampl e of a successful partnership with industry is provided by a project underway with Endicott Interconnect Technologies, a provider of advanced electronic packaging solutions including printed circuit board fabrication, semiconductor packaging and assembly services. EI is partnered with a public company client that develops, manufactures and commercializes medical imaging devices for the diagnosis and treatment of heart diseases. The client is one of the world's leading manufacturers of intravascular ultrasound (IVUS) catheters and functional measurement guide wires, which are small enough to slip inside the coronary artery and give doctors information about the condition of the artery and peripheral vessels, including plaque and lesions, and measure intracoronary blood flow.

Endicott Interconnect developed a technological improvement for the catheter that includes producing the flexible substrates as well as providing the flip chip assembly on the flexible substrate (Figure 1). This is one of the world's finest pitch soldered flip chip interconnect on a thin flexible film. The facilities at the CAMM were instrumental in providing low volume manufacturing prototypes for the development of this product.



The IVUS catheter slips inside the coronary artery, giving doctors a view of a patient's artery from the inside.

The CAMM serves as a centralized resource for new research and development in the area of flexible electronics. As part of this mission, the CAMM is pleased to announce its upcoming annual symposium:

The Annual Flexible Electronics Symposium, hosted by the CAMM, in conjunction with Cornell University, Sandia National Laboratory and the IEEE Components, Packaging and Manufacturing Technology Society (CPMT), will bring together leading researchers from academia, national labs, and industry in the fields of flexible electronics, functional printing, and emerging electronic materials to review and share new research findings in critical technology areas and identify issues for the rapidly growing flexible electronics field. It will provide an opportunity for discussion on key research and development areas and for sharing of ideas and information. The symposium will take place on the Binghamton University campus, in Binghamton, New York. As part of the program, attendees will be able to take a tour of the CAMM, a national research lab focusing on roll-to-roll flexible electronics. The symposium will take place on the Binghamton University campus, in Binghamton, New York. August 17-18, 2010.

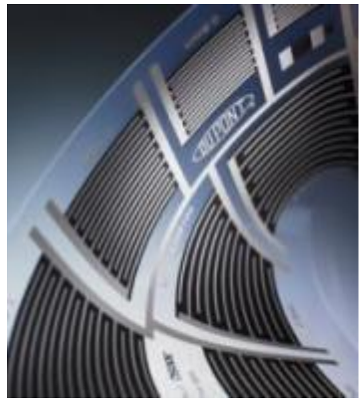
News and news links from the FlexTech Alliance

excerpted from Veritas et Visus newsletters

Advantech to start selling and licensing their OLED TV production technology in 2011

Advantech announced that they have completed a $14 million financing round (from the Pan family and Shanghai Ventures). The investment will be used to build an inline TFT production line using Advantech's patented shadow mask deposition process. Advantech says that their technology can be used to produce an OLED TV for a similar or lower cost than an LCD TV. Advantech plans to start selling and licensing its active-matrix TFT backplanes and production lines to TV and e-paper manufacturers worldwide as early as 2011. The lines are used to produce OLED or e-paper backplanes, at "exceptionally low cost". The production line is also less wasteful (and so more environmentally friendly). They say that it will reduce factory investment requirements of manufacturers by up to 90%. http://www.advantech.com

DuPont introduces new silver conductive inks



DuPont Microcircuit Materials (MCM) is expanding its portfolio of silver conductive inks formulated for use in printed electronics, to meet the need for low-cost processing in the high-growth and emerging markets for touch screens and devices such as Organic Light Emitting Diodes (OLEDs). The new screen printable inks include: DuPont 7723, a low temperature firing silver ink suitable for printing on glass, and DuPont 9169, a low temperature curing Ag ink designed for flexible substrates. New DuPont 7723 delivers excellent adhesion to Indium Tin Oxide (ITO) coated glass; it is lead-free and solderable, ideal for use in touch screen devices. DuPont 9169 has extremely high conductivity; strong adhesion to ITO coated flexible substrates, low contact resistance to ITO, and fine line capability. Both products are recommended where high performance on coated substrates is critical. http://mcm.dupont.com

