Gold 'glitters' in new ways at the nanoscale

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May lead to new computer chips, network switches

Researchers at the U.S. Department of Energy's Argonne National Laboratory have found that gold "shines" in a different way at the nanoscale, and the insights may lead to new optical chips for computers or for switches and routers in fiber networks.

The nanoscale refers to a size one-billionth of a meter, or about 70,000 times smaller than the width of a human hair. Materials that small exhibit entirely different properties from conventional materials. Specifically, temperature, electricity and magnetism are completely different from that of conventional materials, and could form the basis of new technologies.

The Argonne researchers examined the characteristics of photoluminescence - the emission of light when electrons are stimulated - in gold nanorods, and found that they could control the wavelength of the light emitted by the material, making it possible to use as a light source inside an optical chip, allowing transmission of information through light. "The light emitted is dependent on the shape of the gold nanorods," said Gary Wiederrecht, Argonne scientist and leader of the research team.

The gold nanorods are about 20 nanometers wide and range from 70 to 300 nanometers long. The rod-like shape of the material is important, Wiederrecht explained, because the rod shape determines the energy of the collective electronic excitations that radiate light. Thus, photoluminescence at different wavelengths is achieved in nanorods of differing lengths.

The rod shape also produces enhanced absorption of the illumination, increasing the light intensity and also concentrating that intensity to levels high enough to create luminescence. "The rods have strong absorption characteristics in the near-infrared range," Wiederrecht said. The experimenters used an ultrafast titanium-sapphire laser beam at 800 nanometers to create the photoluminescence.

The research is published in the December 31, 2005, of Physical Review Letters.

While the research has future implications for technological advances, Wiederrect is quick to explain that his group has done basic research - an examination of the material for a fundamental understanding of its characteristics. The longer-term implications of the work include the ability to produce nanoscale light sources for faster and smaller optical devices and novel photoluminescent sensors.

"Because materials at the nanoscale behave so differently from conventional materials, we're starting all over again, in a way, to understand how and why these nanomaterials function," Wiederrect said.

Other members of the research team are lead author Alexandre Bouhelier of Argonne's chemistry division and the Center for Nanoscale Materials and Renaud Bachelot, Gilles Lerondel, Sergei Kostcheev and Pasal Royer, all of the Laboratoire de Nanotechnologie et d'Instrumentation Optique in Troyes, France.

Source: Argonne National Laboratory