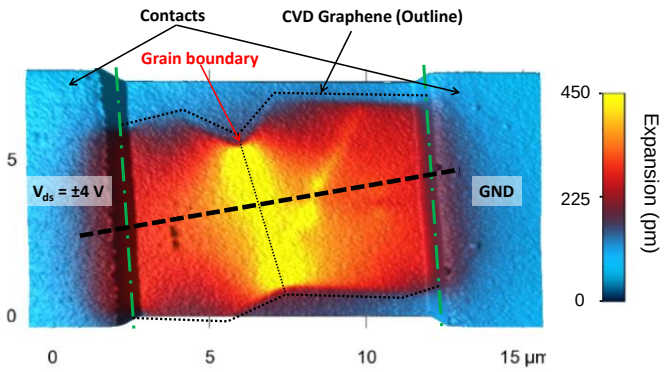
NANOHOUR

Wednesday, October 31, 2012 3:00 pm
Beckman Institute - Room 2269

Nanometer-scale Thermometry of Graphene, Carbon Nanotubes, and Phase Change Memory

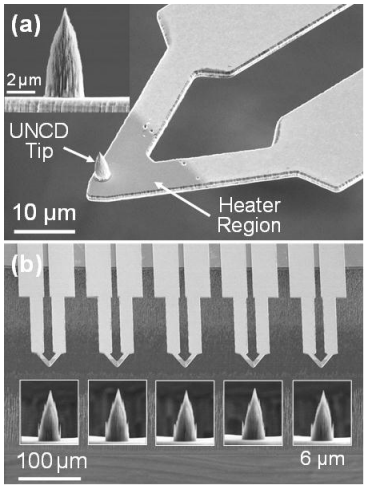
Kyle Grosse, Mechanical Science and Engineering
Graduate Student with Professor William P. King



We report improvements in quantitative thermometry with resolutions of 50 nm and 10 mK, and the application of this thermometry to study the temperature field in new and novel electronic materials, including graphene, carbon nanotubes (CNTs), and $Ge_2Sb_2Te_5$ (GST). Graphene and CNTs are candidates for post-silicon electronics, and GST has promise for phase change memory (PCM) applications. Thermometry is accomplished by an atomic force microscopy (AFM) based technique known as Scanning Joule Expansion Microscopy (SJEM). We directly observe Joule heating across a graphene grain boundary due to inter-grain transport. We have measured the temperature field arising from individual semiconducting and metallic CNTs. Finally, we report measurements of Joule and thermoelectric heating in GST.

Heated AFM Microcantilever Arrays: Thermal Crosstalk and Diamond Tip Integration

Joon Kim, Mechanical Science and Engineering
Graduate Student with Professor William P. King



Heated atomic force microscope (AFM) cantilevers can be scaled to large arrays for high throughput imaging and nano-writing. Two key challenges of heated AFM cantilever array are thermal crosstalk and tip wear. First, we report detailed characterization and analysis of thermal crosstalk in a heated microcantilever array, where the heating of a single cantilever can induce temperature rise in a neighbor cantilever. The fabricated heated cantilever array consists of five identical independently controlled heated cantilevers. We analyzed thermal crosstalk in either steady or transient operating conditions while the array is either in contact with a substrate or freely suspended in air.

In addition, we report wear-resistant ultrananocrystalline (UNCD) diamond tips integrated onto arrays of heated AFM cantilevers. The UNCD tips are batch-fabricated and have apex radii of approximately 10 nm and heights up to 7 µm. The tips were shown to be wear resistant throughout 1.2 m of scanning on a single-crystal silicon grating at a force of 200 nN and a speed of 10 µm/s. Under the same conditions, a silicon tip was completely blunted. We demonstrate the use of these heated cantilevers for thermal imaging in both contact mode and intermittent contact mode, with a vertical imaging resolution of 1.9 nm. The potential application to nanolithography was also demonstrated, as the tip wrote hundreds of polyethylene nanostructures.

Coffee and cookies will be served
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