One nano-step closer to weighing a single atom

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By studying gold nanoparticles with highly uniform sizes and shapes, scientists now understand how they lose energy, a key step towards producing nanoscale detectors for weighing any single atom.

Such ultrasensitive measurements could ultimately be used in areas such as medical research and diagnostics, enabling the detection of minuscule disease-causing agents such as viruses and prions at the single molecule level.

Researchers are interested in nanosized materials because the smaller the components of a detection device, the more sensitive it is.

In this study, the team from the University of Melbourne, Argonne's Center for Nanoscale Materials in Illinois and the University of Chicago synthesized and studied tiny gold rods with a width 5000 times smaller than the thickness of a human hair.

The work will be published online this week in *Nature Nanotechnology*.

Professor John Sader from the Department of Mathematics and Statistics, University of Melbourne says that in the same way as a classroom ruler decreases its frequency of vibration when an eraser is attached, nanomechanical mass sensors work by measuring their change in vibration frequency as mass is added.

The sensitivity of such nanomechanical devices is intimately connected to how much energy they displace. So researchers needed to understand how damping (loss of energy) is transferred both to the fluid surroundings and within the nanostructures. With the lower the damping, the purer the mechanical resonance and higher the sensitivity.

It has not previously been possible to determine the rate at which vibrations in metal nanoparticle systems are damped, because of significant variations in the dimensions of the particles that have been studied - which masks the vibrations.

However, by studying a system of bipyramid-shaped gold nanoparticles with highly uniform sizes and shapes, the researchers overcame this limitation.

"Previous measurements of nanomechanical damping have primarily focused on devices where only one- or two-dimensions are nanoscale, such as long nanowires. Our measurements and calculations provide insight into how energy is dissipated in devices that are truly nanoscale in all three-dimensions," says Professor Sader.

Illuminating these bipyramidal nanoparticle systems with an ultra-fast laser pulse, set them vibrating mechanically at microwave frequencies. These vibrations were long-lived and for the first time damping in these nanoparticle systems could be interrogated and characterized.

Moreover, the researchers separated out the portion of damping that is due to the material itself and that surrounding liquid for which they developed a parameter-free theoretical model that quantitatively explains this fluid damping.

More information: M. Pelton, J. E. Sader, J. Burgin, M. Liu, P. Guyot-Sionnest, and D. Gosztola, "Damping of acoustic vibrations in gold nanoparticles," *Nature Nanotechnology*.

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