GRAZING-EXIT-XRF EXPERIMENTS AT HASYLAB BEAMLINE L

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Total reflection x-ray fluorescence analysis (TXRF) operates with the incident beam impinging below the critical angle of total reflection on the surface of a flat polished surface of reflector. The interference between incident and reflected beam causes in case of microcrystalline samples an intensity increase of the fluorescence signal by a factor (1+R) where R is the reflectivity numerically close to 1. The additional effect due to the penetration depth in the nm region is a low background. Both effects are leading to excellent detection limits in TXRF and are widely used in ultra trace element analysis. Grazing incidence XRF (GI-XRF) uses the angle dependent wavefield intensity in order to characterize the structure of layered materials and the composition gradient of materials that are inhomogeneous along the direction perpendicular to the surface. The inverse GI-XRF with the incident beam perpendicular to the reflector's surface and collecting the fluorescence under grazing angle can also be applied [1]. This mode of analysis was named grazing exit X-ray fluorescence (GE-XRF) and is theoretically based on the reciprocity theorem [2]. The interference in this case is not between primary and reflected beam but among the superposition interference of the fluorescent waves emitted from the sample and observed under the critical angle of total reflection φ_{crit}.

A GE-XRF experiment was performed at HASYLAB beamline L using the newly designed equipment from the Atominstitut Vienna X-ray group. The setup was designed with the axis of rotation of the detector exactly in the plane of the reflector. The experiments were performed with the aim to study XANES self-absorption effects, which were observed previously in GI-XRF geometry.

A series of dried residues with different total amounts of arsenic masses on quartz reflectors were investigated. Angle dependent measurements of the samples were carried out by rotating the detector around the sample in the center of the reflector. The experimental data and the theoretical curves showed good agreement. The GE setup allows spatially resolved measurements of the sample. In order to achieve measurements with higher lateral resolution a polycapillary half lens was used to produce a focal spot of 40µm in diameter. With this setup 2D-scans of the samples have been performed and compared with data from confocal microscopy. XANES measurements of the samples were performed and compared with data gained for the same samples under GI conditions.

[1] T. Noma, A. Iida, K. Sakurai, Phys. Rev. B 48 (1993) 17524.
[2] R.S. Becker, J.A. Golovchenko, J.R. Patel, Phys. Rev. Lett. 50 (1983) 153.