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Morphology and Thickness of Ion-Deposited Fluorocarbon Films by X-Ray Reflectivity

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Beamline(s): X19C

Introduction: A mass-selected polyatomic ion beam method was previously developed to deposit nanometer-thick fluorocarbon films on polymer and semiconductor surfaces [1-3]. The ongoing goal of this work is to develop an improved understanding of this new nanofabrication method by correlating the chemical and morphological structure of these films to the chemical structure, kinetic energy, and fluence of the incident ions.

Methods and Materials: Fluorocarbon films are prepared at UIC by the deposition of mass-selected 50 or 100 eV $C_3F_5^+$ ions onto polystyrene films that have been spin-coated on Si(100) wafers. X-ray reflectivity is performed at NSLS Beamline X19c to probe the morphological structure of the polystyrene films before and after deposition of this fluorocarbon ion.

Results: The polystyrene films are found to be 260 $\pm$ 30 Å, with RMS roughness of <5 Å prior to ion deposition [2]. Preliminary analysis of the x-ray reflectivity data shows that any change in polystyrene film thickness following fluorocarbon ion deposition is less than 30 Å. The 50 eV ions deposit fluorocarbon films that are ~5 Å thick, with similar roughness. The 100 eV ions deposit fluorocarbon films that are both thicker and rougher than the 50 eV films. These results are comparable with tapping mode atomic force microscopy data that found RMS roughness for polystyrene, 50 eV films, and 100 eV films to be 1.0 $\pm$ 0.2 Å, 1.8 $\pm$ 0.2 Å, and 7.4 $\pm$ 0.6 Å, respectively [2].

Conclusions: X-ray reflectivity experiments show that nanometer-thick fluorocarbon films are deposited from polyatomic ion beams onto polymers. The nanoscale roughness and thickness of these films can be controlled by the ion energy [2] and fluence [3]. Final analysis of the x-ray reflectivity data is currently underway.

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References:

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