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## Printed Electronics and Labels

**By Dave Savastano, Editor**

The printed electronics (PE) field is an area that is drawing attention from a wide range of industries. In a way, the name printed electronics is an all-encompassing term, as it includes flexible electronics, organic electronics and other possible applications. The common thread is that the application can be mass produced by low-cost means, potentially including printing, and offer the consumer value at a low price point.

Flexibility is also a huge advantage. A flexible display can be used to wrap around an area. A flexible battery can be used in places where a coin cell cannot.

According to IDTechEx, a consulting firm, there are a few billion-dollar markets already in the PE field: eReaders, displays (most of which are not printed yet) and conductive inks. Medical sensors such as glucose strips and RFID tags are two areas where electronics are being successfully mass produced. Organic light emitting diodes (OLEDs) for displays and lighting and organic photovoltaics (OPVs) are two areas of interest, although commercialization has remained elusive for OPVs.



Temperature-sensitive tags are ideal for food-chain monitoring.

There is still work to be done on PE. Right now, there is more work utilizing hybrid systems, in which some printing is combined with more traditional electronic assembly methods. Either way, anecdotal evidence indicates that flexible and printed electronics are heading into pilot and production stage, and the people producing these systems say they are seeing an increase in their business.

### Printers and Printed Electronics

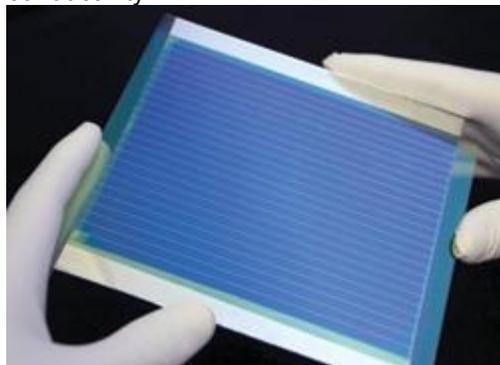
In terms of printing itself, there are plenty of examples of printed electronics already in the marketplace. RFID is used for luggage tags by some airports, led by Print-O-Tape, who partnering with Avery Dennison, has produced luggage tags with RFID inlays via flexo printing for airports in Hong Kong and Las Vegas. Membrane switch specialists such as GM Nameplate and Xymox have brought their printing skills into the PE field.

A prime example are the above mentioned glucose strips. GSI Technologies, LLC, Burr Ridge, IL, USA, has long been a leader in this field. "We are in a good position in the medical device market, producing electrodes for in vitro diagnostic strips for glucose, cholesterol and other tests," says Gordon Smith, chief technology officer for GSI Technologies. "We also have business in the automotive space, in areas ranging from EL to heaters.

"We see quite a bit of interest in going to production, from making a component to a fully integrated device," Smith adds. "We see all types of new ideas. Our phone is ringing more often now, and it seems there's a ramp happening."

Si-Cal Technologies Inc. – A Nissha Company, Westborough, MA, USA, has been producing printed electronics products for the past nine years, using roll-to-roll screen printing. The company has had its most success in areas such as medical devices and RFID. “We have several medical device programs in production (iontophoretic patches, esophageal tube, oxygen sensor) and a very large RFID automotive security tag,” says Jaye Tyler, president and CEO of Si-Cal. Tyler notes that Si-Cal “absolutely” has seen an increase in interest in PE projects heading to production scale.

When it comes to printing the systems, narrow web roll-to-roll is a key technology. Some companies are using inkjet for prototypes, and flexo is making some gains, but screen is still prevalent. Smith says that screen printing offers the best approach for the majority of PE. “We primarily use screen printing for printed electronics,” he says. We do have flexo lines and a new inkjet digital press for our label and industrial graphics printing, but the thicknesses laid down in flexo and inkjet are relatively thin, and that leads to concerns over conductivity.”



Organic photovoltaics is a PE area of interest. (Photo courtesy of imec)

There is the idea that PE is all about saving money, but Smith says that the notion that printed electronics are driven primarily by cost ignores the advantages that these devices offer. He cites wearables as an area where these advantages can play a key role. “The first thing people want to talk about is low cost, but this is a disservice,” Smith says. “Traditional electronics are extremely inexpensive, and PE is not there just to take cost out. Wearables is an interesting area, as there is potential for continuous glucose monitoring, perhaps lactate monitoring for athletes. Here, PE offers advantages, as they are flexible, thin and lightweight, and the inks enable tests that fit well within the PE framework.”

### Materials Producers

To print PE products, conductive materials are needed. Whether they are metallic inks, pastes, graphene, carbon nanotubes or other approaches, conductive materials are critical to the process. These materials are supplied by a wide range of producers, from small start-ups to multinationals such as Sun Chemical DuPont and Hewlett Packard.

