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Medium energy ions for thin films and monolayers

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Modern synthetic approaches and nanofabrication are providing us the means of creating material structures controlled at the atomic scale. Familiar examples include the formation of hetero-structures grown with atomic precision, nanoparticles with designed electronic properties, and new carbon-based devices. One of the challenges here is that electron transport properties of these diverse materials are closely linked to the basic interactions at the interface.
Ion scattering has been very successfully applied in our group to study interfaces of devices based on silicon and higher-mobility semiconductors. We use medium energy ion scattering (MEIS), a powerful tool for depth profiling, with depth resolution of 5-10Å in the near surface region with electrostatic energy analyzer (ESA). It was applied successfully in the past to analyze for elements heavier than carbon, typically on light substrates. It is potentially interesting to extend this technique to perform elastic recoil detection analysis (ERDA) of light elements, such as H, D, or Li. We were also able to detect residual hydrogen presence in Hf silicate thin films grown by atomic layer deposition. The width of the H- ion peak can be correlated well with the film thicknesses in the 3.6-16 nm range, while conventional ERDA does not differentiate them. We observe some dependence of the H- fraction on recoil angle, H- ions are not observed at any emerging angles above 80degrees, while the data reported by Marion-Young predicts H- fraction of 3-5% in this energy range. The H- fraction is expected to increase with decreasing energy of the recoils (incident energy). We comment on the limitations of medium energy elastic recoil detection analysis.

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