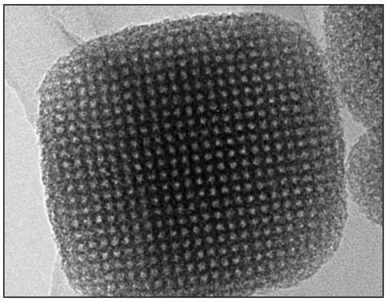
NANOTECHNOLOGY

Novel Nanoparticle Synthesis Sparks Pharmaceutical Innovations



The Institute of Bioengineering and Nanotechnology (IBN) has developed a technique that produces nanometer-sized particles of 50–300 nm with tunable pore sizes in the range of 5–30 nm. Photo courtesy of IBN.

Researchers at the Institute of Bioengineering and Nanotechnology (IBN; Singapore; www.ibn.a-star.edu.sg/) have developed a wet-chemical technique called fluorocarbon-mediated synthesis that allows simultaneous control of both the size and morphology of nanoparticles (*Angew. Chemie Intl. Ed,* **44**, pp. 288–292). IBN has applied for a U.S. patent on the invention and is working with pharmaceutical companies to use these nanoparticles for pharmaceutical synthesis and novel biomedical applications. IBN hopes the technology will be commercialized by 2007.

"The current methods of synthesizing such nanoparticles have been successful in controlling only one of the two variables," says Jackie Ying, executive director of IBN, who worked on the project with research scientist Yu Han. These techniques generally produce 2-dimensional hexagonal structure with small pore diameter (< 5 nm). In many cases, special vapor-phase synthesis equipment is required.

IBN's technology produces nanoparticles of 50–300 nm and tunable pore sizes of 5–30 nm via the use of two different types of surfactants. The first, a tri-block copolymer (comprising ethylene oxide and propylene oxide), acts as the supramolecular template for the mesostructure. The other is a fluorocarbon polymer that limits the growth of the particles to nanometer dimensions. Ying and Han carried the syntheses out in a weakly acidic (pH 1.6–1.8) homogeneous solution formed by mixing the copolymer with the cationic fluorocarbon surfactant and silica precursors at 25–30°C. In some cases, the organic swelling agent 1,3,5-trimethylbenzene (TMB) was added to adjust the pore size or vary the mesostructure. Fluorocarbon surfactants were selected because they have a much higher surface activity than common surfactants. Moreover, unlike the hydrocarbon chains of common surfactants, which are hydrophobic but lipophilic, fluorocarbon chains are hydrophobic and lipophobic.

The silica precursors slowly hydrolyze in the weakly acidic medium, and the hydrolyzed species co-assemble with the triblock copolymers to form well-defined mesophases, the structures and pore sizes of which depend on the type of copolymer and the amount of organic additives. Simultaneously, fluorocarbon surfactants surround the silica particles, thereby limiting their growth. Using this approach, the scientists obtained five different mesoporous structures denoted IBN-1 to IBN-5.

Ying predicts that these nanoparticles will play a crucial role in the production of pure chiral drugs. Current methods use catalysts to selectively synthesize the preferred molecule. However these catalysts exist in a liquid phase, making it difficult for them to be separated and reused. IBN immobilizes these catalysts on nanoporous materials synthesized by its wet-chemical technique. "The catalysts, now in the solid form, can be easily recovered and reused through simple filtering or centrifuging processes," says Han. "This improvement in the drug manufacturing process can potentially lead to greater cost savings for the chiral pharmaceutical industry, in which the production of the chiral ingredient currently accounts for 10–40% of the total cost," he continues.

The chiral pharmaceutical industry generated $143 billion sales in 2003 and is growing rapidly. "These mesoporous particles would also be useful in catalysis and gas adsorption, and would serve as ideal matrices for the synthesis of quantum dots and magnetic nanoparticles in functional materials and bioimaging applications, or as carriers for drugs, genes and proteins for novel biomedical applications," Han concludes.