nanoLAMPS created for use as molecular probes

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(PhysOrg.com) -- Rohit Bhargava of the University of Illinois has come up with an intriguing new class of molecular probes for biomedical research called nanoLAMPs. Unlike most probes used in biomedicine or other types of research they don't require dyes or fluorescence but, like an ordinary house lamp, they do need a light switch in order to illuminate the molecular world.

Bhargava and his collaborators developed the nanoLAMPs, which stands for Nano-Layered Metal-dielectric Particles, to solve a problem in biomedical research: the inability to measure multiple molecules simultaneously with a high degree of accuracy and reliability.

“This method, in principle, will allow us to image hundreds of molecular species quantitatively from a single molecule up to any limit,” Bhargava said.

In addition, different reporter molecules can be embedded in the nanoLAMPs, providing the ability to obtain different results and another reason why the probes have such great potential for use in biomedical research, especially for biomedical imaging purposes.

“We have an almost unlimited ability with this design to put in any molecule and use it as a marker,” said Bhargava, a researcher at Illinois’s Beckman Institute. “We don’t need it to be a dye or fluorescent molecule, but just need to change the molecular structure of the reporter.”

Bhargava's group published the first paper on the method in the Aug. 3, 2010 issue of the Proceedings of the National Academy of Sciences. The new method takes an existing spectroscopic technique called surface-enhanced Raman scattering (SERS) and uses nano-layered metal-dielectric particles that light up when exposed to laser light.

Bhargava said the breakthrough aspect of this method is that it is able to overcome deficiencies found in SERS through the design of the nanoscale structure of LAMPs using classical electromagnetic theory and advanced computing strategies.

The nanoLAMPS were created with a unique concentric, multi-shell structure that allows for fine tuning the electric field surrounding a molecule. They applied fundamental electromagnetic theory to predict the electric field, then used algorithms and the computing power of the National Center for Supercomputing Applications (NCSA) at Illinois to optimize structures for Raman enhancement.

"It is smart design of nanostructures based on very fundamental physics," Bhargava said.

The nanoLAMPS also have the advantage of eliminating the chemical effects seen with SERS enhancement techniques, allowing for more precise modeling.

"The unique part in this paper is we completely ignored the chemical enhancement by decoupling the molecule from the surface," Bhargava said. "Instead, we embed the molecule in the dielectric layer between the metal layers. As a consequence, very, very few molecules are actually even close to the surface; they are all in the dielectric layer. That means we can completely eliminate the chemical effect and only rely on the electromagnetic effect for enhancement."

The nanoLAMPs have a recognition link which connects the target molecule to the multi-shell, onion-like structure containing the reporter molecule. A laser light is used to excite the nanoparticles and acquire signals from the target molecule. The nanoLAMPs can produce reliable, quantitative measurements from a single molecule or from hundreds of molecules, and from multiple species. The particles used are designed to be stable and won't decay over time, and different metals or even dyes can be used in them.

"It's an incredibly flexible platform," Bhargava said. "It allows you to image any molecular species, presents many routes to fabrication, and you can put in any dye you like, any reporter, use most any metal you like."

Bhargava said the acronym LAMPs is appropriate.

"Lamps light the way to 'seeing' molecules and the capability is always on, but you have to hit it with a beam of light to get a response back," he said. "It is like flipping a switch when you shine a laser on it."

More information: Link to website: www.beckman.illinois.edu/index.aspx
Link to paper: www.pnas.org/content/107/31/13 … id=pnas;107/31/13620

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