Polycapillary X-Ray optics alignment in confocal micro-XRF using ANPxyz101 positioners

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Micro x-ray fluorescence analysis (micro-XRF) is a well established tool to determine the spatial distribution of major, minor, and trace elements in a sample. It is widely used to investigate samples from different fields (biology, geology, life science, etc.). The method is nondestructive, requires little sample preparation, and allows simultaneous multi-element detection if an energy dispersive (EDX) detector is used. Most available micro-XRF spectrometers operate in air which does not allow the analysis of low-*Z* elements. Therefore, a special micro-XRF spectrometer has been installed at the Atominstitut of the TU Wien [1]. The key component in this spectrometer is the polycapillary x-ray optics which focuses the x-rays from the x-ray tube to a small spot (31 µm FWHM for Mo-Kα) on the sample. The optics needs to be aligned in two ways. First, the entry focus of the x-ray optics has to be matched with the focal spot on the anode of the x-ray tube. Second, the sample has to be aligned in respect to the optics to achieve minimum spot size. Due to the fixed focal length of the optics and the fact that the whole setup is inside a vacuum chamber, the positioners to align the optic have to be very compact.

A further extension of micro-XRF is confocal micro-XRF. Therefore, a second polycapillary optic (a half lens) has to be installed in front of the EDX detector. The second optic needs to be aligned in a way that the focal spots of both (primary and secondary) optics overlap to create a well defined measurement micro-volume. This enables us to determine the elemental distribution inside a sample in three dimensions by moving the sample relative to the measurement volume. Two xyz-stacks consisting of four ANPx101 and two ANPz101 are used to align the optics. Figure 1 shows the confocal setup inside the vacuum chamber. The positioners' travel range of a few millimeters as well as sub micrometer resolution is required for our purposes. Long time stability is also very important as ideally an alignment must not change over time. The attocube positioners easily fulfill both these requirements. A 2D scan with the primary beam polycapillary across the focal spot of the x-ray tube (Figure 2) shows a clear maximum of intensity (optimum alignment). The optic in front of the detector is aligned in a similar way. Figure 3 shows a 3D measurement of a cross made from 10 µm copper wire which is placed on an x-ray screen and fixed using adhesive tape. This clearly demonstrates our ability to measure elemental distributions in three dimensions on the micrometer scale.

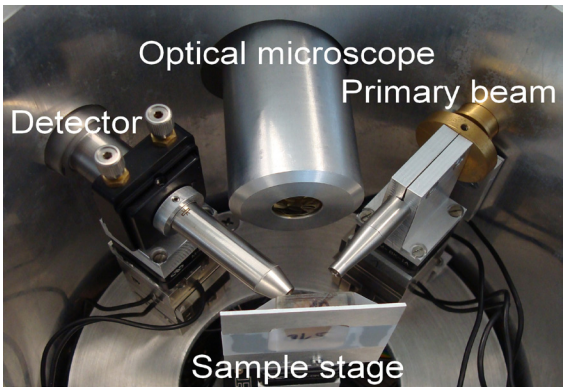

Figure 1: *Photograph of the confocal µXRF setup. The incident beam impinging from the right induces fluorescent radiation in the sample, which is collected by the detector on the left. An attocube xyz-positioner stack is placed underneath each polycapillary optics.*

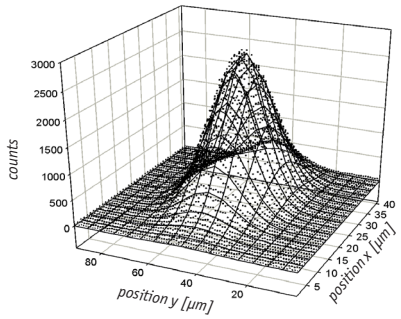

Figure 2: *2D scan of the primary polycapillary showing the point of optimum alignment (peak maximum).*

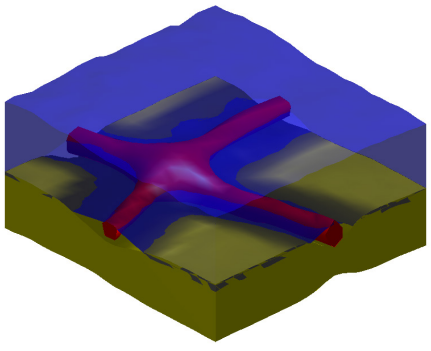

Figure 3: *3D scan of a 10 µm copper wire cross (red) on x-ray screen (yellow) fixed with adhesive tape (blue).*

References

[1] S. Smolek, C. Streli, N. Zoeger, and P. Wobrauschek, Rev.Sci. Instr. **81**, 053707 (2010).