Interaction of low energy electrons with iron surface: Energy loss and penetration depths

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Interaction of low energy electrons with iron surface: Energy loss and penetration depths

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Synopsis: We present Monte Carlo simulation of low energy electrons backscattered from iron (Fe) surface. We take into account both elastic and inelastic collisions during the simulation. In our simulations the primary electron energy is 150 eV and the incidence angle of the electron beam with respect to the surface is varied between 1° and 90 °. The backscattered electron energy loss distributions for primary and as well for secondary electrons and the distribution of maximum electron penetration depths in the Fe sample were calculated using only the bulk and also the surface dielectric function.

The understanding of electron spectra backscattered from solid surfaces is important for many points of views, like it is important for a surface characterization and an elemental analysis using electrons either as excitation sources or as signals for electron spectroscopies. One of the well known way for the interpretation of the experimental data is the Monte Carlo simulation (MCS) of elastic and inelastic interactions of electrons in solids.

In this work we present Monte Carlo simulation of low energy electrons backscattered from iron (Fe) surface. In our theoretical model we take into account both elastic and inelastic collisions. To include the elastic scattering of electrons by Fe atoms we use the static field approximation with non-relativistic Schrödinger partial wave analysis [1]. To include the inelastic scattering we use the dielectric response formalism [2]. In our simulations the primary electron energy is 150 eV and the incidence angle of the electron beam with respect to the surface is $\varphi = 2^{\circ}$. The results are obtained using the bulk and the surface dielectric function. We performed Monte Carlo simulation assuming that after each inelastic collision a secondary electron is generated with kinetic energy directly estimated from the energy transfer. After that, the created secondary electron is treated as a primary electron and the trace of its path is followed in the successive simulation procedure. In our theoretical results beside strong elastic peak we obtained significant inelastic contributions. We believe that our present calculations can be used to generate the input data for the theoretical investigation of collisions between electrons and a single and straight iron capillary.

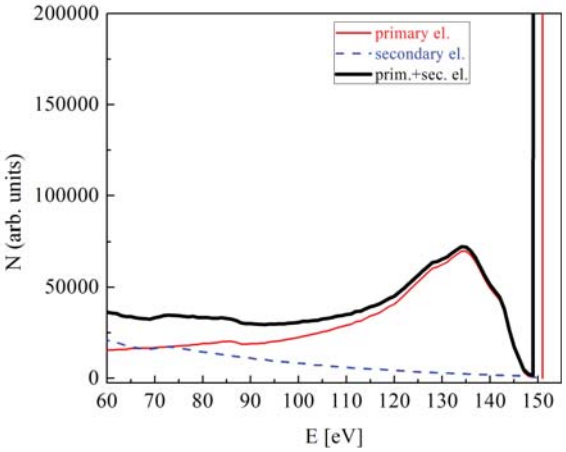

Figure 1. Energy loss distributions for primary (thin solid red line) and secondary electrons (dash blue line) using the surface energy loss function for Fe in the simulations. We also show the sum of energy loss distributions for primary and secondary electrons by thick solid black line. The initial electron energy is E = 150 eV and the incidence angle of the electron beam with respect to the surface is 2°.

References

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