ORNL nanoprobe creates world of new possibilities

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A technology with proven environmental, forensics and medical applications has received a shot in the arm because of an invention by researchers at the Department of Energy's Oak Ridge National Laboratory.
ORNL's nanoprobe, which is based on a light scattering technique, can detect and analyze chemicals, explosives, drugs and more at a theoretical single-molecule level. This capability makes it far more selective and accurate than conventional competing technologies.

The probe is an optical fiber tapered to a tip measuring 100 nanometers with an extremely thin coating of nanoparticles of silver, which induces the surface-enhanced Raman scattering (SERS) effect. Normally, when a sample is illuminated by a laser beam, there is a small reflection of light, known as Raman scattering. The light shows vibration energies, which are unique to each compound, and that information allows scientists to identify the substance.

With the SERS nanoprobe, the laser light creates rapid oscillations of the electrons in the silver nanoparticles, which produce an enormous electromagnetic field that contributes to increase the Raman scattering signal. The ORNL nanoprobe works with any surface to induce the SERS effect.

"The significance of this work is that we are now able to perform direct analysis of samples -- even dry samples -- with no preparation of the surface," said ORNL's Tuan Vo-Dinh, who leads a team that developed the nanoprobe. "Also, the small scale of the nanoprobe demonstrates the potential for detection in nanoscale environments, such as at the intracellular level."

Ordinarily, surface-enhanced Raman scattering analysis of samples on a surface requires modification or treatment of the sample. This may consist of physically removing the sample and diluting it in a liquid containing silver nanoparticles; however, this practice is unnecessary with the ORNL nanoprobe.

Vo-Dinh and Life Sciences Division colleagues David Stokes and Zhenhuan Chi experimented with nanoprobes made of several materials of varying thickness. They settled on silver-island films because they are easier to reproduce than silver-coated particles and they form only a thin coating, which helps maintain the nanoscale diameter of the tapered tip.

The development of the SERS nanoprobe could lead to increasing interest in SERS as an ultra-sensitive detection tool, allowing direct analysis of samples for a wide variety of applications, Vo-Dinh said. These applications range from environmental monitoring to intracellular sensing and medical diagnostics.

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