Researchers measure nanometer scale temperature

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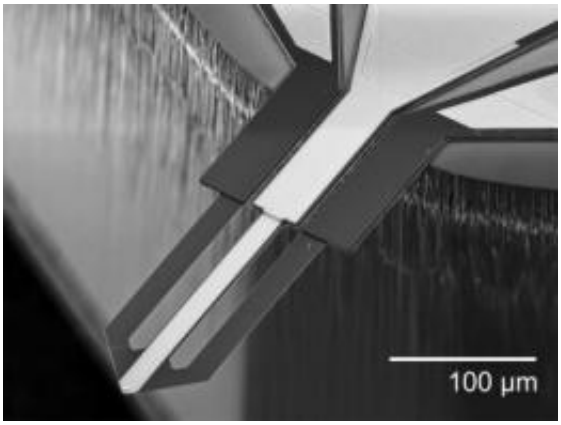

This is an electrothermal cantilever from the University of Illinois, having nanometer-scale electrode tip integrated onto a microheater. Credit: University of Illinois at Urbana-Champaign

Illinois researchers have developed a new kind of electro-thermal nanoprobe that can independently control voltage and temperature at a nanometer-scale point contact. It can also measure the temperature-dependent voltage at a nanometer-scale point contact.

Atomic force microscope cantilever tips with integrated heaters are widely used to characterize polymer films in electronics and optical devices, pharmaceuticals, paints, and coatings. These heated tips are also used in research labs to explore new ideas in nanolithography and data storage, and to study fundamentals of nanometer-scale heat flow. Until

now, however, no one has used a heated nano-tip for electronic measurements.

"We have developed a new kind of electro-thermal nanoprobe," according to William King, a College of Engineering Bliss Professor in the Department of Mechanical Science and Engineering at the University of Illinois at Urbana-Champaign. "Our electro-thermal nanoprobe can independently control voltage and temperature at a nanometer-scale point contact. It can also measure the temperature-dependent voltage at a nanometer-scale point contact."

"Our goal is to perform electro-thermal measurements at the nanometer scale," according to Patrick Fletcher, first author of the paper, "Thermoelectric voltage at a nanometer-scale heated tip point contact," published in the journal *Nanotechnology*. "Our electro-thermal nanoprobe can be used to measure the nanometer-scale properties of materials such as semiconductors, thermoelectrics, and ferroelectrics."

The electro-thermal probes are different than thermal nanoprobes typically used in King's group and elsewhere. They have three electrical paths to the cantilever tip. Two of the paths carry heating current, while the third allows the nanometer-scale electrical measurement. The two electrical paths are separated by a diode junction fabricated into the tip. While the cantilever design is complex, the probes can be used in any atomic force microscope.

More information: The paper is available online at doi:10.1088/0957-4484/23/3/035401

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