Multiple scattering and geometry effects on depth profiling of 2D and 3D structures

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High-resolution ion beam depth profiling often involves using beam at medium or low energy, or using heavy ions with high stopping power. In both cases, multiple scattering (MS) becomes an important effect, which affects depth resolution in way that is not always easy to model. For example, in the case of grazing incidence or detection, the effect of MS becomes asymmetric as the fraction of the particles that are on one side of the trajectory can quit the sample surface. At deeper depth, large angle MS becomes a prominent effect that affects the spectrum background and peak shape in a peculiar way.

In this presentation, we report on how, in the case of 2D or 3D structures, the MS effects combined to the fact that detectors have a finite size also affect the spectrum shape. For this purpose, the latest version of Corteo [1,2], a Monte Carlo (MC) simulation code for ion beam analysis is presented. This version simulates the trajectory of ions in targets described by a pixel or voxel image of arbitrary size, during which the detailed trajectory of each ion is simulated. In simulations of samples with 2D or 3D structures parallel to the beam axis, a fraction of the ions escape the walls of the structures due to MS. Since the MS effect increases with depth, the effect is non-uniform as a function of depth. Also, the shape of the spectrum is influenced by the fact that, when considering a detector with a finite size (rather than a point detector often considered in analysitcal simulations), the ions that escaped the wall of a 2D/3D structure can still reach the detector. Other effects such as re-entry, outlined by MC simulations, are also presented.

References

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[1] Fast Monte Carlo for Ion Beam Analysis Simulations. F. Schiettekatte, Nucl. Instrum. Meth. B 266 (2008) 1880.

[2] Spectrum simulation of rough and nanostructured targets from their 2D and 3D image by Monte Carlo methods. F. Schiettekatte, M. Chicoine, Nucl. Instrum. Meth. B 371 (2016) 106.