

High resolution XRF using capillary optics

D. Tonneau, M. Dehlinger, S. Lavandier, I. Ozerov, F. Bedu, C. Fauquet

CNRS, UMR7325,13288, Marseille, France
Aix-Marseille Univ., CINaM, 13288, Marseille, France

didier.tonneau@univ-amu.fr

Abstract

Classical XRF measurements are commonly performed in synchrotron facilities because the technique requires a high brightness X-ray source. Thanks to the development of polycapillary lens [1], sharply focusing X-ray beams on samples, the technique can now be performed in laboratory. The lateral resolution is essentially linked to the incident beam geometry and is currently in the range of tens of micrometers. On the other hand, imaging chemical composition and structure at nanometer dimensions is a keypoint in nanoscience, especially for structures and properties characterization of embedded interface. For this purpose, non-destructive techniques, based on X-ray irradiation have a leader place.

We have developed an experimental test-bed to estimate the ultimate resolution reachable by XRF. This equipment includes a microfocused X-ray low power source, and an EDX detector equipped with a cylindrical glass capillary, increasing the X-ray fluorescence collection yield. It is based on a confocal configuration since the detected signal comes from the intersect between the volume excited nearby the source lens focal plane and the analyzed volume in the aperture of the capillary.

The set-up was evaluated using test samples consisting in a molybdenum grid (250 μ m mesh) glued on an iron substrate. Significant XRF signal level with 50s acquisition time was recorded through a 25 μ m radius capillary for detection. Spectra were recorded along a scan line crossing the grid. The spectroscopic signal shows good correlation between molybdenum K α and iron K α signals, as shown in figure 1. A similar grid was then used as a mask for thin titanium pattern evaporation on a cobalt sample. A 5 μ m radius capillary was used to collect the sample X-ray fluorescence. The Cobalt K α line is detected on the whole line scanned, since titanium is thin enough to allow the Co-K α photons to escape. The titanium spectroscopic trace fits with the expected pattern.

The use of thin capillaries for XRF detection opens the way to 500 nm lateral resolution in lab and 50 nm using brighter sources such as synchrotron facilities. Furthermore, approaching the capillary extremity towards the surface in near field mechanical interaction would allow to image the surface topography simultaneously to sample chemical mapping. This concept has already been demonstrated in previous works [2, 3].

References

[1] See for example: A. Bjeoumikhov, S. Bjeoumikhova, in *Modern Developments in X-ray and Neutron Optics*, ed. By A. Erko, M. Idir, T. Krist, A. G. Michette, Springer Series in Optical Science, Vol. 137, p287-306 (2008).

[2] C. Fauquet, M. Dehlinger, F. Jandard, S. Ferrero, D. Pailharey, S. Larcheri, R. Graziola, J. Purans, A. Bjeoumikhov, A. Erko, I. Zizak, B. Dahmani and D. Tonneau, *Nanoscale Research Letters* **6** (2011), 308.

[3] Mapping of X-ray induced luminescence using a SNOM probe'
F. Jandard, C. Fauquet, M. Dehlinger, B. Dahmani, A. Bjeoumikhov, S. Ferrero, D. Pailharey, D. Tonneau, *Appl. Surf. Sci.* **Vol. 267** (2013), 81-85.

Figures

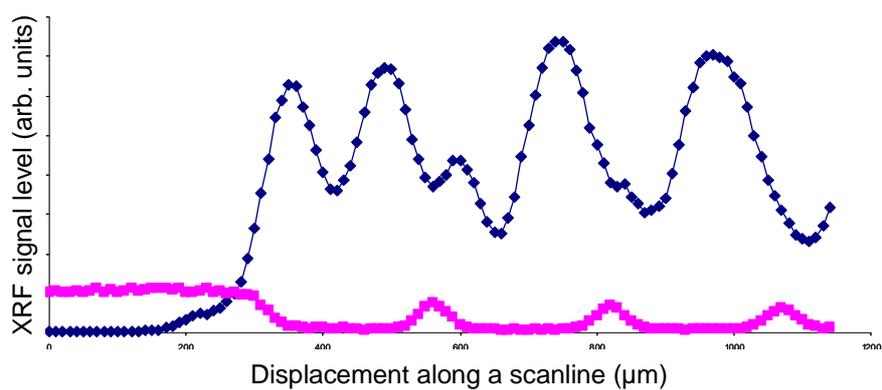


Figure 1 : Fe (blue) and Mo (pink) signals recorded along a scan line on the sample.