Sun Chemical is the largest global printing ink manufacturer, and the company has long been in the conductive ink field. In March 2014, Sun Chemical and T+ink, arguably the leading PE innovator, announced their partnership on T+Sun. In T+Sun, the companies are working together to develop conductive ink solutions. The combination of Sun Chemical’s global resources and T+ink’s technology has the potential to bring PE further into the mainstream.

During the past 10 years, T+ink has built up an array of projects, partnering with leading consumer product and industrial companies, including Ford, General Motors, US Gypsum, Sylvania, Whirlpool, McDonald’s, Coca-Cola, Walmart, Hasbro, Toys R Us, Viacom, Kraft, Nabisco, Hallmark, WestPoint Stevens, Playtex, Elmer’s and the US government. One area where T+ink found success is the automotive market, designing and printing capacitive switches to replace control panels for Ford.

T+ink has developed more than 2,000 ink formulations for flexo, screen, inkjet, gravure, offset and UV inks and coatings for PE projects. “The motivation is the market drive towards electronic packaging, which requires an interaction between electronic design and materials development,” says Roy Bjorlin, commercial director, Electronic Materials, Sun Chemical. “T+ink has developed a strong foundation of creating working devices that enable functionality and enhance the consumer experience at the package level, and Sun Chemical has world

class materials and capability in R&D and global support in electronic materials. The combination was a natural fit.”

Jim Stasiak, distinguished technologist, Printing Technology Development organization at HP, notes that HP’s Printer Technology Development organization in Corvallis, OR, USA has been exploring various printed materials, flexible electronics and printed electronics opportunities for more than a decade.

“We have explored technologies that benefit from large area flexible substrates using roll-to-roll manufacturing,” says Stasiak. “Some of these technologies include flexible displays, sensors, flexible electrics and circuits.”

### Packaging and Sensors

One of the areas of greatest interest for brand owners is smart packaging. In particular, functional labels such as temperature sensitive tags would be ideal for food chain monitoring. IDTechEx estimates that the global demand for electronic smart packaging devices is currently at a tipping point and will grow rapidly to \$1.45 billion in 2023. The electronic packaging (e-packaging) market will remain primarily in consumer packaged goods (CPG), reaching 14.5 billion units that have electronic functionality in 2023.

PakSense is a leader in the field of temperature-sensing for food packaging, serving any market that distributes or stores perishable items such as food (produce, meat, poultry, seafood, floral, wine), life sciences (vaccines, pharmaceuticals, biologics,) and industrial (chemicals, adhesives, sealants, epoxies). PakSense is partnering with Thin Film Electronics (Thinfilm), a printed electronics specialist, to develop printed labels.

“Initially it will enable us to offer an alternative to chemical indicator products with a more sophisticated option,” explains Amy Childress, vice president, marketing for PakSense. “It also enables us to offer a label that can monitor product at a more granular level, such as at the carton or item level. We envision these next generation labels will collect more data and enable ubiquitous temperature monitoring in the cold chain with connectivity to cloud services at a price point that is palatable to the market.”

Aside from its work with PakSense, Thinfilm is collaborating with Bemis Company, a leading supplier of flexible packaging, to develop a flexible sensing platform for the packaging market. Also, Thinfilm and Brady Corporation recently announced a strategic alliance to bring Thinfilm’s printed electronic technology to Brady’s identification product lines, focusing on electronic timing labels for applications in visitor and healthcare identification and tracking.



An automotive PE application from T+ink

Thinfilm is also bringing its near field communication (NFC) technology acquired from Kovio to an alliance with EVERYTHNG, an award-winning Internet of Things (IoT) software company, to apply digital interactivity to billions of everyday objects.

“Once we attach a Thinfilm NFC bar code or smart label to an object and link the tag to EVERYTHNG’s cloud system, we can detect and track critical information about it every time it’s touched by a smartphone,” says Davor Sutija, Thinfilm’s CEO. “Furthermore, each smartphone interaction is also an opportunity to push personalized, relevant and contextual content back to the smartphone user.

“The potential use cases are endless, and opportunities to add electronic intelligence to certain disposable products could quickly grow from the millions to the billions of units,” Sutija adds. “Because NFC bar code and smart label systems can embed intelligence into almost any object, we see it and other printed electronics as a prime foundation for connecting a vast web of ‘things’ that extend beyond the domain of relatively expensive, microcontroller-powered connected devices. By expanding the boundaries of the Internet of Things to create

the Internet of Everything, printed electronics and scalable cloud-based identity management services combine to help us to make better everyday decisions and live more informed lives.”

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