

## [Printed-Electronics RFID Tags: From Promise to Reality](#)

By Jill Gambon, 8/1/2008

*High-frequency tags with printed electronics could be cheaper than conventional RFID tags—and could pave the way for a host of new applications.*

RFID tags made with printed electronics, long thought to be years away from widespread availability, are moving closer to hitting the market en masse. Printed electronics is an emerging technology that uses standard printing processes to enable low-cost manufacturing of a variety of devices, including RFID tags, flexible displays, batteries and transistors. Companies such as Kovio and PolyIC, which have both produced high-frequency tags with printed integrated circuits (ICs), are now fine-tuning their offerings and gearing up for increased production.

Tags with printed electronics hold the promise of lower prices, because commercial printing processes are used to produce the ICs that power the tags instead of the expensive and complicated method of silicon fabrication used in manufacturing conventional silicon chips. The tags, the companies say, can be produced with less capital expense and shorter production cycles. Kovio, a Silicon Valley venture-backed company, says it can manufacture its tags' ICs in a single day, compared with the 90 days it takes to make traditional silicon chips.

Last November, Kovio made a splash in the printed-electronics world when it introduced a thin-film transistor (TFT) printed with silicon ink on a flexible, stainless-steel foil substrate. The transistor is a component of an IC, which contains multiple TFTs that control various functions on the chip. The printed ICs are key to producing RFID tags that cost just pennies, the company says. Kovio has been continuing development of HF tags that use the printed ICs and expects an official product launch later this year. In June, Kovio moved into a 95,000-square-foot headquarters in Milpitas, Calif., that includes space for expanded manufacturing operations. The company says it will provide engineering samples to customers in the second half of this year and expects to ramp up production in 2009.

Last September, PolyIC—a five-year-old joint venture between Siemens and Leonhard Kurz Stiftung, headquartered in Fuerth, Germany—unveiled its PolyID tags, with printed chips that use mostly organic materials. The HF tags comprise roll-to-roll printed transponder chips, based on the polymer semiconductor polythiophene, printed on flexible polyester film. Customers are currently testing the tags, but the company says it is prohibited from identifying them due to privacy agreements.

While PolyIC has optimized its tags for the initial application of authentication, it envisions a far wider market. "Lower-cost tags with printed RFID enables RFID everywhere," says Wolfgang Mildner, managing director of PolyIC. The company is now scaling up production of the tags.

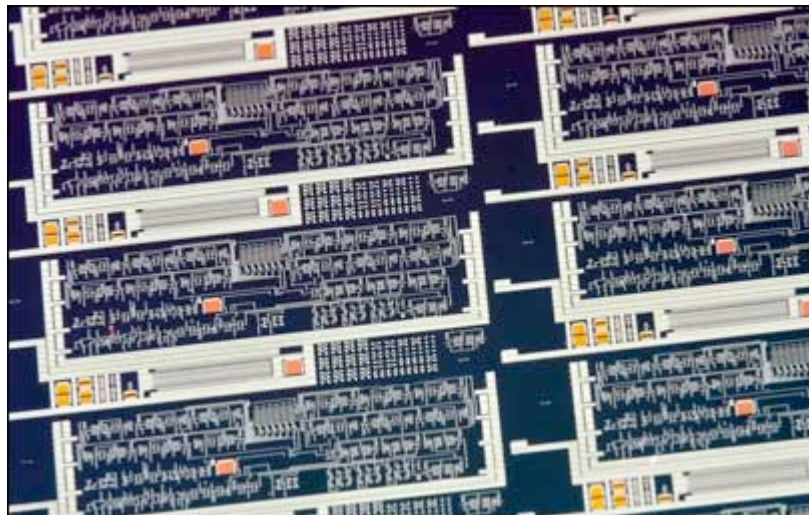
Both Kovio and PolyIC are focusing on HF tags in their initial product releases because of the ubiquity of applications that operate in that range. In addition, the

tag design to support those applications is less complex, requiring less memory and processing power. "The more memory you put into the chip, the more complicated it is to manufacture," Mildner says.

While the read range of the HF tags may be limited—a few centimeters for PolyIC's tags and about half a meter (1.6 feet) for Kovio's—the companies say that's enough for such applications as authentication, access control and ticketing. Both companies also say they will offer UHF tags over time, as the printed-electronics technology matures and if there is demand.

The early generations of the printed-electronics tags don't have the power or performance of conventional tags, but analysts say there is demand for low-cost chips with less muscle. "Printed RFID can be the cheapest, but with sacrifices on performance," says Raghu Das, CEO of [IDTechEx](#), a research firm that focuses on RFID, printed electronics and smart packaging. Conventional and printed RFID can exist side by side, he says.

