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TECHNOLOGY UPDATE

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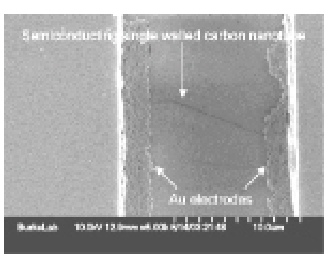
Nanotube transistors speed up

Engineers in the US have made the first high-speed transistor from a carbon nanotube. Peter Burke and colleagues at the University of California at Irvine showed that their device - which consists of a single-walled carbon nanotube sandwiched between two gold electrodes - operates at extremely fast microwave frequencies. The result is an important step in the effort to develop nanoelectronic components that could be used to replace silicon in a range of electronic applications (S Li *et al.* 2004 *Nano Lett.* 4 753).

The feature sizes in conventional microelectronic circuits are getting smaller and smaller and look set to reach the limit imposed by the fundamental properties of silicon in a decade or so. The semiconducting properties of carbon nanotubes - rolled up sheets of graphite just nanometres in diameter - make them a promising alternative to silicon, and nanotubes have already been used to fabricate a variety of electronic components, including diodes and field-effect transistors.

Conventional transistors have three terminals: the source, drain and gate electrodes. The gate controls the electron density in the central region of the transistor, which is usually made of a semiconducting material. If the electron density is high, current flows from the source to the drain. However, current does not flow if the electron density is low. This property allows the transistor to operate as a switch.



(http://images.iop.org/objects/ntw/news/3/4/18/burke.jpg)

High-speed nanotransistor (http://images.iop.org/objects/ntw/news/3/4/18/burke.jpg)

Burke and colleagues made their transistor by sandwiching a semiconducting single-walled nanotube between source and drain electrodes made of gold (see figure). When they varied the gate voltage in the device, they found that the circuit operated at 2.6 gigahertz (2.6 x 10^9 Hertz). This means that current can be switched on and off in about 0.1 nanoseconds, making it the fastest nanotube transistor made to date.

At present, the device only works at 4 Kelvin but Burke is confident that it can be made to operate at room temperature. Moreover, he believes that the transistor could be made to switch at even higher frequencies. "I estimate that the theoretical speed limit for these transistors should be terahertz (10^{12} Hertz)," he said. "This is about 1000 times faster than modern computer speeds."

About the author

Belle Dumé is science writer at *PhysicsWeb*.