Uni-Pixel announces "UniBoss" embossing technology

Uni-Pixel unveiled UniBoss, an embossing technology that enables high-speed, low-cost production of printed electronic devices. In addition, the technology eliminates the need for photolithography or screen printing typically required to produce fine line conductors for rigid and flexible electronic devices. Potential applications for UniBoss include the production of transparent electrically conductive grids or patterns that can be used for capacitive and resistive touch and multi-touch displays. In addition, the process can be used to fabricate flexible and rigid printed circuit boards, RFID antennas, and as transparent electromagnetic Interference (EMI) and radio frequency interface shielding films. Uni-Pixel is currently scaling up the process and plans to have pilot production quantities of UniBoss available by Q3'10. http://www.unipixel.com

HP develops process that could make a plastic wristwatch

Hewlett-Packard is developing a next-generation wristwatch for the US military. The company says the watch will have a flexible display that shows maps and other strategic information to soldiers in remote combat fields. The watch's screen will be made of plastic and it will run on solar energy, making it less likely to malfunction or run out of power in a tense scenario. The US military plans to use the prototype with a small group of soldiers first before deciding whether to expand its use of the technology. The watch may eliminate the need for soldiers to carry cumbersome technological gear and backup batteries. Flexible solar panels also will be printed onto the watches, using a technology developed by a company called PowerFilm. That company also has developed solar-powered tents for the military. HP said its plastic-display technology could also be used in laptops, e-readers and commercial signs. http://www.hp.com

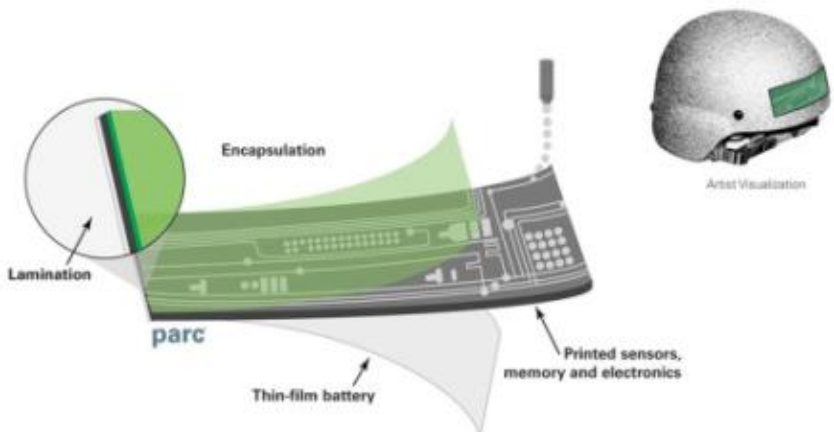
HP has developed a process for creating flexible plastic displays that could be used in a number of gadgets

Cambrios awarded contract to produce flexible solar cells

Cambrios Technologies announced that it has been awarded a DOD contract to produce lightweight, flexible, cost-effective solar energy photovoltaics (PV). Known for its development of ClearOhm, a transparent, conductive, liquid material used in the manufacture of various electronics, this contract represents Cambrios' first public announcement regarding the feasibility of using this material as the electrode of a photovoltaic cell. Cambrios has selected thin film solar module developer Ascent Solar Technologies as its research partner for the duration of the contract. Under a contract with the Department of Defense, U.S. Army Natick Soldier Research, Development and Engineering Center (NSRDEC) and in collaboration with Ascent Solar, Cambrios will deliver flexible solar cells that incorporate a Cambrios ClearOhm electrode layer. Because of the material's improved transparency and light handling capability, it is expected that these cells will be 1 to 3 percent more efficient than the equivalent cells made with the conventional transparent electrode material. The period of performance for this contract will be through March 21, 2011. http://www.cambrios.com