While both PolyIC and Kovio are working on printed electronics, they take different approaches. PolyIC uses mostly organic materials in its chips, while Kovio uses silicon-based ink. A key advantage with organics is lower cost, but such materials have been less reliable than inorganic compounds in terms of quality and stability, analysts say. Kovio says it chose to work with silicon to leverage the existing standards and [reader](#) infrastructure, as well as for the superior performance of silicon chips. The company claims its manufacturing procedures, which use silicon inks in ink-jet printing processes, are less harmful to the environment, consuming just 25 percent of the power that conventional manufacturing requires. The company also says it uses only 5 percent of the chemicals and 0.005 percent of the hazardous gases needed for traditional silicon chip manufacturing.



Other companies are investing in the development of printed-electronics RFID tags but have been less public about their progress. [OrganicID](#), acquired by [Weyerhaeuser](#) in August 2006, has been working on low-cost tags printed with organic materials for supply-chain and inventory-control applications. Little news on the tag development has been released since the Weyerhaeuser acquisition. But in March, Thin Film Electronics of Oslo, Norway, announced it had reached a consulting

agreement with Weyerhaeuser to work on printed ferroelectric memory for the company's printed RFID products.

[Mu-Gahat Enterprises](#), a Sunnyvale, Calif., RFID startup specializing in printed electronics, cites a need for low-volume production in the early stage of the emerging market. The company claims it can produce economical printed-electronics RFID tags in volumes as low as 150 units.

### **Printed Applications**

[Cubic](#), a San Diego-based company that designs and manufactures automatic fare-collection systems for public transit projects, has been working with Kivio to create a transit card that incorporates a printed [RFID tag](#) to replace magnetic-stripe cards. Cubic believes it can lower the costs of the transit cards by more than 50 percent using printed-electronics RFID. Kivio has made significant improvements to the tags' performance within the past nine months, says Walt Bonneau, a senior VP with Cubic. "We're probably 90 percent of the way there," he says. Now, the key enhancement Cubic wants is more memory on Kivio's printed tags. Bonneau expects his company to be using Kivio's tags in the transit cards within a year.

The lower cost of producing RFID tags with printed electronics will not only drive down the price of tags, it will also usher in a "third wave" of RFID adoption, opening up new possibilities in smart packaging and interactive labels, predicts PolyIC's Mildner. RFID with printed chips will be "the enabling technology" that will allow labels or packages to sense environmental factors and communicate and display product information to users, he says. Prescription pharmaceuticals, for example, could have electronic labels that display information proving their authenticity or providing instructions on how to take the medications properly; a milk carton could [flash](#) a message validating its unbroken cold-chain storage.

Vik Pavate, Kivio's VP of business development, also envisions a raft of new RFID applications, such as integrating printed tags and sensors with product packaging to prevent the loss of fresh produce and other food due to spoilage. The sensors could detect chemical changes in the food and trigger an alert to the grocer, he says.

### **Challenges Remain**

While expectations for printed-electronics tags are high, numerous questions must be resolved before the technology is ready for widespread adoption. "There's a mixed bag of challenges, but that's true with any new technology," says Michael Liard, a research director at [ABI Research](#). One key hurdle, he says, is the expense that consumer goods companies will face to make changes to their design and manufacturing processes to incorporate the tags into their packages.

Another potential [barrier](#) is the absence of standards for printed electronics, says Keiichi Utaka, CTO and managing director of [Toppan Forms](#), a Tokyo-based printing and equipment company that has partnered with and invested in Kivio. Performance improvements, such as expanding read ranges and increasing read rates for RF-unfriendly items containing metal or water, will be necessary, Utaka says.

Once some of those hurdles are overcome, adoption of printed-electronics tags is expected to grow quickly, several RFID experts say. IDTechEx, for instance, estimates that by 2017, more than 50 percent of the 650 billion tags that are expected to be sold worldwide will be made with printed electronics. Das believes significant sales volumes of printed-electronics RFID tags won't be seen until 2011.

As the nascent market takes shape, continued research and development is needed to better understand the materials and technologies involved in manufacturing printed-electronics tags, says PolyIC's Mildner. The German government has gotten behind the effort, sponsoring a consortium of chipmakers, chemical manufacturers and RFID companies to advance printed tag technology. Known as the MaDriX project, its members include BASF, Elantas Beck, Evonik Industries, PolyIC and Siemens. Some €15 million (\$22.6 million) has been invested in the consortium's efforts—more than half of that from the German government.

To keep advancing the technology, companies and research organizations need to continue working together, Mildner contends: "I would say it's not time for competition—it's time for collaboration."

#### **Who's Who in Printed-Electronics RFID Tags**

- Kovio ([www.kovio.com](http://www.kovio.com))
- Mu-Gahat Enterprises ([www.mugahat.com](http://www.mugahat.com))
- OrganicID ([www.organicid.com](http://www.organicid.com))
- PolyIC ([www.polyic.com](http://www.polyic.com))