Surface plasmon resonances of metal nanoparticles in array can have narrower spectral widths

November 14 2008

Researchers at the Harvard School of Engineering and Applied Sciences (SEAS) have demonstrated experimentally and theoretically that the surface plasmon resonances of metal nanoparticles in a periodic array can have considerably narrower spectral widths than those of isolated metal nanoparticles. Further, as the optical fields are significantly more intense in a periodic array, the method could improve the sensitivity of detecting molecules at low concentrations.

While researchers have known that a group of nanoparticles could be used to increase signal levels for sensor applications, the electromagnetic interactions between the particles have often been overlooked. A team led by Ken Crozier, John L. Loeb Associate Professor of the Natural Sciences at SEAS, showed that by spacing a nanoparticle array appropriately, the interactions between nanoparticles can be optimized.

The study, published in the November 3 issue of *Applied Physics Letters*, was carried out by Yizhuo Chu, Ethan Schonbrun and Tian Yang under the direction of Professor Crozier, all of SEAS. "We used numerical electromagnetic simulations to design nanoparticle arrays exhibiting narrow surface plasmon resonance peaks and intense optical fields, and checked our predictions experimentally," said Crozier.

To do so, Crozier and his team fabricated the nanoparticle arrays using electron beam lithography on glass substrates. By measuring the optical transmission of collimated beams of white light through the arrays, the team found that their experimental results confirmed their original theoretical predictions of sharp plasmon resonance peaks.

"The narrow peaks occur when the product of the nanoparticle spacing and the refractive index of the surrounding medium approximately matches the plasmon resonance wavelength of a single nanoparticle," explained Crozier.

Over the past several years, Crozier and his colleagues have helped to advance the field of plasmonics, harnessing its ability to confine electromagnetic fields to deep sub-wavelength dimensions for spectroscopy, sensing and optical manipulation. The larger field enhancement demonstrated in their latest finding could be important for further refining surface enhanced Raman spectroscopy and for improving biosensors.

Source: Harvard University