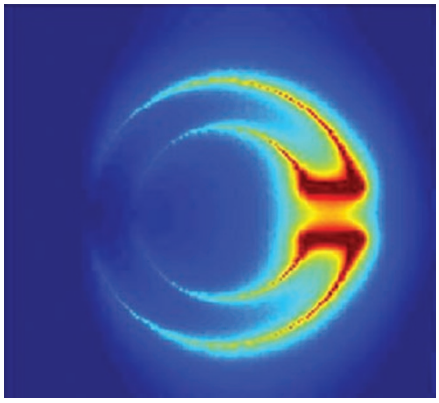
gold — have a number of uses in fields ranging from catalysis to optics. Whether or not the metal nanoparticles are perfect crystals is an important consideration in these applications, but this property is often difficult to control during synthesis.

To tackle this problem, Yun Tang and Min Ouyang at the University of Maryland in the US took advantage of the fact that the chemical reactivity of a surface depends on its crystal structure. Thus, in a particular chemical environment, certain crystal faces are formed in preference to others and, in principle, one 'crystallite' will dominate. It is found that if the nanoparticles are made from silver-based complexes that contain nitrates, they comprise multiple crystallites. If the complexes contain chloride ions, however, perfectly crystalline nanoparticles can be synthesized — at least under certain conditions. Apparently, the chloride ions act as strong etchants whenever a boundary forms between two distinct crystallites, therefore favouring single-crystal growth.

Tang and Ouyang find significant differences in the reactivity and optical properties of single-crystal and polycrystalline silver particles. Moreover, the tunable crystallinity can be used to test theories in fundamental physics and chemistry.

OPTICAL PROPERTIES

Golden crescent



Appl. Phys. Lett. **91,** 093109 (2007)

The collective excitations of electrons, known as plasmons, are particularly strong on the surface of metal nanoparticles. In particular, gold and silver nanoparticles tend to be intense absorbers and scatterers of the ultraviolet light that excites these plasmons — an optical property that could be exploited for numerous applications provided the wavelength of the absorption can be suitably tuned.

Now, Jon Cooper and colleagues at the University of Glasgow in Scotland show that visible-light plasmons can be excited in arrays of crescent-shaped gold nanostructures. Arrays of the structures, which are split rings about 75–135 nm in radius, were fabricated on glass slides using electron-beam lithography. The optical excitations were measured by polarization-dependent absorption spectroscopy using a linear film polarizer and an ultraviolet absorption spectrometer. The experimental results were compared with numerical calculations.

The excitation of plasmons in the split rings depended on the polarization of the incident light. Furthermore, rings with radii of less than 75 nm exhibited resonances in the visible portion of the spectrum, which is important for the detection of single biomolecules.

NANOCAPSULES

An inside job

J. Am. Chem. Soc. **129,** 10652–10653 (2007)

Enzymes, which are made up of amino acids, catalyse chemical transformations by providing a reaction pathway that is lower in energy than those through which they usually proceed. Critical to this ability are the presence of so-called active sites — well-defined pockets in the enzyme structure that bind substrates and subsequently mediate their conversion into products with a high degree of specificity. Making artificial enzyme mimics is not straightforward, but with a modular self-assembly process, researchers in Japan have made hollow nanocages with inner chiral cavities.

Makoto Fujita and co-workers have developed a strategy to make spherical nanostructures using palladium ions to link 24 bent organic building blocks (ligands) into a hollow cage approximately 4 nm in diameter. By attaching an amino acid or a short peptide chain to the concave side of the curved ligand, nanospheres are formed with internal cavities that are lined with these chiral groups. This robust assembly process is demonstrated for a range of amino-acid modified ligands, and these can be mixed together in one pot to produce a variety of spheres with different chiral cavities.

Although the mixed assembly process is statistical in nature, it is also reversible, which suggests that a template could be used to bias the system to favour just one (or a few) specific cavities. Ultimately, it is hoped that these nanospheres could be evolved to produce functional artificial enzyme pockets.

TOP DOWN BOTTOM UP

Going for growth

Researchers from a national laboratory in Japan have teamed up with a nearby company to mass-produce carbon nanotubes.

After discovering the 'supergrowth' method for producing single-walled carbon nanotubes last year, Kenji Hata of the AIST laboratory in Tsukuba, Japan, decided he wanted to "produce something that would last for decades". He concluded that mass production was the answer and contacted eight companies working on carbon nanotubes. Although interested in supergrowth, they were reluctant to abandon their existing approaches and Hata eventually formed a partnership with Zeon Corporation, a Tokyo-based company that specialized in manufacturing rubber and plastic materials but not nanotubes.

The standard method for growing single-walled nanotubes involves expensive silicon substrates, but the supergrowth approach uses a cheaper nickel alloy to achieve comparable purity and properties (*J. Am. Chem. Soc.* **128,** 13338; 2006). Hata and colleagues can now synthesize a 1-mm-thick layer of nanotubes on an A4-size foil in just ten minutes with the supergrowth technique. The next challenge is to get the production cost down to about $200–500 per kilogram. At present it costs around $100– 500 to buy just one gram of nanotubes.

"Because companies and national labs have different cultures, is it easy to have conflicts, but the most important thing is to have trust and a strong motivation", says Hata. "It is also important to understand the strengths and weaknesses of your material before attempting to mass produce. Our knowledge of nanotube synthesis, combined with our industrial partner's expertise in simulations, instrument design and chemistry, enabled us to develop large-area synthesis and economical catalyst systems."

The work has received $20 million from the government under the Carbon Nanotube Capacitor Project, and the team includes Junko Nakanishi, of the Center for Chemical Risk Management at AIST who is responsible for evaluating waste management and safety at the facility.

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.