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IT-13-O-2051 Modeling of Ion Generated Secondary Electrons

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The arrival of high performance ion beam scanning microscopes has made it essential to have a quantitative model of the ion beam interactions with specimens and their contribution to the generation of the ion induced secondary electron signal (iSE). We have developed an enhanced Monte Carlo simulation, based on our earlier IONiSE program (1) , which is designed to better understand the physics of ion-solid interactions and to perform quantitative simulations. Two key pieces of data are required for this model. The first is the stopping power of the incident ion in the chosen target. Here we use recent data from Berger et al, (2) whose ASTAR program provides stopping power and other data for the He+ ion . ASTAR stopping power profiles were computed for He+ energies from 10keV to 105keV and for elements with atomic number of 90 as seen in figure 1. The second step is to be able to compute the generation rate, the range, and the subsequent transport of the iSE deposited in the sample which has been done by a Monte Carlo method. The Bethe (3) model of secondary electron production requires two parameters, e which represents the generation rate of iSE in the target material, and l which determines the probability of the generated iSE signals reaching the sample surface and ultimately escaping from the specimen surface. So far there is only limited experimental data for iSE yields as a function of their landing energy but good agreement has been found with what little data is available.

References

1, Ramachandra R, Griffin B, Joy DC, (2009), ‘A model of secondary electron imaging in the Helium Ion scanning microscope’, Ultramicroscopy 109, 748-757

2. Berger M J, Coursey, J S, Zucker M.A,and J. Chang, J, (2011). ‘Stopping-Power and Range Tables for Electrons, Protons, and Helium Ion’. This is freely available from: http://www.nist.gov/pml/data/star/index.cfm

3. Bethe H, (1941), The generation of Secondary Electrons, Phys Rev. 59, 940-942

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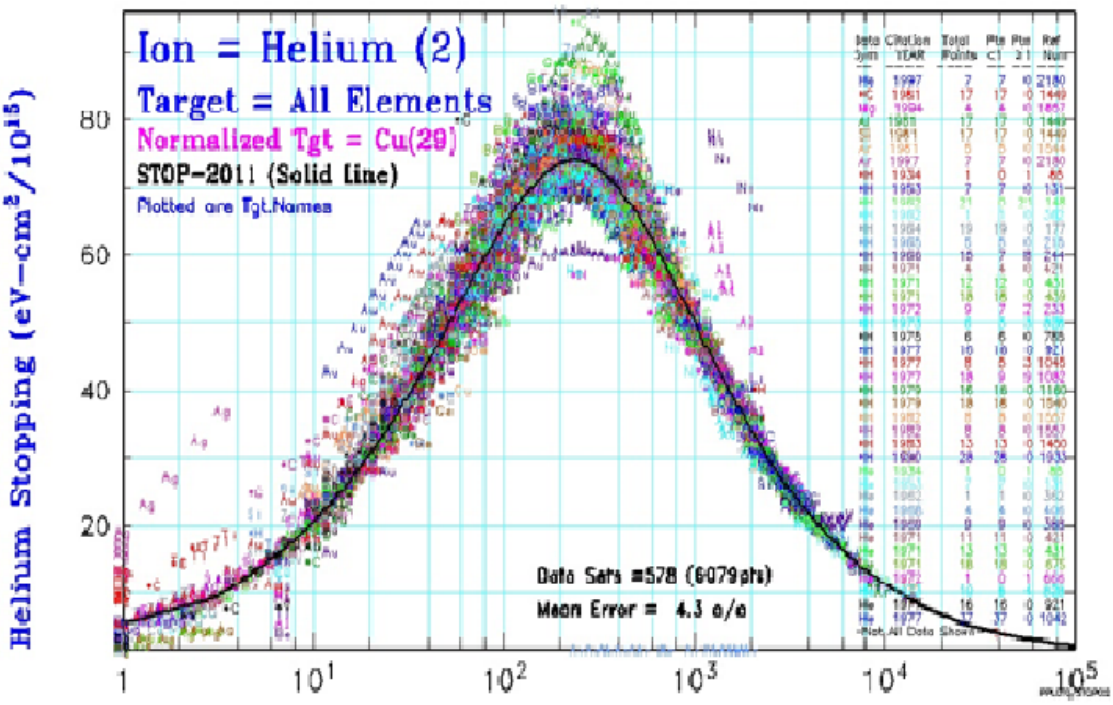

Fig. 1: Composite plot of the variation in stopping power (eV/cm2/1015) predicted by ASTAR for a helium ion source as a function of its beam energy (keV) and of the target material. The black line shows the averaged stopping power for all materials tested as a function of ion energy