FUNDAMENTAL PARAMETER METHOD FOR LOW ENERGY REGION INCLUDING CASCADE EFFECT AND PHOTOELECTRON EXCITATION

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Low energy characteristic x-ray measurements take a key role in XRF analyses both of light elements and of thin layer materials. Besides primary excitation by source x-rays and secondary excitation by fluorescent x-rays, some secondary processes contribute to low energy characteristic x-ray emission. One of them is the excitation by photoelectrons, which has been evaluated experimentally. The other one we will present is the emission of L-series x-rays following radiative and non-radiative relaxations of K-shell ionization. This "cascade" effect occurs when the energy of source x-rays is higher than the K-shell binding energy, or mainly for L-lines of low energy in a measurement by using a XRF spectrometer with for example a Rh-target end-window tube. The contribution of the cascade effect exceeds the direct excitation in these situations. Obviously this effect can contribute also to M-series x-ray emission.

We demonstrate this effect with Cr-L line measurements by using monochromatic radiation of high spectral purity and well-known flux provided by two PTB beamlines at the electron storage ring BESSY II. The plane grating monochromator beamline for undulator radiation covers the energy range from 0.1 keV to 1.9 keV and the four-crystal monochromator beamline for synchrotron radiation the one from 1.75 keV to 10.5 keV. The Cr-L intensity shows a considerable jump at Cr-K edge energy as raising the source photon energy, indicating the magnitude of the cascade effect. The newly developed fundamental parameter method including the cascade effect as well as the excitation by photoelectrons shows good agreement with the measurement. The evaluation of this computation method for the measurement by using a conventional XRF spectrometer will also be presented.