New measurements of X-ray mass attenuation coefficients

Y. Ménesguen[(1)], M.-C. Lépy[(1)], B. Beckhoff *et al.*[(2)]
(1) CEA, LIST, Laboratoire National Henri Becquerel (LNE-LNHB), 91191 Gif-sur-Yvette cedex, France
(2) Physikalisch-Technische Bundesanstalt, Abbestr. 2-12, 10587 Berlin, Germany

X-ray applications based on fluorescence analysis for quantification with or without reference specimens require an accurate knowledge of fundamental atomic data to provide reliable results associated with low associated uncertainties. For example, mass attenuation coefficients are basic parameters characterizing the interaction of the incident beam in the sample and also the attenuation of the emitted fluorescent radiation. Users of attenuation coefficients can find these collected in databases made accessible through the internet on websites such as the National Institute of Standards and Technology (NIST) one (http://www.nist.gov/pml/data/index.cfm), which provides the compilation made by Hubbell, under the name XCOM. Certain measurements and calculations carried out by Chantler are also made available by NIST under the name FFAST. The database from the Center for X-Ray Optics (CXRO) calculates filter transmission, mirror reflectivity etc. based on Henke's compilation. Another accessible database called EPDL97 has been assembled by the AIEA.

Although very practical for the user, some of these tables are based on rather old measurements or on theoretical calculations where measurements were missing. However, the associated uncertainties are often rather quite large, especially for low photon energies, i.e., below 1 keV. Indeed, the smaller the photon energy, the more difficult the measurement of mass attenuation coefficients with reliable uncertainties becomes. The estimated uncertainties of existing values below 1 keV are a few % for all elements and certainly above 25 % for photon energies below 500 eV [1]. Recent measurements have also revealed significant differences of a few % above certain K-edge absorption thresholds [2] for transition metals.

New measurements of mass attenuation coefficients carried out by the Laboratoire National Henri Becquerel took the advantage of using tunable monochromatic radiation at SOLEIL synchrotron, on the METROLOGIE beamline and using a specific procedure. Within the frame of different institutional and industrial metrology research projects, the LNHB & partners studied several elements from photon energies as low as 100 eV up to 35 keV, special care was taken to ensure reliable uncertainties. We compare the new experimental obtained values with the EPDL97 library and other tables.

[1] M. O. Krause, C. W. Nestor, C. J. Sparks, and E. Ricci, X-ray Fluorescence cross sections for K and L X-rays of the elements, Oak Ridge National Laboratory, vol. 5399, 1978.
[2] Y. Ménesguen, M Gerlach, B Pollakowski, R Unterumsberger, M Haschke, B Beckhoff and M-C Lépy, "High accuracy experimental determination of copper and zinc mass attenuation coefficients in the 100 eV to 30 keV photon energy range", Metrologia, 2016, *53*, 7-17