approach to selectively metallize only the P2VP domains. An acid treatment leaves the P2VP cylinders with a net positive charge, which subsequently attracts negatively charged metal-containing anions when the film is immersed in a metal salt solution. The resulting metal complexes are reduced to form metallic wires by an oxygen plasma treatment that also removes all organic material from the substrate.

The power of this technique lies in its simplicity and versatility — combining a graphoepitaxy polymer assembly approach with a second electrostatic assembly step results in arrays of ~10-nm-wide wires, relying only on solution-based techniques. Although the resulting material quality is largely unexplored, an important first step has been taken in characterizing the resistivity of the nanowires and correlating their electrical properties with their physical dimensions. Arrays of gold, platinum and palladium nanowires have been produced, and opportunities clearly exist for a wide variety of material choices. It is not hard to imagine the technique soon being extended to technologically relevant materials such as magnetic alloys and semiconductor industry favourites such as silicon, tungsten, aluminium and copper.

With no technology solution presently available to meet the requirements of the ITRS roadmap for manufacturing devices with feature sizes of 15 nm in 2016 (termed the 22-nm technology node), polymer self-assembly has emerged as a legitimate patterning option. Although this technique is capable of producing such small feature sizes, there remain many other difficult targets and fundamental questions relating to edge roughness (which needs to be less than 1.2 nm) and defects. An exciting aspect of this approach to making inorganic nanowire structures, however, is its versatility. Although the deposited wire material may or may not have sufficient electronic quality for microelectronics applications, one could imagine using the deposited material as a structural element during circuit fabrication — for example, as a mask material for subsequent etch processes.

There may well be other applications for this flexible fabrication technique outside of the demanding semiconductor industry. Buriak and co-workers have presented a wet chemical method for producing sub-20-nm electronically active elements using only micrometre-scale lithography and self-assembly methods. Low-cost sensor devices are an obvious application that would benefit from this fabrication technique. The clear advance of this work comes in demonstrating a low-overhead self-assembly-based metallization approach to accompany a straightforward self-assembly-based high-resolution patterning method. The combination of these two manufacturing-friendly techniques is an enticing prospect for nanotechnology.

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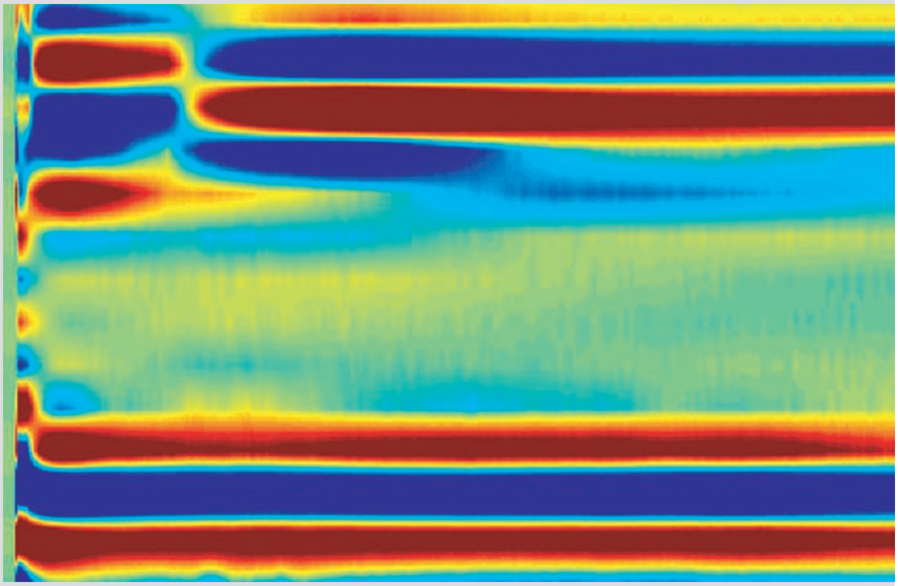
CARBON NANOFIBRES

On the brain



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Whereas many nanoscientists look to nature for inspiration, other researchers rely on nanotechnology to tell them more about natural systems. An example of this is the use of arrays of ultrafine electrodes to explore how electrical signals move along neurons, as demonstrated in this image of the electrical activity in a slice of rat brain recorded by Barclay Morrison III and colleagues at Columbia University and the Oak Ridge National Laboratory (Yu, Z. *et al. Nano Lett.* doi:10.1021/nl070291a; 2007).

Morrison and co-workers started by preparing an array of 40 electrodes — each made of vertically aligned carbon nanofibres — on a silicon wafer using standard fabrication techniques. The array was then cleaned and coated with proteins to make the surface compatible with neural cells. The brain slice, bathed in artificial cerebrospinal fluid, was placed on the array and the spontaneous electrical activity was recorded. The array was also able to detect responses when a constant current was applied to evoke a response, or when chemicals were added to induce epileptic activity.

The image above shows the electrical activity measured at different positions along the array (vertical axis) as a function of time (horizontal axis) in response to electrical stimuli being applied to two of the electrodes. Electrical activity is shown in units of mV mm^{-2} (red for positive values, blue for negative).

This new tool might allow researchers to record multiple electrical signals simultaneously with high spatial resolution, and improve our understanding of the complex neuronal circuitry in the nervous system.

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