PARC develops battlefield blast meter for DARPA

Since explosive blasts could inflict cumulative head injuries over time to soldiers and emergency responders in the battlefield, the US government's Defense Advanced Research Projects Agency (DARPA) needed to develop an early detection solution that could prevent traumatic brain injury. The dosimeters needed to monitor and record the intensity and frequency of battlefield blasts without requiring maintenance (e.g., additional personnel) in the field – while remaining low cost. No commercial alternative existed that met DARPA's needs. The solution needed to be robust enough to be read after a period of time in the field, yet low-cost enough to be discarded after the data was read. It needed to integrate a variety of sensors in different locations to collect and record the various data associated with the blasts. Furthermore, the sensors would need to conform to the irregular shape of battlefield workers' helmets. PARC scientists designed and developed the technology for a printed blast dosimeter electronic "tape" that could sense, record, and read back various data associated with exposure to explosive blasts in the battlefield. Comprised of flexible, lightweight patches – which could be mounted on battlefield workers' helmets for a week at a time and remain robust enough to be read later – the tape contains memory, control electronics, and multiple sensors that record pressure waves, acceleration, acoustic levels, and light intensities. Most importantly, the PARC technology yielded results that were comparable to more expensive commercially available sensors, yet the sensor tapes were designed to be fabricated less than one dollar – making them low-cost enough to meet DARPA's requirement for disposability. http://www.parc.com



Vitex Systems' licensees receive multiple orders for Barix thin-film encapsulation equipment

Vitex Systems announced that its equipment licensees, SNU Precision and Sunic Systems, have received multiple orders for Barix thin-film encapsulation (TFE) equipment. "SNU Precision just received a Barix TFE tool order from Taiwan," said Chyi-Shan Suen, president and COO, Vitex Systems. "This is the first TFE tool sold into Taiwan, marking an important milestone for both Vitex and SNU. Additionally, our licensee Sunic Systems has received an order from its second customer in China. Sunic Systems had already delivered its first Barix TFE equipment order to a customer in China at the end of last year." The Barix encapsulation process and Barix barrier film are proven solutions for manufacturing OLED displays that are lighter and thinner than any other commercially available displays. The same characteristics that make Vitex's technology valuable in the display market have been applied to thin film photovoltaic (solar) cells. By eliminating costly, heavy and fragile glass packaging, Vitex technology lowers the cost and opens up new possibilities for building integrated photovoltaics (BIPV) and consumer applications. http://www.vitexsys.com

Novaled demonstrates long lifetime white top emitting OLEDs

Novaled demonstrated white top-emitting devices with a lifetime exceeding 50,000 hours and a power efficiency of 30lm/W at an initial luminance of 1,000cd/m^2. The white top emitting OLED structure offers the realisation of OLED lighting products made on metal substrates. Metal substrates bring advantages such as good heat dissipation, mechanical stability, bended designs and open the roadmap towards low cost roll-to-roll production. Novaled has developed a high performance white top emitting OLED using the Novaled PIN OLED technology with its proprietary doping and host materials in association with a blue fluorescent emitting material from SFC Korea. In addition the device has an ITO-free top contact and incorporates a Novaled-specific light extraction material layer to enhance the efficiency. http://www.novaled.com

Novaled introduces ultra-flat OLED luminaries

Novaled introduced its innovative long life organic LEDs. These new area light sources not only deliver unique design possibilities, but also enable completely new lighting applications by emitting light from a surface. OLED light is perceived as being very natural due to the broad emission spectra of the organic materials. Color tunable OLEDs which cover a broad span of colors from light blue through clear white and all the way to orange were also introduced. The OLED devices, which are manufactured on glass and metal substrates, are extremely thin, lightweight and come in various sizes from 25cm^2 up to 225cm^2 active area. Depending on the substrate material and device structure chosen, OLEDs can be transparent, have a diffuse appearance or behave like a mirror in the off state. http://www.novaled.com

