Creating a memory device out of paper

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(PhysOrg.com) -- As technology continues to shrink, and as memory needs become more demanding, the industry dealing with microelectronics requires devices that are cost-efficient and lightweight. And, while organic materials have shown some promise, they still lack some of the essential qualities needed for application in a wide variety of fields. “The longest time that has lasted from organic memories,” Rodrigo Martins tells *PhysOrg.com*, “is about 5,000 seconds. This just doesn’t allow for practical use in many cases as a memory device.”

Martins, a scientist at the New University of Lisbon in Portugal, continues: “What we have shown is that it is possible to store information on paper, electronically, for more than a year and a half.” Martins is part of a team that includes Pedro Barquinha, Luís Pereira, Nuno Carreia, Gonçalo Gonçalves, Isabel Ferreira and Elvira Fortunato. The group has demonstrated memory performance using a field-effect transistor built on paper. Their work is published in *Applied Physics Letters*: “Write-erase and read paper memory transistor.”

“What we are doing is exploiting the memory effect,” Martins explains. “We have a sort of type of integrated foam composed of fibers set up that increases the capability of storing carriers – or charges – in our paper.” These charges allow the paper to display information that is also erasable – and the paper is rewritable so that additional information can be added.

One of the attractive features of this memory paper is that it is produced at room temperature, meaning that it does not need special conditions

for its manufacture. To create the paper, long fibers from pine and polyester were mixed together and put into an ionic resin matrix. The fibers were then coated with gallium indium zinc oxide, using magnetron sputtering. “We have integrated discrete fibers, and contacts are applied on the extremes of the channel region to allow the induced carriers to move,” Martins says. “Electrons move along the fibers.”

Martins points out that another of the attractive features of this paper is its ability to hold multiple layers of information. “If I want my paper to catch information,” he explains, “I can apply a signal of, say, five volts. And it writes on the paper. If I want to erase the information, I basically apply minus five volts – the opposite. But, at the same time, I can write another layer of information using 10 volts. The paper can distinguish between the two, and even if I erase the five volt information, the 10 volt information remains.”

The main applications that Martins sees for this work right now involve product information for merchandise. “You can have multiple layers of information on a product label,” he says. “Instead of just the expiring date, you can have more than this, including information about when it went on the shelves.” However, Martins also sees the potential for this paper’s use in books. “You can create a display, bringing a new dimension to the paper,” he says. “You push a button and it changes. You can see a static or dynamic picture, or even another page.”

“Such technology,” he cautions, “is still some years away. It will take five or six years to really work out how to use this technology to such an effect. But we do know that paper can store a great deal of information. We have the paper transistor; we have the memory. We have everything we need to make this happen.”

More Information: Rodrigo Martins, Pedro Barquinha, Luís Pereira, Nuno Correia, Gonçalo Gonçalves, Isabel Ferreira, and Elvira Fortunato.

"Write-erase and read paper memory transistor," *Applied Physics Letters* (2008). Available online: link.aip.org/link/?APPLAB/93/203501/1 .