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On the Simulation of True EDS X-Ray Spectra

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The Monte Carlo method has been used recently to simulate complete EDS X-Ray spectra of planar and of rough surfaces[1]. However, these simulations only include the statistics of the generation and emission processes that are shown by varying the number of simulated electrons. Above a critical number of incidents electrons (5000 to 20000 simulated trajectories), the effects on the number of electrons on the shape of the X-Ray spectrum becomes negligible. Since the X-Ray yields are very low (10^{-4} to 10^{-6} typically), the statistics of the EDS spectra are dictated by the number of detected photons, i.e. by the physics of the detection process. In order to simulate true X-Ray spectrum including the effect of the statistic of the detection process, a new Monte Carlo program was developed.

This new Monte Carlo program simulates the EDS detection process. From the simulated emitted spectrum, the ratio of the intensity of the characteristic lines to that of the total bremstrallung intensity is computed. A random number is generated and if it is smaller that the ratio, a characteristic lines is generated. From the weight of the characteristic lines, a random number is used to choose the appropriate line. If the first random number is greater than the ratio, a bremstrallung photon is generated and its energy is picked with another random number and the computed energy distribution. The photon with specific energy is then send through the detector and its absorption location computed. Then a photoelectron is generated and Monte Carlo simulations compute its diffusion through the crystal. Its energy dissipated in the crystal is used to compute the number of electron – holes pairs generated including the statistical fluctuations with the Fano factor. The effect of incomplete charge collection with the Si dead layer is included in this program[2]. Figure [1] shows the emitted X-Ray spectrum used to generate the photons that are sent through the EDS detector. It is a Fe- 50 (wt%) B allow at incident electron energy of 8.3 keV. Figure [2] shows the simulated EDS X-Ray spectrum with a total of 100 000 photons. Clearly, the effect of the statistical noise coming from the detection process on the bremstrallung is visible. Also, in this simulation, very bad parameters for incomplete charge collection were used, giving the disappearance of the B K_{α} line in the bremstrallung.

References

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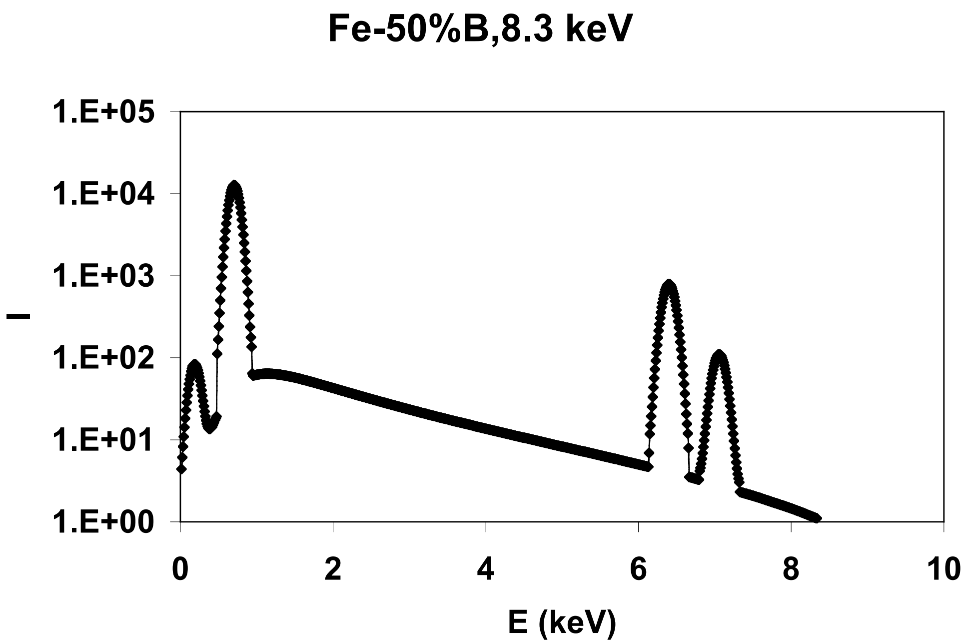

Figure 1 Emitted Fe- 50 (wt%) B X-Ray spectrum used to generate the photons that are sent through the EDS detector.

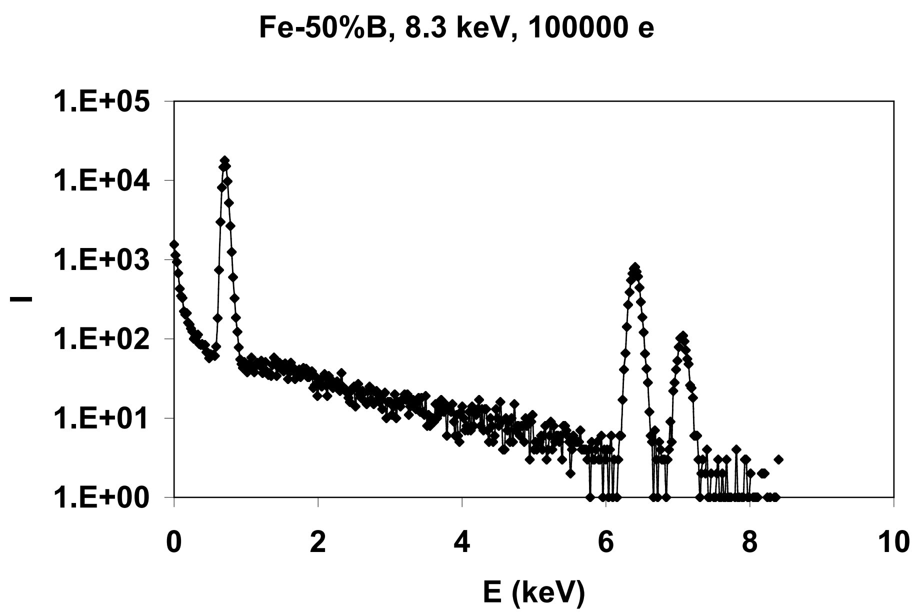

Figure 2 Simulated EDS X-Ray spectrum with a total of 100 000 photons.

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