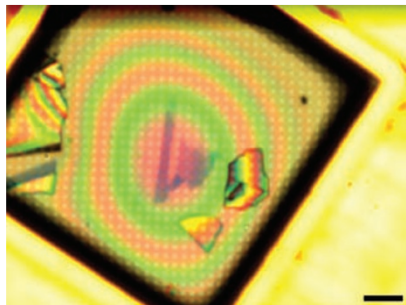


The structures remain stable over a wide temperature range, suggesting they are suitable for a variety of applications. Moreover, the alloys were tested in cooling devices and it was found that they performed significantly better than commercially available materials.

GRAPHENE

Keep it simple



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Appl. Phys. Lett. **92**, 123110 (2008)

Potential applications of graphene — a single layer of carbon atoms — in nanoelectronics are limited by the lack of simple procedures for producing freestanding membranes and fabricating nanoscale structures on them. Now Jannik Meyer and colleagues at Berkeley have developed a straightforward way to overcome these problems by using electron beam induced deposition (EBID) of carbon to fabricate periodic patterns on free-standing graphene.

The Berkeley team started by making graphene flakes by repeated peeling of pyrolytic graphite — the ‘scotch-tape method’ — and then demonstrated three different methods for transferring the graphene to a commercial grid for electron microscopy. All three methods rely on the addition of a drop of isopropanol, which then evaporates to pull the grid so that it makes good contact with the graphene.

The samples were then inserted into a transmission electron microscope and patterns of carbon were directly deposited by EBID, the smallest pattern being an array of dots with a spacing of 5 nm.

MOLECULAR ELECTRONICS

Shedding new light

J. Am. Chem. Soc. **130**, 5016–5017 (2008)

Two issues are important in the design of organic molecular electronic devices — how the donor and acceptor modules are built into the molecule and how the molecules are oriented on the electrode. Flexible

molecules are traditionally used in molecular electronics experiments, but this means that little is known about the detailed relationship between molecular structure and device performance. Now Yutaka Matsuo, Eiichi Nakamura and colleagues at the Japan Science and Technology Agency have synthesized rigid fullerene-based molecules that allow them to study such relationships.

The molecules had five anchoring legs and a cavity that can accommodate various organic or metallic groups with minimal change to the overall shape, which made it possible to systematically change the donor molecule and study the effect on performance. By changing the lengths of the anchoring legs they could also investigate the effects of different orientations of the molecule with respect to the surface.

The molecules were then deposited as self-assembled monolayers on an indium/tin oxide surface and exhibited respectable quantum yields for photocurrent generation when illuminated. More importantly, it was also shown that the molecular structure and orientation has an effect on the direction of current.

NANOELECTRONICS

Logical progression

Appl. Phys. Lett. **92**, 093101 (2008)

The ability to manipulate single electrons represents the ultimate miniaturization of electronics. Researchers have already built transistors that rely on the quantum tunnelling of single electrons for their operation. Now Jung Choi and co-workers at Chungbuk National University and Hokkaido University have demonstrated two multi-valued logic gates based on single-electron transistors (SETs) that could be used in fast arithmetic circuits.

Choi and co-workers used electron-beam lithography to make silicon SETs that were less than 100 nm in size. The logic gates were formed by combining two such devices with a field-effect transistor, so that the two input voltages to the SETs acted as the two binary inputs to the logic gates. When the SETs were aligned in series, the circuit functioned as a NAND (‘not and’). Connecting them in parallel resulted in a NOR gate.

Moreover, the researchers noticed that when they adjusted the size of the binary input voltages they could make the NAND gate to behave as an OR gate, and similarly make the NOR gate behave as an AND gate. This functionality is unique to SETs, making them potentially more flexible for logic circuits than traditional metal oxide semiconductor transistors.

TOP DOWN BOTTOM UP

Ivy league

A phenomenon that interested Charles Darwin has led to bioengineers and chemists working together.

Mingjun Zhang, a professor of bioengineering and robotics at the University of Tennessee, was playing with his son one afternoon when he noticed some ivy climbing over the fence in his backyard. Curious about the climbing mechanism, and the yellowish material secreted by the ivy, Zhang pored through the literature and found just one publication on the subject — a book by none other than Charles Darwin in 1876. He then got three former colleagues from Agilent Technologies interested in the problem and they decided to look at ivy in more detail.

The team started by allowing ivy branches to climb up silicon and mica wafers in their lab for a week. Harry Prest and Steve Fisher, who are chemists at Agilent Labs in California, then isolated and analysed the yellow secretion using chromatography, while Maozi Liu imaged it with an atomic force microscope. To their surprise, they found that the ivy secreted a large number of nanoparticles with diameters of about 70 nm. Chemical analysis revealed the presence of a large number of different compounds, but Zhang and co-workers were able to show that oxygen, nitrogen and sulphur — elements widely known for their ability to form hydrogen bonds — featured strongly (*Nano Lett.* doi:10.1021/nl0725704; 2008). The team concluded that hydrogen bonding and weak adhesion (due to the presence of tiny ‘fingers’ in the rootlets of the ivy) made it possible for the ivy to climb. Besides providing inspiration for Zhang in his work as an engineer, the work might also lead to new ways of making eco-friendly nanoparticles.

“It is not difficult to start an interdisciplinary collaboration because most people will be interested,” says Zhang. “The problem is that most of the preliminary work is not funded, so we must work around our main research schedule and consider it an investment.”

The definitive versions of these Research Highlights first appeared on the *Nature Nanotechnology* website, along with other articles that will not appear in print. If citing these articles, please refer to the web version.