Mauro Ferrari, professor of internal medicine at the University of Texas Health Science Center-Houston, believes that the new approach is very exciting. ''If successful, it would completely revolutionize the way coronary artery disease is treated, and probably several other vascular disorders'', he says.

The researchers are now looking to collaborate with Mount Sinai Medical Center in New York on large animal studies over the next 2—3 years, which if promising could pave the way for clinical trials in human patients.

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Boron nitride nanotubes grown just like carbon nanotubes

Cordelia Sealy

Boron nitride nanotubes (BNNTs) have extraordinary mechanical properties ideal as reinforcements in composites and offer the possibility of a tunable band gap for electronic applications. But synthesizing BNNTs has proven difficult, with current methods requiring high temperatures, specialized instrumentation and producing nanotubes of low quality contaminated with impurities.

Now researchers from Michigan Technological University believe they have changed all this using an approach that makes the growth of BNNTs as simple and convenient as carbon nanotubes [C.H. Lee et al., Chem. Mater. (2009), doi:10.1021/cm903287u]. Using catalytic chemical vapor deposition (CCVD) at 1200 °C with MgO, Ni or Fe catalysts, Yoke Khin Yap and his team have achieved patterned growth of BNNTs directly on Si substrates for the first time (Fig. 1).

The researchers use a conventional resistive furnace, but with two key features. First, a growth vapor trapping (GVD) approach is crucial, where a closed-end inner quartz tube inside the furnace spatially traps the growth vapors. The second key aspect of the process is using one of the catalysts identified by the researchers, but with an Al_2O_3 under layer to prevent cross-reactions between the catalysts and the Si substrate. The technique produces up to several milligrams of high-quality, nearly vertically aligned BNNTs in predefined locations.

''Our technique makes the growth of BNNTs just as convenient as growing CNTs and nanowires,'' says Yoke Khin Yap.

The researchers hope that the new technique will encourage new research into BNNTs and their potential

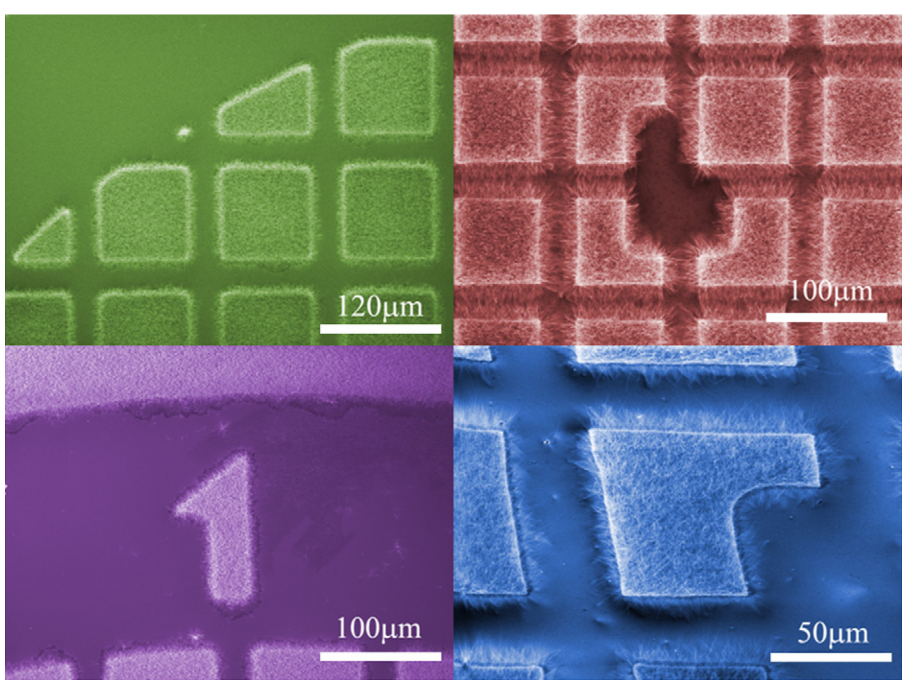

Figure 1 Artificially colored scanning electron micrographs of well-defined patterned growth of BNNTs on a substrate. (Reproduced with permission from C.H. Lee et al., Chem. Mater. (2009), doi:10.1021/cm903287u. ©American Chemical Society 2010.)

applications. Even this first step has led to the discovery that arrays of the nanotubes, which are typically 60 nm in diameter and 10 μm in length, display superhydrophobicity—a property that could find use a as transparent, self-cleaning anti-corrosive layer.

