# Purifying nanorods: Big success with tiny cleanup

September 22 2008

Chemists at Rice University have discovered a novel method to produce ultra-pure gold nanorods -- tiny, wand-like nanoparticles that are being studied in dozens of labs worldwide for applications as broad as diagnosing disease and improving electronic viewscreens.

"The content of high-aspect-ratio gold nanorods produced by today's best synthetic methods is only about 20 percent," said lead researcher Eugene Zubarev, assistant professor of chemistry at Rice. "A nanoparticle's shape plays a crucial role in determining many of its physical and chemical properties, so when four out of five particles in a batch are the wrong shape, it's a tremendous impediment to practical applications and commercialization."

Zubarev and graduate student Bishnu Khanal's new purification method filters more than 99 percent of impurities from gold nanorods. The research is available online and will appear in the Sep. 25 issue of the *Journal of the American Chemical Society*. It's an example of the sort of processing and synthesis methods that the federal government called for last year in a key report that examined the economic potential of nanotechnology.

Nanotechnology refers to a set of tools and methods that scientists use to see, measure and control matter with exquisite control, sometimes moving just one atom at a time. By building materials from the bottom up, at the molecular level, scientists can tailor particles that interact in precise ways with living cells, light waves, drugs and other chemicals.

The word nanotechnology refers to the nanometer, a unit of length equal to one-billionth of a meter.

The nanorods studied by Zubarev and Khanal are about 25 nanometers in diameter and about 250 nanometers long. In comparison, a single gold atom is only about one third of a nanometer in diameter. Thus, the cross-section of each nanorod is made of just a few thousand gold atoms. Because of their long, narrow shape, the nanorods interact with light, electricity and magnetic fields differently than spheres or discs containing the same number of atoms.

Tuning the shape- and size-specific properties of nanoparticles is critically important for the emerging U.S. nanotechnology industry. The U.S. has invested more than $8 billion in nanotechnology research and development since 2000, and the National Science Foundation estimates the global market for nanotechnology products will be about $1 trillion by 2015. In its 2007 strategic plan, the National Nanotechnology Initiative, which oversees U.S. nanotechnology research spending, pointed to the critical need for synthesis and processing techniques that yield high-quality, pure nanomaterials.

Nanorods are produced by mixing several chemicals in a precise, multi-step process. The method also produces gold nanoparticles of other shapes, including spheres and flattened sheets called platelets. Researchers had previously found a way to remove the spheres; the nanorods and platelets were allowed to gradually sink to the bottom of the mixture, and the spheres were siphoned away.

While conducting research on a different project, Zubarev and Khanal noticed that the nanorods and platelets in the remaining solution shrank when a solution of gold ions was added. They found that the platelets shrank much faster than the nanorods, and by tuning the process they discovered they could filter out the platelets and produce nanorod solutions that were more than 99 percent pure.

Source: Rice University