**Nanoparticles with gradient structures**

The ability to manipulate the underlying template allows preparing gradient structures of nanoparticles with varying characteristics. The main advantage is that large numbers of structures can be combined on a single substrate for high-throughput processing.

A MATERIAL with a gradient of gold nanoparticles on a silica covered silicon surface using a molecular template has been created by American scientists.

The material developed at the North Carolina State University (NCSU) was tested at the National Synchrotron Light Source (NSLS) at the U.S. Department of Energy's Brookhaven National Laboratory and has been described in the journal *Langmuir*.

It provides evidence that nanoparticles — each about one thousand times smaller than the diameter of a human hair — can form a gradient of decreasing concentration along a surface.

To build the material, the scientists first prepared a very thin layer of organosilanes, sticky molecules with a head and a tail, on a rectangular surface of silica.

The head glues to the surface, while the tail sticks out, acting like a hook waiting for a gold nanoparticle to attach to it. The molecules, emitted vertically in the form of a vapour by a source close to one side of the surface, slowly fell on it with decreasing concentration as the distance from the source increased, thus creating a gradient to serve as a molecular template.

The next step was to dip the material in a solution containing the gold nanoparticles, each of which was coated with a negatively charged chemical. In the solution, the tails of the organosilane molecules took on a positive charge, so the negatively charged gold particles attached to the oppositely charged tails underneath.

To visualise the gradient of gold particles the research team used an atomic force microscope, in which a tiny needle moves along the surface, following its bumps and valleys to reveal its topography.

To look at the gradient of the organosilane molecules, the scientists used a technique called near-edge x-ray absorption fine structure (NEXAFS).

In NEXAFS, extremely intense x-ray light is sent toward the material, and the electrons emitted by the material and collected with a sensitive detector providing information about the concentration of the organosilane molecules on the surface.
The distinguishing feature of the approach is that the particles follow a pre-designed chemical template provided by the organosilane sticky groups.

The ability to manipulate the underlying template allows preparing gradient structures of nanoparticles with varying characteristics.

The main advantage of the studied gradient structure is that a large numbers of the structures can be combined on a single substrate and used for high-throughput processing.

It might, for example, save time for chemists testing clusters of nanoparticles used as catalysts — chemicals actively sought by the chemical industry to create new, less polluting sources of energy.

Clusters made of different numbers of nanoparticles could be put on a single surface, and scientists could test this surface only once in a chemical reaction, instead of having to run each cluster separately through the reaction.

The material could also be used as a sensor to detect species that have specific affinities for nanoparticles, or as a filter to select particles of given sizes.

© Copyright 2000 - 2002 The Hindu