The nanotubes can also be removed from the substrate by scratching or extracted into suspension, and show a 6 eV bandgap, confirming their perfect insulating nature. But Yoke Khin Yap believes the next stage of development could be even more exciting.

''Doping of BNNTs will now come in,'' he told *Nano Today*, ''enabling the production of functional BNNTs for electronic devices.''

Gianni Ciofani of the Italian Institute of Technology at the Scuola Superiore Sant'Anna, Italy agrees that this is where the most exciting implications of the work lie.

''I strongly believe that the possibility of obtaining well-defined patterns of highly pure BNNTs opens important and exciting perspectives in the field that could range from sensors and transducers for biomolecule detection up to 'sensible' substrates for tissue engineering,'' he says.

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IBM demonstrates band gap and high on/off current in graphene FETs

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IBM researchers have demonstrated graphene-based field-effect transistors (FETs) with an on/off current ratio a factor of 25 times higher than reported previously at room temperature and a band gap [F. Xia et al., Nano Lett. (2010), doi:10.1021/nl9039636].

Graphene has outstanding electrical, mechanical and thermal properties that have made it an attractive option for future nanoscale electronics. However, its use in electronics based on electric field induced current switching is limited because it does not have a band gap.

Phaedon Avouris and his team at IBM's Thomas J. Watson Research Center believe they may have changed all that. They have used bilayer graphene, where two single-atom thick layers of graphene are stacked on top of each other, to create FETs that exhibit an on/off current ratio of 100 at room temperature and 2000 at 20 K (Fig. 1). Furthermore, the researchers also demonstrate that, as predicted, when a perpendicular electric field is applied to the bilayer graphene, a band gap of 130 meV opens up.

''These results open up the possibilities that further enhancements may allow graphene to be used not only in high frequency analog electronics, as we have demonstrated already, but also in digital electronics such as logic circuitry,'' says Avouris.

A key element of the device is the separation of the graphene from the gate oxide insulator with a thin polymer film. This allows the high electric fields necessary to create a band gap to be applied without degrading the effect of the oxide on the electrical properties of the graphene, explains Avouris.

There is a long way to go before the devices are optimized, he admits. The team is now looking at reducing the thickness of the insulating layers and improving their quality to allow the use of higher fields. Avouris suggests that the purity of the graphene could also be improved to achieve higher on/off ratios.

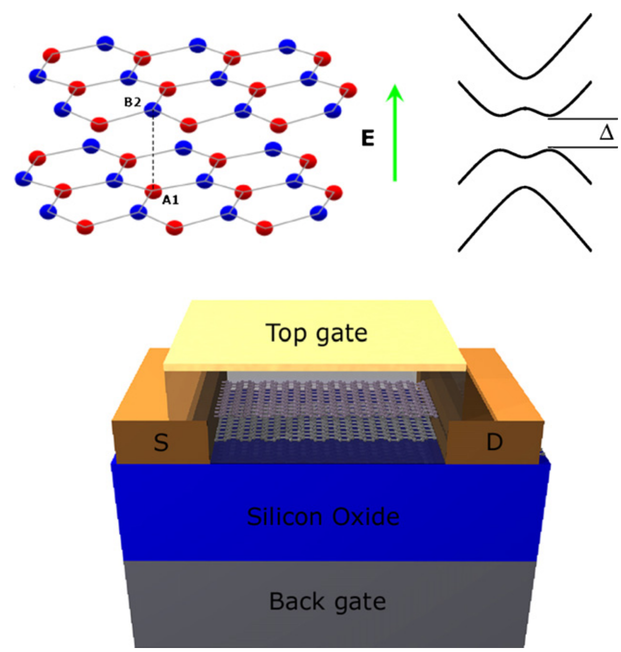

Figure 1 Bilayer graphene FETs schematic and band gap diagram.

The results are ''a milestone in the development of high-speed electronics based on nanoscale carbon,'' says Joshua Robinson of Pennsylvania State University. ''This work is a step in the right direction and indicates there is significant promise toward achieving the required on/off ratios for many next generation electronic devices,'' he told *Nano Today*.

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