Could a paper transistor offer an alternative to silicon?

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(PhysOrg.com) -- As technology advances, scientists look for ways to enhance electronic applications and devices. Indeed, electronics are getting smaller and more diverse. And as this happens, there is an increased requirement for flexibility in transistors, which make the electronic devices we desire work. Unfortunately, silicon and polymers may not fulfill the requirements needed to advance on to the transistors of the future.

“The problem with silicon is that it is toxic and brittle,” Jaehwan Kim tells *PhysOrg.com*. “An increase in transistors from polymers can solve the problem of brittleness, but many of these polymers are also toxic for humans, and they can also produce a lot of pollution in their manufacture.”

Kim is a scientist at INHA University in South Korea. Along with Sungryul Yun, Sang-Dong Jang, Gyu-Young Yun and Joo-Hyung Kim, Kim has been studying a way to develop a transistor that is more environmentally friendly and fulfills the requirements of flexibility and usability in the advancement of electronic devices. “What we have found,” he says, “is that it is possible to make a transistor out of a special kind of cellulose paper.” The results of the team’s efforts are available in *Applied Physics Letters*: “Paper transistor made with covalently bonded multiwalled carbon nanotube and cellulose.”

“This cellulose paper is flexible and more environmentally friendly,” Kim explains. “We modified the cellulose paper so that it has the

properties of a transistor. We added carbon nanontube to improve the electrical property of the cellulose, since a transistor should be a semiconductor. We fabricated this transistor, tested it, and found that it worked."

The South Korean team had to deposit electrodes on the top and the bottom of the transistor in order to produce the proper electric field. "This is a very unique feature," Kim points out. "This is quite challenging technology, putting electrodes and wires on this paper, and using nanotubes as part of the transistor. You can see why there are challenges ahead to fully implementing this."

Even though this is a good first step, Kim realizes that there is much yet to be done before mass production of this type of transistor can move forward. "First of all, we have to fully understand why this material offers such an interesting phenomenon. We will also need to improve its performance. While it works, the transistor could have better performance, and we will need to work on enhancing it."

He continues: "We need to study the mechanics of the paper, and figure out how it can be mass-produced. Our lab can't start mass production, and we will have to develop a system that can capture the unique process required to make these transistors."

However, Kim is hopeful that answers can be found. "We have been working on this for about six years, and are pleased with the progress made so far. While this technology won't be made fully available to us immediately, we are still making the first steps to having transistors that are flexible, biocompatible and more sustainable for the environment."

More information:

• Visit CRI EAPap from INHA University.

• Sungryul Yun, et. al., “Paper transistor made with covalently bonded multiwalled carbon nanotube and cellulose,” *Applied Physics Letters* (2009). Available online: http://link.aip.org/link/?APPLAB/95/104102/1.