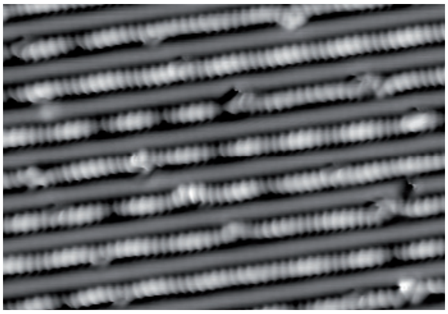
ALKANE POLYMERIZATION

Surface control

Science **334,** 213–216 (2011)



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Alkanes are a major constituent of natural gas and petroleum, but are one of the least chemically reactive classes of organic compounds. As a result, it can be difficult to convert them directly into more useful chemicals in a controlled manner. Gerhard Erker, Harald Fuchs, Lifeng Chi and colleagues at the University of Münster have now shown that a gold surface can be used to carry out precise polymerization reactions of linear alkanes.

Long-chain alkanes that contained more than 20 carbon atoms were adsorbed on a gold(110) surface and imaged with a scanning tunnelling microscope. On heating to around 440 K, the surface reconstructs to form 1.22-nm-wide grooves that constrain the alkane molecules to one-dimensional paths. Moreover, after cooling the surface back down to 78 K, the alkane molecules were found to have bound end-to-end, forming linear molecular chains within the channels (see image; the bright lines correspond to the polymer chains and the dark spots in the chains are due to underlying gold vacancies rather than breaks in the polymer).

In this thermally activated polymerization process, hydrogen atoms on terminal methyl groups dissociate and desorb from the surface. C–C coupling can then occur between the terminal carbon atoms of neighbouring molecules. The Münster team also show that dehydrogenative C–C coupling can occur between the terminal carbon atom of one molecule and the penultimate carbon atom of a neighbouring molecule. *OV*

PERIODIC NANOSTRUCTURES

A searchable database

Small http://dx.doi.org/10.1002/smll201100681 (2011)

Periodic nanostructures have applications in areas such as photonic crystals, data storage devices, tissue engineering and biosensors. As new forms of these materials continue to emerge, there is a need for a system that can classify, store, process and analyse these functional structures. Lin Jia of MIT and Edwin Thomas of Rice University have now proposed a searchable database system that connects the morphologies, fabrication technologies and physical properties of various two- and three-dimensional periodic structures.

Representing a periodic structure by its unit-cell function can take up huge amounts of storage space in a database. Therefore, Jia and Thomas represent a periodic structure by its Fourier components and categorize the structure in a tree format according to their symmetries using the 7 crystal systems, 32 point groups and 230 space groups common in crystallography. Every structure inside the database has a name, which consists of the structure's symmetry, plane (two-dimensional) or space (three-dimensional) group, and physical properties. The database, which will contain a library of various two- and three-dimensional periodic structures, and their corresponding fabrication techniques and parameters, is intended to help design structures with unusual properties. The user inputs a target structure and an automated programme extracts the Fourier coefficients of the target and compares it with structures in the database to output the most similar structure along with their corresponding fabrication parameters.

For such a database to be useful, it will require a large number of structures fabricated from various technologies and worldwide cooperation. *ALC*

LITHOGRAPHY

Written with neon beams

Nano Lett. **11,** 4343–4347 (2011)

The two most important figures of merit for particle-beam lithography are the resolution and the exposure efficiency. Electron-beam lithography allows structures with features as small as 9 nm to be fabricated, but it is proving difficult to reduce this resolution further, which is why researchers are exploring the use of ions. Now researchers at MIT and Carl Zeiss NTS have demonstrated the potential of neon ion beams for lithography.

Karl Berggren and co-workers explored how lithographic performance was influenced by three factors: the spot size of the ion beam; the volume of the interaction between the beam and the lithographic resist; and the rate at which energy is deposited by the ions as they travel through the resist material — a factor known as the stopping power.

The MIT–Carl Zeiss researchers modified a commercial helium ion microscope so that it could deliver a neon ion beam with an energy of 20 keV, and they used this beam to make gratings with line widths of just 7 nm on a silicon surface. The resist was a 16-nm-thick layer of hydrogen silsesquioxane. Moreover, they showed that the exposure efficiency was about 1,000 times better than that achieved with 30 keV electrons. *PR*

NON-VOLATILE MEMORIES

Better together

Appl. Phys. Lett. **99,** 152105 (2011)

Magnetoresistance and phase change are two rival approaches to non-volatile memory, and have been developed largely independently of one another. Now, Alexander Kolobov and colleagues at the Japanese National Institute of Advanced Industrial Science and Technology and the Japan Synchrotron Radiation Research Institute have identified a system in which the two effects are intimately linked.

Magnetic random access memory exemplifies the magnetoresistive approach, and consists of two ferromagnetic contacts separated by a tunnel barrier. A magnetic field manipulates the alignment of the contacts, which leads to high or low resistance states. Phase-change memories, on the other hand, typically achieve switching by using current-induced Joule heating to alter the bulk structure of a conductor.

Kolobov and colleagues focused on interfacial phase-change memories, in which a solid–solid phase transition occurs at the interfaces (rather than the bulk) of a layered structure. Although the structure they chose is made of non-magnetic materials, certain alloys of these materials are topological insulators, which have conductive surface states that are sensitive to a magnetic field.

The researchers found that a magnetic field applied to their memory shifted its switching voltage and current–voltage slope. It was also capable of changing the behaviour of the device, from a memory cell to a threshold switch that is not hysteretic. The observation of combined magnetoresistive and phase-change effects may lead to the development of memories that combine the benefits of each technology. *MS*

Written by Ai Lin Chun, Peter Rodgers, Michael Segal and Owain Vaughan.