

Developing Tomorrow's Tags

The printable electronics conference in Las Vegas last week provided a glimpse of what the future holds for RFID tag technology.

By Mary Catherine O'Connor

Nov. 16, 2004—In its third consecutive year, the [Information Management Institute](#) (IMI) Printable Electronics Conference, which was held Nov.9-11 in Las Vegas, attracted about 170 research scientists and engineers from industrial printing and manufacturing companies like DuPont, Ricoh, Samsung, Precisia, Corning and Spraylat. The participants came to learn and share information about the state of technology in printable electronics. Many of the more than 20 sessions presented focused on or addressed the advances being made toward printing RFID antennas and entire RFID tags.

Currently, antennas printed using electrically conductive ink are estimated to make up less than 15 percent of the market today. But that percentage is growing because printing antennas offers significant cost savings over etching them from copper, which is the most common method today. Through advances in materials science, design and printing, entire circuits can now be printed out of conductive and semiconductive polymers, which means that entire RFID tags can now be printed (see [Start the Presses](#)), though they are in early stages of development and do not yet function at frequencies much higher than 125 kHz. Among attendees and speakers at the IMI conference, most estimates are that printed RFID tags that operate at 13.56 MHz will be a reality in roughly two years, but it will take upwards of four years before we see large-scale production.

[Poly IC](#), a printed-electronics firm formed last year as a joint venture between the German industrial giant [Siemens](#) and German printing company [Kurz](#), is one of the leaders in developing printed RFID tags. Andreas Ullmann, senior research scientist for Poly IC, presented at the conference a session on the materials, design and production that went into the creation of its polymer transistor, the building block of its completely printed integrated circuit (IC), which Poly IC claims is the world's first. The company has used this IC to print a passive RFID tag that operates at 125 kHz and has a read range of 2-3 centimeters.

Semiconductors made of polymers have lower charge mobility than those made of silicon, which lowers the frequencies at which they can process information. This means printed ICs operate more slowly than conventional silicon-based semiconductors. In fact, the consensus among speakers and attendees at the IMI conference was that no amount of research or development is likely to lead to printed RFID tags that operate at UHF ranges. For that reason, companies developing printed tags are aiming for the item-level tracking market in which 13.56 MHz HF tags will likely be the prevalent.

Once RFID tags are used at the item level, the amount of chips and antennas that could end up in the waste stream would increase significantly. While etched metal antennas could be separated out and recycled, the market value of copper does not make the reclamation process economically viable, according to Dan Lawrence, director of technology at [Precisia](#), a maker of printed RFID antennas and printed electronics. Lawrence says he is working with a team of researchers that are looking into how silver, which has a higher dollar value than copper, and polymers used in printed RFID antennas and chips could be separated out and recycled in a manner that would be economically viable.

Ullmann says that researchers at Poly IC are looking at ways of extending their ICs' operating range to frequencies beyond 125 kHz while also experimenting with different printing methods. The printing process for polymer ICs is very complex, as each element of the chip needs to be printed separately and then merged together.

Once they are refined enough to operate at higher frequencies and mass production begins, however, printed tags could make a very significant impact on the RFID industry, because developers are predicting they'll cost as little as a penny each—much lower than the best predictions for silicon-based tags. Semiconductor companies and tag manufacturers are trying to bring the price of silicon down to make the much-heralded 5-cent tag a reality. But even if that happens, the amount of time required to assemble RFID tags using silicon-based chips will keep yield lower than for printed RFID tags. This means printed tags could take over the market for 13.56 MHz tags.

This potential is what one Colorado Springs, Colo.-based startup, [OrganicID](#), is banking on. Running on capital from Los Angeles-based ITU Ventures, the 10-person crew is developing its own IC and says it should have a printed 13.56 MHz tag produced in two years that will be production-ready by 2007, which it believes will be well timed with manufacturers turning to item-level tagging. "We've all got different backgrounds, from chemistry to physics to materials science to device design and we need this multi-disciplinary approach to make the circuit. If there's a silver bullet in this development process, it will be bringing all our areas of expertise together as affectively as possible," says Klaus Dimmler, the firm's president and CEO. "It's not going to be easy, but it's worth the uphill battle."

Compared with printing RFID tags, printing antennas is a much simpler process, which is why printed antennas are already in use. But some hurdles still need to be addressed in terms how to improve the conductivity of the ink, how to cure it quickly and how to deposit it thickly enough. Also, there are no industry standards around which printers of antennas can test their products (see [Proposed Standard for Ink Antennas](#)).

Chuck Edwards, general manager of printed electronics and displays for [Cabot](#), a materials engineering firm in Albuquerque, N.M., presented at the IMI conference the steps that Cabot is taking toward producing conductive inks and polymer-based ICs. What sets Cabot's printable conductive materials apart is the use of nanoparticle silver (see [Making Inks for Printable Tags](#)), which is suspended in an ink that is printed and then heated to a temperature between 100 and 150 degrees Celsius. This sinters the silver particles to form an extremely conductive ink. Unlike Cabot's, many conductive inks use a binder to link conductive flakes, but this binder lowers the overall conductivity.

Regardless of advances in materials, the development of printed antennas and chips for RFID applications is going to require collaboration among the types of companies and innovators who attended the IMI conference.

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