

## ***Tip-Based Nano-Fabrication and Nano-Metrology using Heated Nanoprobe Tips***

This talk describes research on nano-fabrication and nano-metrology using heated nanoprobe tips. Our platform for fabrication and metrology uses an atomic force microscope (AFM) cantilever tip with an integrated heater-thermometer. When the heated tip of an AFM cantilever is in contact with a substrate, the interfacial contact is a nanometer-scale hotspot. The tip can be used to deposit materials from the tip to the substrate, remove materials from the substrate, or induce chemical or physical reactions on the substrate. Our team has recently fabricated arrays of heated AFM cantilevers, where each tip in the array is fabricated from nanocrystalline diamond. The tips have a radius of curvature of about 10 nm, and are extremely wear resistant over long scan distance and high forces. We demonstrate that these tips can be used to perform thermal nano-fabrication and nano-metrology while undergoing almost no wear. We have integrated this cantilever array into our commercial AFM system, where the hardware and software of the AFM system can be used to drive the cantilever array. We show independent, parallel nano-imaging using the cantilever array with scan speeds about 1 m/sec. We demonstrate how the cantilever array can rapidly image mm-scale regions with nm-scale resolution. The ability to independently read each cantilever channel independently enables the high imaging speed. We demonstrate fabrication and characterization of several types of nanostructures using heated tips, including graphene nano-ribbons and polymer nanostructures.

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