ANSOM Microscope Achieves Sub 10nm Resolution

The idea behind near-field microscopy is to offer a technique by which extremely small structures (at the nanometer level) can be measured and manipulated. However, 20 nanometers has been the best resolution accomplished. Until now.

“We were able to resolve molecules when they were only 15 nanometers apart,” Stephen Quake tells *PhysOrg.com*. Quake and his group at the California Institute of Technology in Pasadena have created a fluorescence near-field microscope that can distinguish single molecules. The results are published in an article titled “Fluorescence Near-Field Microscopy of DNA at Sub-10 nm Resolution” in *Physical Review Letters*.

“Conventional light microscopes use lenses, and so their imaging properties are limited by the properties of these lenses,” Quake explains. “The main limitation is the wavelength of light. But for the last 20 years, near-field microscopy has provided ways to look at objects without being limited by the wavelength of light. For the most part, that has meant two to four times better than the diffraction limit.”

Along with Ziyang Ma, Jordan Gerton and Lawrence Wade, Quake designed and built a microscope that worked with fluorescence near-field microscopy (ANSOM -- apertureless near-field scanning optical microscope). In their Letter, the authors describe how fluorescence fluctuations and the limited number of photons available before the molecule is destroyed has created problems in imaging fluorescent molecules. However, thanks to a new phase filtering method, Quake’s group demonstrates how this new kind of microscope can be useful for any number of applications, but especially for biomolecules like DNA.

In fact, Quake and his collaborators used DNA to test their microscope. “One of the most stringent tests for a microscope is to put two items together and see how close you can get them and still tell them apart.” He points out that in near-field microscopy this test is not often done. “But we wanted rigorous evidence that the resolution is as high as we claim.”

Quake feels that this new kind of microscope could be valuable if commercially produced. “If a commercial manufacturer picked these up and got them into labs, it could greatly advance the frontiers of both biology and nanoscience. They could be used as tools to learn more about the function of macromolecules.”

According to the Letter, the microscope’s phase filtering method can also be applied to such things a nanoantennas and supersharp carbon nanotube probes. The resolution of both of these instruments could be improved with the group’s process. Additionally, the microscope could be altered to work on a level that approaches the resolution of an electron microscope.

Quake predicts that there will be more to this new fluorescence near-field microscope. “So far, we only have results from molecules in air,” he says. “The next step is to make it work in water, and we have been modifying the instrument for that purpose.” The advantages to having such a microscope are obvious. Right now, with an electron microscope (which has sharper resolution), biomolecules cannot be observed directly in their natural conditions.

But this new microscope, if properly adapted, could change that. “We could image live cells, for example. Look at things in motion. Observe proteins that are on the cell surface membranes. This microscope offers a powerful new tool for imaging single molecules and nanostructures.”