Science & Technology

# See You, Silicon

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**Columbia researchers** achieved major breakthroughs recently in developing tiny cylindrical pieces of carbon, known as nanotubes, as electronic circuits, which could have applications for building faster and smaller computers and also for creating new environmental sensors. Carbon nanotubes are elongated organic threads much smaller than the silicon transistors in today's computer chips, and yet they are extremely strong and pliable. Most importantly, some nanotubes are natural semiconductors, so they can be made to act as transistors, that is, tiny switches that turn on and off the flow of electric current.

Back in January, Colin Nuckolls '98GSAS, an associate professor of organic chemistry, coauthored a paper in Science that demonstrated how carbon nanotubes could link in stable arrangements to single organic molecules. The resulting molecular bridge could operate as an electronic switch when its pH is altered by adding a proton to it. Scientists and engineers working in this area of nanotechnology previously had been unable to achieve stable electronic connections between carbon nanotubes and other molecules. Nuckolls's research team used a lithographic technique called oxidative cutting to slice open a nanotube, whose ends were the same size as a single organic molecule and proved chemically receptive to it.

And in a forthcoming article in the Proceedings of the National Academy of Sciences, Nuckolls's research team describes how a similarly constructed transistor can sense and respond to its chemical environment. New types of molecular sensors based on the technology could be used to detect cancer cells in the body, for example, or identify biotoxins in the atmosphere.

"Molecular electronics has real-world relevance," says Nuckolls. "It opens the door to new types of ultrasmall switches and sensors. We are able to form a bridge, both literally and figuratively, by combining reaction chemistry with ultrafine lithography."

Nuckolls’s collaborators include Philip Kim, an assistant professor of physics, and Jim Hone, an assistant professor of mechanical engineering.



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