Qualcomm applies for a multi-fold display patent

Qualcomm has registered a patent application at the US Patent and Trademark Office for a mobile device with a multi-fold screen. The patent has been registered as a “Multi-fold mobile device with configurable interface”. Qualcomm claims it applied for the patent because, traditionally, mobile devices are limited by their fixed size and small display screens. Qualcomm intends to use the technology to create a flexible display screen that can be unfolded or even extended depending on the use. The description reads, “When fully extended, the device may provide a panorama view, similar to wide-screen televisions. When fully folded, the device may provide a small form factor with an abbreviated view similar to cellular telephones.” The user interface (UI) on its multi-fold display also has the ability to change depending on the configuration of the device. The patent application says, “The UI may be a panorama UI, a desktop UI, an application UI, a web browser UI, an alarm clock UI, a media player UI, or some other UI.” http://www.qualcomm.com

Plextronics announces critical developments for the organic solar market

Plextronics made two announcements related to the company’s organic solar inks, including the use of Plexcore PV 2000 for energy harvesting applications and a breakthrough manufacturing method that allows for low-temperature processing of organic photovoltaics (OPV). http://www.plextronics.com

Universal Display awarded contract for novel encapsulation technology for flexible electronics

UDC announced that the company has been awarded a $500,000 Small Business Innovation Research (SBIR) Phase II contract from the National Science Foundation (NSF) to demonstrate further advances in its novel thin-film encapsulation technology. In the Phase II program, Universal Display will focus on demonstrating that its environmentally-friendly, single-layer approach exhibits manufacturing scalability and prospective cost effectiveness. This program follows a successful Phase I program during which the company, working with Princeton University, demonstrated that this approach has the performance characteristics to be an ultra-hermetic, transparent and flexible permeation barrier that can provide OLEDs with the long-term operational stability for a variety of demanding conditions. http://www.universaldisplay.com

UDC presents all-phosphorescent white OLED to address commercial white lighting applications

Universal Display Corporation announced advances in white OLED performance on a commercial-scale 15x15cm lighting panel using the company's highly-efficient phosphorescent OLED technology and materials. This new white OLED panel is believed to have the most energy-efficient performance, at this scale, reported to date. The company employed a new light-blue PHOLED emitter system that helps reduce the power consumption of the panel and extend its operational lifetime and emission color stability with aging. UDC can now offer a full set of emitters for warm-white OLED lighting applications. http://www.universaldisplay.com

UDC supports establishment of an OLED lighting pilot manufacturing facility

Universal Display, along with Moser Baer Technologies, has been awarded $4,000,000 for a two-year program from the United States Department of Energy (DOE) under the American Recovery and Reinvestment Act of 2009 for a program titled "Creation of a U.S. Phosphorescent OLED Lighting Panel Manufacturing Facility". Under the new program, Universal Display will demonstrate the scalability of its proprietary Universal PHOLED technology and materials for the manufacture of white OLED lighting panels that meet commercial lighting targets. http://www.universaldisplay.com

DuPont delivers OLED technology scalable for television

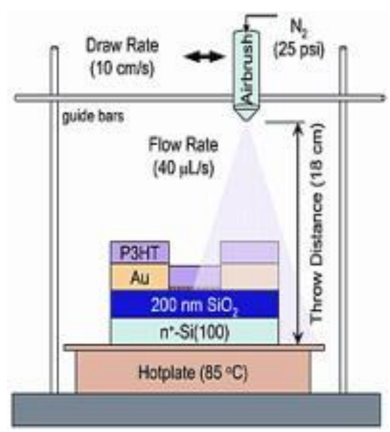
DuPont announced that it has achieved record performance in printed OLED displays, sufficient to enable future adoption of OLED television. Using proprietary DuPont Gen 3 solution OLED materials, DuPont demonstrated a solution-based manufacturing process in which OLEDs can be cost effectively printed while delivering the necessary performance and lifetime. DuPont made printed test devices that can be operated at elevated luminance for an accelerated lifetime test. Printed devices using the DuPont process have reliably achieved lifetimes to 50% of initial luminance of 29,000 hours for red, 110,000 hours for green and 34,000 hours for blue at typical television brightness levels. http://displays.dupont.com

