nanotechweb.org

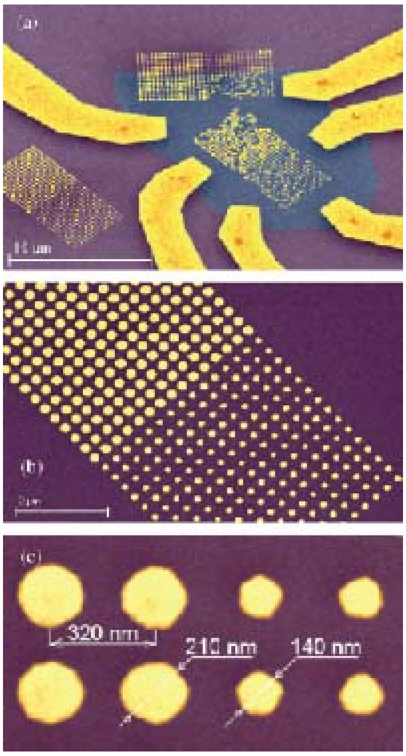
TECHNOLOGY UPDATE

Sep 30, 2010

Understanding the physics of SERS

Surface enhanced Raman scattering (SERS) is a powerful way to identify molecules at very low concentrations – something that is crucial for many analytical applications, such as forensics, medical diagnostics and identifying new drugs. Researchers at the universities of Manchester and Cambridge in the UK and the University of Ioannina in Greece have now developed a new quantitative analytical model that shows how metallic nanodiscs can greatly enhance SERS signals. The work could help us better understand the physics behind SERS for 2D materials.

"We are confident that this research will become a key reference in the SERS field and will stimulate follow-up studies," team leader Andrea Ferrari told *nanotechweb.org*.



(http://images.iop.org/objects/ntw/news/9/9/27/AFerrari.jpg)

False colour SEM images of SERS sample (http://images.iop.org/objects/ntw/news/9/9/27/AFerrari.jpg)

In recent years researchers have discovered that they can increase the interactions between light and matter by taking advantage of the electrons that oscillate collectively at the surface of metals – called "surface plasmons". Light fields are enhanced when they are resonant with these plasmons – an effect that has already been successfully used in techniques like SERS. Indeed, scientists have already succeeded in producing SERS enhancements as high as 10^{14} for random "hot-spots" of metal nanostructures on surfaces. However, it still remains difficult to fabricate SERS substrates with uniform enhancements over large areas.

This is because most SERS-active systems studied before now were based on random nanostructures, whose properties varied from experiment to experiment, explains Ferrari. This made quantitative comparisons between theory and experiment quite difficult too. To overcome this problem, we decided to use graphene (a sheet of carbon just one atom thick), which is the ideal prototype 2D material to investigate SERS since its Raman spectrum is well known, he says. Uniform, virtually defect-free graphene samples can now be reproduced quite easily and the height of these samples can be controlled on the atomic scale.

Modelling SERS

The UK-Greece team modelled its system by considering metal dots of various sizes placed on the graphene. The researchers then solved Maxwell's equations for each sample using the "finite difference time domain method".

Ferrari and colleagues observed significant enhancements of the Raman signal and found that the enhancement is inversely proportional to the tenth power of the distance between graphene and the centre of a metal nanoparticle. "These results could help us better understand SERS physics of 2D materials," added Ferrari. "The work also proves that plasmonic nanostructures can enhance light absorption and scattering from 2D materials, like graphene, something that could have direct applications for photodetectors and sensors."

Spurred on by these findings, the team will now try and optimize the SERS substrate to achieve even bigger enhancements by using different metals and dot shapes. "We will also implement plasmonic nanostructures on various devices made from graphene," revealed Ferrari.

The work was reported in *ACS Nano*.

About the author

Belle Dumé is contributing editor at *nanotechweb.org*