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Combining Rutherford Forward Scattering with Elastic Recoil Detection in a Single Detector*

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Research in the Ion Beam Lab at Sandia has encountered two projects where it has become advantageous to perform both RBS (actually RForwardS) and ERD together using just one detector mounted in the forward direction (RFSERD). The first project involves determining the stoichiometry of nanometer-thick Ta_2O_x films to perfect deposition of memristive materials for high-density memories. RFSERD's advantage is that the accuracy of determining the stoichiometry of these films depends only on the statistics of the yield measurement, since the cross-sections are just Coulomb scattering and recoiling. The optimum beam for RFSERD in this case was found to be 42 MeV Si, target-tilt=75^o , detector angle=30^o and a 13.5 micron Mylar foil to range out Si scattered from the Si substrate. The RFS and ERD cross sections are both large providing a statistical accuracy of ~1%, a requirement to calibrate the Ta_2O_x deposition system. The second project was to microscopically map the H concentration in ceramics used in neutron tubes where outgassing was a problem. The new microbeam in the IBL was used to focus 0.75 MeV He onto these ceramics that had been thinned to 1 micron. RFSERD was then performed in transmission without a range foil, where the ERD provided the H areal density and the energy shift of the RBS signal gave an accurate measurement of the sample thickness, thereby providing the spatially-resolved H concentration in the sample. RFSERD using one forward detector is a new IBA technique that is therefore finding great utility in our lab, and could be broadly applied across the IBA community.

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