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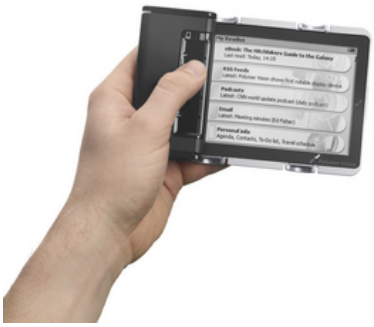

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The Readius' display is based on a flexible printed substrate that rolls up into the device.

Printed Electronics Advance by Creating Markets

By Meredith Courtemanche, assistant editor

Printed electronics, including thin-film electronics that will become printable, may be a disruptive development for human interfacing, networks, and environment technology (elements such as wallpaper and product packaging). Reports and industry input suggest that intelligent, mass-producible printed electronic circuits will reduce costs, environmental waste, and limitations, but primarily in markets that were previously inaccessible. Various sources agree that the printed electronic device will be less likely to compete with existing technologies that meet current needs.

Printed electronic devices currently under development rely on organic and inorganic substances to create structured circuits. Co-depositing various devices — memory, sensors, etc. — can lead to economical and sophisticated products that interact with the environment. For example, EoPlex Technologies of Redwood City, CA, uses a deposition process that builds microstructures with layers of materials; micro-channels, dielectric

layers, ceramic cavities, and sensors can co-exist within the same device. The company is developing a fuel-cell reformer that incorporates approximately 300 printed layers. "This small device then acts as a catalytic chemical plant," explained Art Chait, CEO of EoPlex. Smart clothing, such as that under development for the U.S. Army, uses embedded, flexible electronics in the fabric to generate electricity, regulate a micro-climate, and send and receive communications. Inkjet printing tolerates uneven substrates like a woven fabric, according to "Printed Electronics — On Track to a Major Industry," by Chris Clare of IDTechEx, opening a market that traditional semiconductor packages, with tight flatness tolerances to prevent cracking and warpage, cannot access.

These products serve as examples of the developing markets that printed electronics will serve. The technology provides a "feasible solution" to existing roadblocks, explained Clare, and may eventually break into traditional markets, more slowly. Chait agrees, "Eventually we may look at commercial applications, such as replacing the batteries in handheld devices with a printed electronic device that lasts longer, but that is not driving the industry." Chait sees potential for profit and progress by "filling a void" with the company's proprietary high-volume print-forming products, like the reformer, that as yet do not exist.

In the middle of the spectrum — between established technology and the avant garde — are consumer products printed on flexible paper or polymer substrates. The potential for security, such as a printed RFID tracking device on legal documents or a cardboard shipping box, and entertainment, such as an electronic reader that mimics the visceral feel of a paperback, are drawing investment and headed toward commercialization. Flexible substrates offer the lowest installation cost, according to IDTechEx's report, and products such as e-readers can be printed in large formats, speeding production. Plastic Logic, a Cambridge, U.K.-based start-up that spun off from Cambridge University, plans to begin production of plastic substrates for wireless e-readers, an active-matrix display module, in 2008. This technology, which mimics a sheet of paper but displays downloaded books, reports, and newspapers, competes with other electronic devices such as PDAs and lap top computers that also display text. The format, however, is markedly different, resembling a traditional, non-electronic environment for more intuitive interaction.

Some printed electronics will directly compete with established technologies, particularly in the display industry. Flexible organic LEDs (OLEDs) will reduce operating costs, installation concerns, and manufacturing costs compared to conventional lighting, notes Clare, though this development won't pan out for at least a decade. Replacing an existing solution and improving the capabilities of an industry does not draw significant funding or customer interest, and the printed-electronics companies — largely start-ups — lack capacity and depth to attack the entrenched, established technologies. As disruptive products roll-out in mass production, and these start-ups gain more funding and look to a broader audience, products such as printed MP3-player batteries and OLED displays may gradually begin to replace rigid semiconductor devices. One company, E Ink Corporation (Cambridge, MA), is developing and manufacturing flexible plastic displays for the mobile phone market. Customers Motorola and Polymer Vision were recognized with awards at teh 3GSM World Congress 2007 in Barcelona, Spain. The displays, integrated into mobile devices, are rollable, foldable, and bistable (using power only when an image is changed). Low power consumption and clear images, even in sunlight, allowed the electronic paper display technology to penetrate this mainstream market, said Russ Wilcox, president and CEO of E Ink.

For more information on the capabilities of printed electronics to generate new markets, see EoPlex Raises $8M to Expand Printed Circuitry Technology and USDC Promotes FPO Adoption. To find out more about Plastic Logic's commercial products, read Dresden Factory Aims to Commercialize e-Reading from our January/February issue. *Advanced Packaging* also conducted an interview with Ashok Maliakal, researcher for flexible, printed ICs at Bell Labs, the R&D center for Lucent Technologies.

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