Technique uses humidifier to create nanocomposite materials

photo by Bill Wiegand

Chemical catalyst *UI chemist Kenneth S. Suslick, a William H. and Janet Lycan Professor of Chemistry, and his colleagues are using ultrasonic household humidifiers to make complex nanocomposite materials that could prove useful as catalysts in applications ranging from refining petroleum to making pharmaceuticals. Graduate student Won Hyuk Suh presented early findings from their work, which is funded by the National Science Foundation, at the 227th national meeting of the American Chemical Society.*

By James E. Kloeppel
News Bureau Staff Writer

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In what may sound like a project from a high school science fair, scientists are using a household humidifier to create porous spheres a hundred times smaller than a red blood cell. The technique is a new and inexpensive way to do chemistry using sound waves, the researchers say.

In the home, ultrasonic humidifiers are used to raise humidity, reduce static electricity and ease discomfort from the common cold or cough. In the lab, UI chemists are using the devices to make complex nanocomposite materials that could prove useful as catalysts in applications ranging from refining petroleum to making pharmaceuticals. The procedure is both simple and efficient.

"Normally, the chemical effects of ultrasound (called sonochemistry) are due to intense heating of small gas bubbles as they collapse in an otherwise cold liquid," said Kenneth S. Suslick, a William H. and Janet Lycan Professor of Chemistry at Illinois. "But in this case we are looking at using ultrasound to make very small liquid droplets and heating them while they are separated from one another in a heated gas. It's the inverse of what we do sonochemically."

To create their novel nanocomposite materials, Suslick, graduate student Won Hyuk Suh and research fellow Yuri Didenko start with a solution of chemical reactants and surface-stabilizing surfactants. The solution is turned into a mist using a high-frequency ultrasound generator – an ordinary household ultrasonic humidifier the researchers purchased at a local discount store.

The resulting droplets are carried by a gas stream into a furnace, where the solvent evaporates and the chemicals coalesce into inorganic-organic composite materials nanometers in size. The particles are carried to a second, hotter furnace, where the organic part burns away, leaving behind porous inorganic nanospheres. These nanospheres are then trapped in a liquid and collected by centrifuge. The entire formation process takes only a few seconds.

"Each tiny droplet serves as its own microscopic chemical reactor," Suh said. "The micron-size mist results in particles a few hundred nanometers in size."

Among the materials the chemists have created with their ultrasound induced mists are porous nanospheres that could be useful for catalytic reactions, and encapsulated nanoparticles with potential drug delivery applications. They also have formed metal balls within ceramic shells, reminiscent of decorative, hand-carved concentric ivory spheres from China. The nested nanoballs could prove useful as molecular sieves.

"Because the outer sphere is porous, we can selectively dissolve some of the core, which frees the inner ball from the shell," said Suh, who will describe and present early results from the pyrolysis generated porous nanospheres at the 227th American Chemical Society national meeting, which was held March 28-April 1 in Anaheim, Calif.

The work was funded by the National Science Foundation. ◆