Application of SR-TXRF-XANES for the analysis of indoor aerosol samples at BESSYII and ELETTRA

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The term airborne particulate matter usually refers to particles present in air having aerodynamic diameters less than 10 µm (PM_{10}). These particles and especially the fine fraction below 2.5 µm ($PM_{2.5}$) are of particular interest, as they can enter the human respiratory system and cause acute and chronic respiratory or cardiovascular diseases. The composition and health effects of airborne particles in outdoor air have been studied abundantly, so that our focus lies on the analysis of airborne particle samples collected indoors. Health effects do not only depend on the chemical elements present in the particles, but also on their chemical bonding state. This chemical speciation can be obtained using X-ray absorption near edge structure (XANES) analysis, which requires a tunable excitation source and therefore has to be carried out at synchrotron facilities. For this work, samples were collected in an office room of the Atominstitut building.

The BAM*line* at BESSYII, Berlin, features a double-crystal monochromator (DCM) with an energy resolution $\Delta E/E$ of about $2 \cdot 10^{-4}$, which makes it suitable for X-ray absorption fine structure (XAFS) applications. An SR-TXRF vacuum chamber, developed by the Atominstitut, is located at the beamline. The chamber offers a sample changer for up to 8 quartz carriers suitable for total reflection X-ray fluorescence analysis (TXRF) and was equipped with a 30 mm² silicon drift detector (SDD). Aerosol samples were produced using a modified three-stage Dekati™ impactor, collecting particles >1 µm in three size fractions on coated 30 mm quartz reflectors. XANES analysis was performed for the elements Cr, Cu and Zn. Results obtained from these measurements will be presented.

The X-ray Fluorescence beamline at ELETTRA operates in partnership with the IAEA an ultra-high vacuum instrument with a 7-axis manipulator suitable for a variety of X-ray analytical techniques, such as grazing incidence X-ray fluorescence analysis (GI-XRF), TXRF, X-ray reflectometry (XRR) and XANES. Samples were produced using a four-stage Sioutas Personal Cascade Impactor, which produces size-fractionated samples down to the sub-µm range (>250 nm). Direct sampling was performed on coated 1” Si wafers suitable for TXRF. Cu- and Zn-K edge SR-TXRF-XANES analysis was carried out on samples of all four impactor stages. Results of these experiments will be shown.