Helium Ion Microscopy Focus Topic
Room: Central Hall - Session HI-ThP

Aspects of Helium Ion Microscopy Poster Session

HI-ThP1 Fabrication of Carbon Nanomembranes by Helium Ion Lithography, *X. Zhang, H. Vieker, A. Beyer,* ***A. Gölzhäuser***, University of Bielefeld, Germany

A helium-ion microscope (HIM) is capable of creating nanoscale patterns and its beam can perform ion milling as commonly done in focused ion beam (FIB) systems. Here we use a helium ion beam as direct writing tool to cross-link 4'-nitro-1,1'-biphenyl-4-thiol (NBPT) SAMs with arbitrary patterns. The cross-linked SAMs were transferred to either silicon substrates with an oxide layer for optical characterization or transmission electron microscopy (TEM) grids for preparing free-standing carbon nanomembranes (CNMs). The required dose for the complete cross-linking with helium ions is quite similar to the dose earlier established with electrons. To determine the feature resolution limit, we prepared dot arrays of CNMs at various doses and 5 nm feature sizes have been achieved. Proximity effect and sample damage on the nanoscale patterns were also investigated. Furthermore, we use the ion beam to form nanopores in the CNM with an attainable feature size of 5 nm.

HI-ThP2 Site Specific He Ion Irradiation Damage Studies in Nanolayerd Thin Films, ***V. Shutthanandan***, *A. Devaraj, R.S. Vemuri, C.M. Wang, T. Varga, C.H. Henager Jr, S. Thevuthasan*, Pacific Northwest National Laboratory

Over recent years materials with a high density of nanoscale interfaces are finding increasing attention due to their improved radiation tolerance in comparison to their bulk form. The efficient trapping and recombination of radiation induced point defects such as vacancies and interstitials at such interfaces are proposed to be the fundamental reason for their increased radiation tolerance. Several different ODS steels, nanostructured ceramic materials and nanolayered thin films have been recently investigated to understand the fundamental mechanism of radiation damage. In many of these investigations high energy He ion irradiations were carried out in a large area over the entire specimen followed up with characterization of radiation damage. The spot size of ion irradiation beams from conventional sources was in the order of 100s of microns or larger preventing a site specific irradiation damage investigation of individual microstructural features. In such cases often the overall irradiation damage evolution in the material would be a cumulative response of the entire material microstructure (grain boundaries, interphase-interfaces, second phase precipitates and other preexisting defects) to the ion beam irradiation. A nanoscale site specific He ion irradiation method, if made possible can aid in decoupling and individually analyzing the He ion irradiation response of different microstructural features in a mutually exclusive manner. He ion microscopy (HIM) developed in recent years offer such a capability for obtaining coherent He ion beams that can be precisely controlled and directed to areas as small as few nanometers. In EMSL, a DOE national user facility in PNNL, efforts are underway to look at irradiation response of nanoscale microstructural features in nanolayered metallic thin films by cross coupling site specific He ion irradiations with site specific TEM and Atom probe tomography (APT) sample preparation methods made possible by Focused ion beam system. Proof of principle experiments are being conducted in nanoscale PVD synthesized Ti/Al nanolayer thin films using He ion irradiation doses ranging from 1E14 to 1E17 ions/cm2 and subsequent analysis by TEM and APT. Recent results from this study will be presented in this paper.

HI-ThP3 Helium and Neon Ion Beams Induced Platinum Deposition, ***H. Wu***, *D. Ferranti, D. Xia, W. THompson, L.A. Stern,* Carl Zeiss, *P.D. Rack, C.M. Gonzalez,* The University of Tennessee, *M.W. Phaneuf*, Fibics Incorporated

Gallium focused ion beams (Ga-FIB) have been used by the semiconductor industry to provide nanoscale deposition or milling. However, Ga ion implantation and limited spatial resolution capability encourage people to explore other ion sources for nanofabrication. Helium and Neon ion beams have been studied for many years as good alternative ion sources to replace Ga ion beams. The GFIS (gas field ion source) microscope is able to provide both He and Ne ion beams. Because of the mass difference of He and Ne ions, the interactions of ions with precursor molecules result in different sputtering rates, implantation and deposition yields. In this study, we use methylcyclopentadienyl trimethyl platinum (PtC_9H_{16}) as the precursor, and the metal deposition is induced by He and Ne ion beams respectively. To optimize the deposition process, beam current and dwell time have been studied. Compared with Ga ions, both He and Ne ion beams have smaller probe sizes, cause less surface damage and results in deposited material with superior properties without gallium contamination. The Pt nanowires using Ne ion beam exhibit lower resistivities, as low as 600 μΩ-cm, than those nanowires using He ion beam. Composition analysis by EDX shows the higher Pt: C ratio of Pt deposition by Ne ion beam than that by He ion beam, which is consistent with the resistivity results.

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