Nano World: New microphone microscope tip

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New microscopic probes resembling mergers between needles and microphones could help speedily measure chemical and mechanical properties of a material or a drug with just one poke, experts told UPI's Nano World.

These probes could also help manufacture devices on the nanometer or billionth of a meter scale far more quickly than ever before, said electrical engineer Levent Degertekin at the Georgia Institute of Technology in Atlanta.

Crucial drivers of nanotechnology are devices known as atomic force microscopes or AFMs, which run extraordinarily sharp probes across surfaces to scan them with three-dimensional molecular detail much as a blind person uses his or her fingers to read bumps on a page of Braille. As popular as atomic force microscopes are, two chief disadvantages of theirs are that they are relatively slow and not sensitive to the physical characteristics of a target surface.

A new microphone-inspired probe developed by Degertekin and his colleagues is up to 100 times faster than current atomic force microscopes and can capture details never before possible with atomic force microscopes. The force sensing integrated readout and active tip, or FIRAT, can be added to existing atomic force microscopes with little effort.

"I think this technology will eventually replace the current AFM," Degertekin said. "We've multiplied each of the old capabilities by at

least 10, and it has lots of new applications."

"It is possible that this device provides us with the 'ubiquitous' tool for examining nanostructures," said researcher Calvin Quate, an electrical engineer at Stanford University in California and one of the inventors of atomic force microscopes.

In one typical version of the probe, a sharp platinum or tungsten tip 10 microns long ending in a point only 50 nanometers or billionths of a meter across emerges from a flexible aluminum membrane. This structure and its driving mechanism are together far smaller and less bulky than those often used to move probes up and down in regular atomic force microscopes, making FIRAT far faster.

Just before the tip reaches a target, attractive forces from the sample begin tugging it down. By behaving much like microphone diaphragms pick up sound vibrations, the membrane starts receiving sensory readings well before the tip touches down.

Once the tip hits the surface, the degree to which the material pushes back reveals how elastic and adhesive it is. Prior atomic force microscope probes responded too slowly to properly resolve all these transient interactions.

"From just one scan, we can get topography, adhesion, stiffness, elasticity, viscosity -- pretty much everything," Degertekin said. The researchers presented their findings in the February issue of the journal Review of Scientific Instruments.

Just as scientists use atomic force microscope probes as fingers to read surfaces, so can they use these fingers to build devices. However, atomic force microscope slowness made them impractical for such a purpose. "FIRAT may change that," Degertekin said.

In future, the scientists plan to explore other designs for their probes. For example, instead of placing tips on membranes, Degertekin suggested they could place them in the middle of beams or the ends of levers. Further refinement could also lead to sharper tips with points 10 nanometers or less wide. They are currently in talks with several companies to commercialize their tools, and could have a FIRAT system that could adapt to most any conventional AFM in a year.

Physicist Thomas Thundat at Oak Ridge National Laboratory in Tennessee noted FIRAT could have biological applications. "They could image DNA and proteins," he said. Degertekin speculated about configurations of his team's device for the pharmaceutical industry, where arrays of many FIRAT membranes coated with a target of interest, such as a protein linked to a disease such as cancer, were lowered over arrays of tips coated with potential drugs. By noting how such drugs interacted with their targets, researchers could rapidly screen for effective medicines.