DiscoveryNews

Ultra-Thin Electronics Bend to Your Eyes

Very thin, flexible carbon-based electronics can become any shape, anywhere.

By Jesse Emspak | Tue Nov 22, 2011 07:00 AM ET

Remote-controlled insect armies and better artificial retinas are just a few of the possibilities for new flexible, ultra-thin sensors made of carbon.

A new way of creating carbon-based electronics is making it easier to build such super-thin sensors by reducing the number of steps in the process and getting better control of the shapes the carbon takes.

BLOG: Bulletproof Skin Made From Spider Silk

Researchers at the Ulsan National Institute of Science and Technology and Harvard published their work in the most recent *Nature Materials*.

They say their circuits could also be used in smart windows that detect pressure and curvature, and could tell you when they need to be replaced.

An array of the sensors floating on water could test for contaminants. Attached to the back of an insect, they might be used to control the insect or to see what conditions they thrive in. Sensors implanted in the body or on the skin could transmit vital signs without patients having to carry any equipment or remain on a gurney. Other uses might be for radio frequency identification tags, which would no longer be limited by the shape of chips made of silicon.

Producing carbon-based electronics has always been difficult because it's hard to control the way the carbon layers form. The usual method is to use a carbon vapor at a high temperature that settles on to a substrate. But the carbon atoms don't always cooperate to form uniform sheets or patterns.

BLOG: Cooling Down Electronics With Graphene

In this case, the circuit pattern was laid down using metals, around which carbon atoms coalesced, like a scaffold. By used a combination of different metals, the team was able to get graphene to form in some areas and graphite in others, creating an all-carbon circuit in one step. The metals were washed away chemically, leaving just the carbon scaffold.

Graphene is a form of carbon in which the atoms are all arranged in a regular lattice, like chicken wire. When graphene layers are stacked on top of one another the lattices are aligned. Graphite is structured in a similar way, except the chicken-wire lattices are shifted, first to one side and then the other.

"It can be certainly pronounced as a nice progress in graphene-based flexible electronics," said Swastik Kar, assistant professor of physics at Northeastern University whose work also focuses on graphene-based systems.

"A simple technique ... that simultaneously allows the integration of different elements of graphene-based circuits (both active and passive) to be mounted on flexible matrices."

SungWoo Nam, now at the University of Caifornia, Berkeley, and

Jang-Un Park, of UNIST, were the lead authors of the research paper.

BLOG: Graphene and Buckyballs Might Be Lurking In Space

The graphene, Nam said, functions like a semiconductor, and the graphite is the conductor. Ordinarily the conducting material is metal, which is fine most of the time, but isn't very flexible. The reason is that the metal and graphene react to stress differently, so one breaks before the other does and the circuit fails.

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"When we tried to use it for more flexible electronics, we found the interface between metal and graphene is its weakest point," he said.

Graphite isn't all that flexible either in ordinary usage -- pencil leads, after all, feel stiff -- but when it is only a few nanometers thick, that changes. Just as a thin piece of metal bends more easily than a thick one, thin graphite bends when it is only a few atoms thick. Getting the two forms of carbon to bend is important for building electronics that mold to a curved surface.

Another property of the thin carbon is transparency. The team put the circuits on a contact lens, which is a step toward applications such as artificial retinas. Park said they are experimenting with making an eye-safe lens. “We are doing in-vivo experiments ... as the next project,” he said.