Quantitative elemental speciation of aerosols by means of reference-free X-ray spectrometry

Yves Kayser[(1)], Philipp Hönicke[(1)], Janos Osan[(2)], Beatrix Pollakowski-Herrmann[(1,3)], Stefan Seeger [(3)] and Burkhard Beckhoff[(1)]

(1) Physikalisch-Technische Bundesanstalt, Abbestr. 2-12, 10587 Berlin, Germany
(2) Centre for Energy Research, Budapest, Hungary
(3) Federal Institute for Materials Research and Testing BAM, 12489 Berlin, Germany

E-Mail: yves.kayser@ptb.de

The physical and chemical analysis of aerosols using reliable and physically traceable methods is of importance for a thorough investigation of airborne particles in order to support a better understanding of their origin and impact on health and climate effects. Within the AEROMET project the aim of PTB's X-ray spectrometry group is to develop and establish traceable and reliable X-ray methods to measure the elemental mass deposition per unit area, the elemental composition of particulate matter supported by a flat substrate. This approach can substantially contribute to support quantitative analytical methods during on-site measurement campaigns where portable instrumentation is employed by qualifying suitable calibration samples and by investigating a posteriori samples collected during the field campaign.

During field campaigns in Hungary and Italy, airborne particles were sampled in a time and size-dependent partitioning using cascade impactors in which they were deposited on substrates suitable for TXRF analysis. A selection of the samples collected and analysed by means of different techniques during the field campaigns has been reinvestigated using reference-free X-ray spectrometry. In comparison to the mobile TXRF instrumentation used on-site, a mapping of the collected samples was required due to the smaller spot size, hence smaller investigated area when using synchrotron radiation. A reference-free quantification of the total mass of the deposited material could be carried out and the results allow for a validation of the quantitative results reported from the field campaign. This is important in view of the qualification of mobile instrumentation. Indeed, an accurate quantification relies heavily on the sample loading on the top of the substrates, hence on the collection time and the pollution level. It was found that the X-ray standing wave field is drastically changed for high particulate load which makes a correct quantification tedious and requires correction factors for the absorbance within the collected deposit.

In addition, artificial micro- and nanostructured samples were investigated by means of reference-free GIXRF in view of a future qualification of quantitative and size-dependent investigation of particulate matter using X-rays. The developed structures are foreseen for a calibration of instrumentation developed for a non-destructive and contact-less analysis of deposited aerosol samples.

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