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WinX-Ray: A New Monte Carlo Program for the Simulation of X-Ray and Charging Materials

Hendrix Demers, Paula Horny, Raynald Gauvin and Eric Lifshin*

Department of Mining, Metals and Materials Engineering, McGill University, Montréal, Québec, Canada H3A 2B2
*Albany Institute for Materials, University at Albany, Albany, New York, US

The modeling of the electron-matter interaction in the SEM by Monte Carlo simulation have been used to exploit and fully understand the capabilities of electron microscopes [1]. This new Monte Carlo programs, WinX-Ray [2], is a extension of the well known Monte Carlo program CASINO [1], which includes statistical distributions for the backscattered electrons, trapped electrons, energy loss and $\phi(\rho z)$ curves for X-ray. The new added features in WinX-Ray are: the complete simulation of the X-ray spectrum with horizontal and vertical layer, the charging effect for insulating specimen [3] and improvements of some algorithm of simulation.

This program is made to run on personal computer (PC) and has an easy to use Windows^{TM} based interface (see figures 1 and 2). This interface gives a complete control of the simulation parameters, the physical model used and results simulated by the program to perform the task required by the user.

The full X-ray spectrum, characteristic lines and background intensity, can be simulated including the detector efficiency and resolution response as well as the absorption by the specimen. Figure 3 shows the $\phi(\rho z)$ curves for the L_α and M_α lines of a Au specimen with and without absorption at $20k\,\mathrm{eV}$. A full spectrum is show in figure 4, including the background and the L and M lines, for a gold specimen at $20k\,\mathrm{eV}$. Also the program can be used to import a experimental spectrum for a direct comparison between the experimental and simulated X-ray spectrum for a better analysis of the result.

For the charging model, we use the one-dimensional electrostatic model for the distribution of the field and the potential developed by Cazaux [3]. In this model, the charge density is supposed uniform in a coated specimen and the electric field change only with depth. This model supposes a steady state of charging (i.e. no time dependency in the density of trapping centers) and the specimen is assumed to be irradiated by an incident beam scanned over a large area during analysis (i.e. the lateral dimensions of the scanned area are far larger than the range of incident electrons). The mean value of the electric field can be determined by a comparison of the simulated and experimental X-ray spectrum.

This program is a shareware that is available for download throw this website: **www.minmet.mcgill.ca/montecarlo**. The details related to the use of this program are also found at this address.

Acknowledgments

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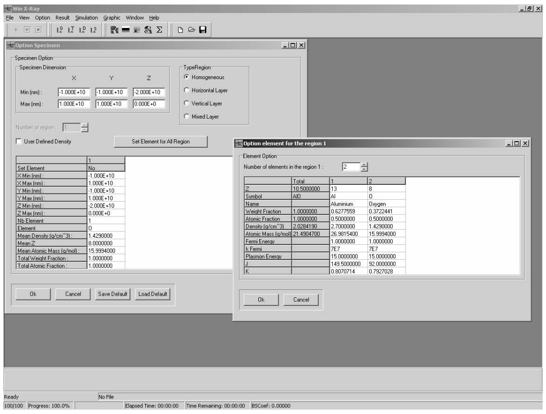

Fig 1.

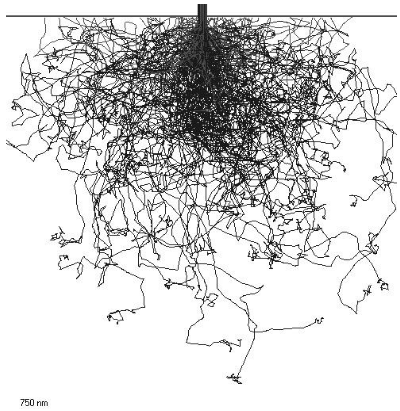

Fig 2.

FIG 1. Program interface snapshot.

FIG 2. Electrons trajectories for Au at $20k$ eV.

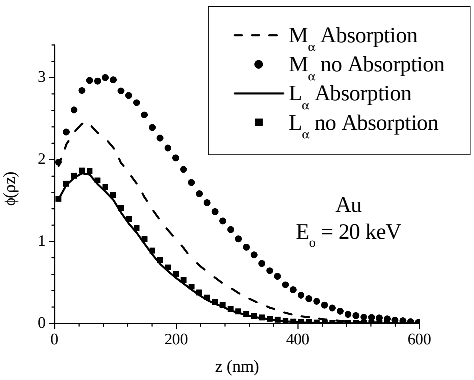

Fig 3.

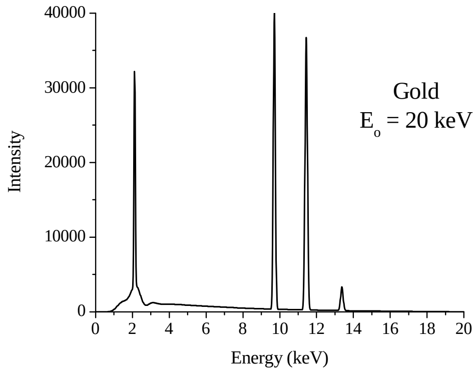

Fig 4.

FIG 3. $\phi\,(\rho z)$ curves for the L_α and M_α Lines of a Au specimen at $20k$ eV.

FIG 4. X-Ray spectrum for a Au specimen at $20k$ eV.

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