NIST to advance flex initiatives

The National Institute of Standards and Technology (NIST) recently posted a federal funding opportunity "Manufacturing and Biomanufacturing: Materials Advances and Critical Processes". The RFP is under the Technology Innovation Program. Of particular interest to FlexTech member companies is that NIST gives examples of materials to advance displays, batteries, storage devices, electronic inks and other products of the relevant industries. NIST estimates that ~$25M will be available for project funding. http://www.nist.gov/tip/

NIST studies spray-on manufacturing of transistors

A multidisciplinary research team at the National Institute of Standards and Technology (NIST) has found that an organic semiconductor may be a viable candidate for creating large-area electronics, such as solar cells and displays that can be sprayed onto a surface as easily as paint. While the electronics will not be ready for market anytime soon, the research team says the material they studied could overcome one of the main cost hurdles blocking the large-scale manufacture of organic thin-film transistors, the development of which also could lead to a host of devices inexpensive enough to be disposable. The simplicity of spray-on electronics gives it a potential cost advantage over other manufacturing processes for organic electronics. http://www.nist.gov



This airbrush technique deposits a well-studied material called P3HT to create spray-on transistors, which perform comparably to lab-standard equivalents made by spin coating.

GE to increase investment in thin film photovoltaic technology

GE announced it is focusing its research and development efforts on thin film photovoltaic (PV) technology in conjunction with PrimeStar Solar Inc., the startup firm in which GE is a majority investor. The GE/PrimeStar product is being developed at PrimeStar's headquarters in Arvada, Colorado. A team of PrimeStar technologists is working closely with GE researchers, who are focused on several key areas in order to achieve best-in-class technology. These include device efficiency, reliability, production and installation costs, and manufacturability. http://ge.geglobalresearch.com

Corning launches slim LCD glass substrates

Corning announced the commercialization of EAGLE XG Slim, a new line of thin glass substrates. While the initial focus is on enabling lighter-weight portable devices - with glass sizes up to Generation 5 at 0.4mm thick - Corning will add more gen sizes and thicknesses to the line to support larger applications like LCD TV. Currently, most panel makers begin with 0.5mm thick substrates for portable devices, and then employ a costly thinning process that uses chemicals to reduce the thickness of the glass. Thin input glass requires no additional panel thinning to achieve weight and thickness targets. Benefits include a lower total cost, a simplified supply chain, and reduced energy consumption. Moving forward, Corning plans to develop 0.3mm substrates for glass sizes that support portable electronic devices and to broaden the line to include gen sizes that support TVs and other large displays. http://www.corning.com

E Ink and Chilin Technology announce joint partnership

E Ink and Chilin Technology announced a partnership to bring low-power industrial and other specialized electrophoretic displays to the marketplace. The cooperation between the two companies enables solutions that are highly integrated, easy to use and install, and tailored to unique customer environments. The partnership makes the patented E Ink Vizplex imaging film available to Chilin for mass production, distribution, and sales to consumers. The collaboration not only expands E Ink's product offerings but also leverages Chilin's extensive ability to engineer and manufacture low-power, customized solutions for the industrial market. The agreement entails greater cooperation between the two firms to expand the rapidly growing e-paper business. http://www.eink.com http://www.chilindisplay.com

FUJIFILM Dimatix expands capabilities of its materials printer

FUJIFILM Dimatix introduced its new D-128/1 DPN, a 1pL drop volume printhead and companion D-128/10 DPN, a 10pL model, for use with the Fujifilm Dimatix DMP-3000 printer. These printers are used for an expanding range of materials deposition applications and developments. Both D-128 DPN printheads are designed to aid in the orderly progression from experimentation to scale up using the DMP-3000 printer. D-Class printheads have been specifically designed for non-contact printing of functional fluids for applications such as displays, electronics and biotechnology. D-Class printheads are based on Fujifilm Dimatix's proprietary silicon MEMS (Si-MEMS) technology and use robust silicon material. End-users can utilize the D-128/1 DPN printhead to manufacture products requiring precise feature definitions as small as 20µm, such as silicon-based solar cells and other photovoltaic devices, small-size RFID antennae, organic thin-film transistors (TFTs) and printed circuits. The D-128/1 DPN produces conductive lines and features that are virtually invisible or allow biomaterials to be printed at twice the previously achievable density in a true production mode. The D-128/10 DPN with its larger drop size is used for coarser feature generation. http://www.dimatix.com

