SINAM NANO SEMINAR

Center for Scalable and Integrated NAno Manufacturing (SINAM) - NSF Nanoscale Science and Engineering Center Presents:

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Nanoscale Patterning with the Helium Ion Microscope

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Monday, November 7, 2011
11:00 AM - 12:00 PM
3110 Etcheverry Hall

Abstract

The Helium Ion Microscope (HIM) is a new imaging technology based on a high brightness and stable Gas Field Ion Source (GFIS). The GFIS employed exhibits a low energy spread (<1 eV), small virtual source size (< 0.3 nm) and a high brightness > 4 x 109 A/cm2.sr. This, in conjunction with the shallow escape depth (<1 nm) of the secondary electrons generated by the incident 30 keV helium ions, contribute to the HIM's primary advantage in the imaging of solid samples: its high spatial resolution (0.25 nm). We have applied this novel technology across a broad spectrum of multidisciplinary applications (from basic materials science and semiconductor applications to the biological sciences) to assess its utility and possible advantages over alternative techniques.

One area where our investigations have gained significant traction is in the field of nano-structuring. The focused helium ions have the ability to directly modify the sample surface under a high ion flux (via surface sputtering). This enables the direct patterning of structures and promises great utility in the fabrication of sub-10 nm devices. It also provides a mechanism for high resolution patterning on nonconventional substrates (such as suspended graphene membranes), where resist-based lithographic techniques are not feasible. We have observed sub-10 nm pattern transfer on both supported (Si bulk, 300 nm Si02) and suspended structures, with graphene nanoribbons of 5 nm width and individual holes of 5 nm diameter being demonstrated. We have extended this technique to fabricate extremely fine features (<5nm demonstrated) through optically thick metallic films. Our demonstration explores plasmonic applications using fractal apertures, which feature higher order structures requiring critical dimensions on the order of 10 nm for resonance in the ultraviolet, Figure 2. Near field distributions and resonant modes studied with electron energy loss spectroscopy (EELS) will be presented and compared with current models based on Finite Difference Time Domain (FDTD) simulations. The present limitations of this fabrication technique will be discussed, with an emphasis on re-deposition and requisite writing strategy, influence of grain orientation (channeling) and boundaries, and limitations due to sub-surface helium implantation.

Biography

Dr. Daniel S. Pickard is a faculty member in the Department Electrical and Computer Engineering at the National University of Singapore and is the Director of the Plasmonics and Advanced Imaging Technology Laboratory. His graduate studies were completed at Stanford University where he earned his M.S. and Ph.D. in Electrical Engineering. His Ph.D. research culminated in the demonstration of a novel nanoscale imaging technique aimed at dramatically improving the speed of electron beam systems (both for lithography and defect inspection at nanometric levels). Dr. Pickard graduated from the University of California at Berkeley with a B.S. in Electrical Engineering and Computer Science (Honors) and a B.A. in Physics. His research interests include electron and ion optics, plasmonics, high brightness charged particle sources, advanced photoemitters, nano-photonics, nanofabrication/characterization and novel imaging techniques.

Refreshments Provided

Hosted By: Professor Xiang Zhang, 3112 Etcheverry Hall
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