UNH Materials Science Seminar

13:10-14:00, Wednesday, Feb. 17, 2010
DeMeritt Hall 240
University of New Hampshire

Progress toward Understanding the Mechanism of Transport during Field Assisted Nanopatterning

Prof. Todd Gross

Department of Mechanical Engineering and Materials Science Program
University of New Hampshire

Liu and Miller[1,2] have shown that they can deposit lines that are several nm high and 10-40 nm wide on conductive substrates evaporation by applying a negative bias to semiconducting AFM tips coated by solution or suspension. Our goal is to scale up this process to cover large areas for bottom up nanostructure fabrication. However, control of a process like this requires understanding of the mechanism of material transport. The materials that can be deposited range from organic molecules including C60, napthalene, and polyaniline with low melting temperatures deposited by solution evaporation to high melting point materials like MnO_2, ZnO, and Fe deposited by suspension evaporation. Their only common feature is that the coatings are likely to be physisorbed rather than chemisorbed and are therefore weakly bound to the tip.

We propose that the high electric fields (~10^9 V/m) ionize the air between the tip and the substrate and that these positively charged ions are accelerated toward the negatively-biased tip held thereby dislodging the weakly adsorbed coatings which then stick to the first surface they contact. This is consistent with the observation that deposition does not occur for reverse bias. Further, the surface can be modified even if the tip is not coated. We will present experimental evidence that the substrate surface can be modified if the bias is reversed *even if the tip is not in contact with the surface.* We have estimated the volume of gas that is above the dielectric breakdown field of air, the potential ion current, and the temperature rise of the tip as a function of current. We are currently attempting to measure the electric current during deposition and will present our most current results.

1. Liu, J-F., Miller, G.P., Field-Assisted Nanopatterning, J. Phys. Chem. Lett. C, 2007, 111, 10758-10760
2. Field-assisted nanopatterning of metals, metal oxides and metal salts, Jun-Fu Liu Miller, G.P., Nanotechnology, v 20, n 5, p 055303 (6 pp.), 4 Feb. 2009

This work was supported under the Nanoscale Science and Engineering Centers Program of the National Science Foundation (Award # NSF-0425826)