UNI-SOLAR unveils roadmap for conversion efficiency of 12% by 2012

UNI-SOLAR, a wholly-owned subsidiary of Energy Conversion Devices revealed its technology roadmap to achieve 12% conversion efficiency by 2012 with a cost-per-watt of less than one dollar. In the following years, the company is targeting 20+% conversion efficiency. The roadmap calls for evolutionary development of the company's existing including enhancing the laminate to improve conversion efficiencies to 8.2% by close of 2010 calendar year, High Rate Deposition which targets 10% by end of 2011, and HybridNano Technology targeting 12% by end of 2012. http://www.energyconversiondevices.com

QD Vision acquires Motorola patents covering use of quantum dots in displays and lighting

QD Vision announced it has purchased from Motorola a patent portfolio pertaining to the use of quantum dot technology in display and lighting products. The addition of this portfolio augments QD Vision's position in quantum dot intellectual property. Included in the acquisition is U.S. Patent No. 5,442,254 of Jaskie, one of the earliest patents on the use of photoluminescent quantum dots in product applications, and pending applications relating to the use of quantum dots to a wide variety of display applications, including LCD backlight units. Prior to this acquisition, QD Vision's position in quantum dot intellectual property already included nine issued patents and more than 130 patents pending. http://www.qdvision.com

CHA Industries high vacuum deposition system accepted at Binghamton University's CAMM

Binghamton University and The Flex Tech Alliance announced that the CHA Industries Web Coater has been accepted at the Center for Advanced Microelectronics Manufacturing (CAMM). The addition of the web coater to CAMM'S array of R2R microelectronics manufacturing equipment is the culmination of a long-standing relationship between CHA Industries and the Flex Tech Alliance. Almost 2 years ago, CHA Industries was chosen by the Flex Tech Alliance to develop a R2R deposition process tool with web handling capability. The partnership draws on CHA's ability to customize design and engineering to address unique application requirements, such as those specified by the Flex Tech Alliance. Funded by the Army Research Laboratory and cost-shared by CHA and Flex Tech Alliance, the $6M partnership project will advance the capability of U.S. industry in the burgeoning flexible microelectronics market. http://www.chaindustries.com

Merck KGaA presents new materials for organic electronics, photovoltaics and flexible displays

Merck KGaA showcased its latest developments in organic electronics and organic photovoltaics and introduced its custom-formulated fluids for color electrophoretic display technology at LOPE-C 2010. The "lisicon" brand provides materials and formulations for producing innovative OE applications such as flexible displays, organic solar cells and organic RFIDs. A significant benefit of OE technology is the appeal of solution processable fabrication methodologies that allow freedom of size, form factor and application architecture as well as cost efficient manufacturing processes. "lisicon" materials and formulations are customized to target specific requirements and are compatible with mass production techniques, including spin coating, inkjet printing, gravure and flexographic printing. The extended livilux range now includes a complete new set of electron, hole transport and matrix (host) materials for small molecule-based OLEDs. These materials enable display and lighting customers to decrease the operating voltage and at the same time increase the overall efficiency of the OLED. With state-of-the-art analytical equipment and methods Merck ensures high purity and reliability. Therefore livilux OLED materials are suited for mass production. http://www.merck.de

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 Program 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 – http://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 Cheryl Serame-Turk at 1-408/477-1300
cheryl.serame-turk@flextech.org
For more information and membership forms,
visit http://www.flextech.org