CALCULATION METHODS OF X-RAY SPECTRA: A COMPARATIVE STUDY

B. Chyba, M. Mantler, H. Ebel, R. Svagera
Technische Universität Wien, Austria

The accurate characterization of the spectral distribution of x-rays emitted from x-ray tubes is crucial in many analytical investigations. This includes the primary production of radiation within the tube target as well as absorption by the tube window and eventually applied filters.

In this work two calculation methods of tube spectra are presented and compared: an analytical program using algorithms proposed by H. Ebel (DXC 2005) and a public available software package (MCNP[1]) based on Monte-Carlo code. Calculations were also compared to measured spectra generated on a SEM with Au and Cu targets at voltages from 10kV to 30kV.

Good agreement is achieved between both computational methods except for some characteristic lines (with respect to energy as well as intensity) as MCNP seems to omit many L-lines and all M-lines. Both programs cut off energies below 1keV.

Measurements were in good agreement to both simulations for the high energy part of the spectra. This is an important result for applications where accurate knowledge of the spectral distributions at high excitation voltages (eventually up to several 100 kV) are required. A topical example is computed tomography (CT) where the demand for increased image resolution causes twofold problems: In clinical diagnostics the absorbed dose of the radiation from a CT device by the patient may already come to a critical level according to recommended dose limits, which makes the need for dose calculations obvious. On the other hand, accurate non-destructive material testing in industry based on CT with cone beam geometry requires detailed mathematical modelling of all interactions of the primary beam with the analyzed object including scattering and excitation of secondary radiation; such data can be used for proper interpretation of the measured image as well as for finding optimized conditions for a measurement.

[1] Monte Carlo N-Particle Transport Code, Los Alamos National Laboratory.