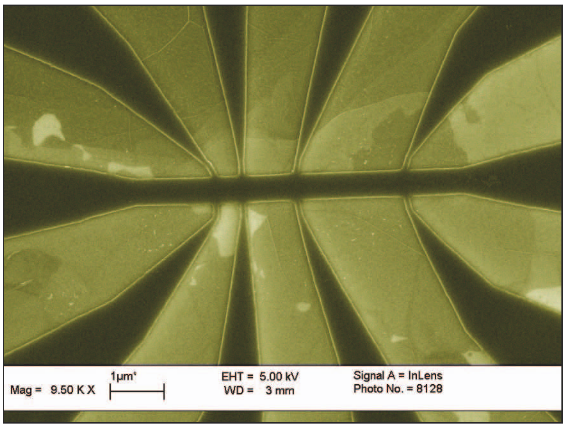
ACADEMIC

Emerging Technologies

Circuits with wavelike electrons

Researchers at the Georgia Institute of Technology, Atlanta, led by Walt de Heer, have discovered some surprising properties of electrons in circuitry made from ultrathin layers of graphite, known as graphene. These findings suggest that the material could provide the foundation of nanometer-scale devices that manipulate electrons as waves.



Developers: Researchers at Georgia Tech.

What's new: Circuitry made from graphene with electron transport properties comparable to carbon nanotubes.

How it works: Narrow ribbons of graphene are lithographically formed into circuits.

Applications: Graphene-based electronics that manipulate electrons as waves.

Web site: www.gatech.edu

Challenging carbon nanotubes

Because carbon nanotubes conduct electricity with virtually no resistance, they have attracted strong interest for use in transistors and other electronic devices. However, the discrete nature of nanotubes, and variability in their properties, pose significant obstacles to their use in practical devices. By contrast, continuous graphene circuitry can be produced using conventional microelectronics processing techniques.

"We have shown that we can make the graphene material, that we can pattern it, and that its transport properties are very good," explains de Heer. "The material has high electron mobility, which means electrons can move through it without much scattering or resistance. It is also coherent, which means electrons move through the graphene much like light travels through waveguides." But beyond this mobility and coherence, the researchers noted that the speed of electrons through the graphene is independent of energy, just like light waves.

"Nanotubes are simply graphene that has been rolled into a cylindrical shape," de Heer explains. "Using narrow ribbons of graphene, we can get all the properties of nanotubes because the properties are due to the graphene and the confinement of the electrons, not the nanotube structures."

The key to the properties of the new circuitry is the width of the graphene ribbons, which confine the electrons in a quantum effect similar to that seen in carbon nanotubes. The width of the ribbon controls the material's band-gap.

These results should encourage further development of graphene-based electronics, though de Heer cautions that practical devices may be a decade away. Among the challenges ahead is improving the technique for patterning the graphene, since electron transport is affected by the smoothness of edges in the circuitry.

"This is really the first step in a very long path," says de Heer. "We are at the proof-of-principle stage, comparable to where transistors were in the late 1940s. I believe this technology will advance rapidly."

Herding lenses with magnets

Researchers at Duke Univ., Durham, N.C., have used magnetic ferrofluids to precisely align tiny lenses. The Duke team manipulated ferrofluids by using a network of underlying magnetic "traps" or by moving the particles from one trap to another via interactions with additional imposed magnetic fields. They then used the magnetically-directed ferrofluids to shepherd around non-magnetic latex beads which acted as lenses to focus light to tiny dots which could be chemically etched away to create a pattern of tiny holes.

>>More info: www.duke.edu

Creating DNA origami

DNA strands can be weaved into any desired 2-D shape or figure using a method created by Paul Rothemund at the California Institute of Technology (Caltech), Pasadena. In this new method, long single strands of DNA can be folded back and forth to form a scaffold that fills up the outline of any desired shape. To hold the scaffold in place, 200 or more DNA strands are designed to bond the scaffold and staple it together. Each of the short DNA strands can act like a pixel in a computer image, resulting in a shape that can bear a complex pattern, such as words or images.

>>More info: www.caltech.edu

Controlling silicon strain

A method to release thin membranes of semiconductors from substrates and transfer them to new surfaces while retaining all the properties of silicon in wafer form has been created by researchers at the Univ. of Wisconsin, Madison. The technique used to create these flexible nanomembranes stretches them in a predictable and easily controlled manner, which makes tuning the strain of the materials extremely manageable while avoiding the defects that normally result.

>>More info: www.wisc.edu