INVESTIGATION OF XSW RELATED EFFECTS ON REFERENCE-FREE QUANTITATION OF NANOPARTICLES

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Air quality issues of large cities are becoming more and more important due to the dynamic growth of surface and air traffic. The sources of fine particulate matter ($PM_{2.5}$) have large temporal and spatial variation. In order to correlate the elemental composition of fine particulate matter in different size fractions to sources, special instrumentation and analytical technique need to be used. A combination of cascade impactor sampling and Total reflection X-Ray Fluorescence (TXRF) analysis employing synchrotron radiation allows for the determination of ultra-trace amounts (pg m^{-3}) of most elements from samples collected for less than 20 min. TXRF allows for non-destructive analysis of nano- and microparticles located on semiconductor surfaces [1]. In combination with X-ray absorption spectrometry, the technique is able to contribute to the speciation of the atmospherically important elements [3].

In TXRF geometry, an X-ray Standing Wave field (XSW) results from the superposition of incident and reflected beam. Different particle dimensions and loads are affected differently by the XSW. For reference-free quantitation in TXRF, the influence of deposited particles on the angular dependence of the XSW is to be examined by tuning the angle of incident radiation.

For methodological investigations (a) artificial structures (pads) and (b) particles of known composition, have been measured. The artificial structures of 2.7 µm diameter with different heights in the range of 10 nm to 100 nm were deposited on the surface using a lift-off technique. Sub-micrometer copper sulphate particles were deposited on Si wafer surfaces through a May-type cascade impactor also used for sampling of atmospheric aerosols. The samples containing $CuSO_4$ particles were prepared in four size fractions in the 250 nm to 4 µm range. Measurements in both the soft and hard X-ray range were performed in the PTB laboratory at BESSY II. All instrumentation used is calibrated with respect to response behaviour and efficiencies [2]. Initial results indicate the high potential of this methodological approach to further contribute to reliable TXRF quantitation.

The artificial metallic pads show a pronounced angular dependence of the X-ray intensities. The measured angular scans are to be interpreted by modeling the XSW field intensity in dependence of the height above the Si wafer surfaces. By use of calculated XSW intensities, reference-free quantitation gave rather good agreement with the results expected.

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