| ESRF | **Experiment title:** Heavy-element sensitive tomography using tunable beams | **Experiment number:** MI-219 |
|---|---|---|
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**Report:**

The aim of this experiment was to study the feasibility to perform heavy-element, in this case uranium, sensitive tomography of artificial and natural samples. In order to do this a sample is scanned using a wide syncbrotron beam having two different energies, one below and one above the K edge of the element under study. The difference **spectrum** then becomes only sensitive to the element under investigation.

At ID15A two 5mm thick bent Si crystals, having a asymmetric cut of 37.76 and 4.26 degrees for the [111] reflection, provided the monochromatic beam in fixed exit Laue-Laue mode. A reasonable homogenity was such obtained over a 5mm high and 20mm wide surface at the sample position. The beam energies used were 114.5 and 116.5 keV.

As the beam intensity prohibits the standard procedure used in ref [l], it was decided to use a CCD camera as detector for this experiment. Because this camera would be the first to operate above 100 keV, the ESRF detectors group studied carefully its design and opted for the use of a 80 µm thick $Gd_2O_2S$:Tb layered MB-Detail phosphor screen. Using an 1 : l optics and a mirror the screen is observed by the CCD camera, having a sensitive area of 24.6x24.6 $mm^2$. The CCD has 1024X1024 pixels and a 14 bit dynamical range. This solution is also very interesting from a tomographic point of view as the position sensitivity of the detector makes that the sample only needs to be rotated. The standard procedure used rotations of the sample, place sample at second height, rotate etc.... After the whole sample was scanned the beam energy was changed and the whole procedure repeated at the second energy. After each energy change the beam intensity and homogenity was measured with the sample removed. In total eight different samples were scanned. They were chosen such that the uranium concentration, distribution and granularity was very different, allowing the assessment of the possibilities of the method. Because of the wide variety of samples the CCD camera had to measure with exposure times which ranged from 2 ms to 2 s. To adapt the amount of data to the structure of the sample different. binnings of pixels were chosen defining data pixels between 100x100 and 25x25 $micron^2$.

The preliminary off-line analysis of the collected data, shows that heavy element sensitive tomographies using the ESRF beams are possible and have a great potential. The results also prove that the absorption process of photons above 100 keV, do not degrade the spatial resolution of the detector. The resolution was limited due to light scattering in the powder phosphor screen to approximately 50 µm. The results are illustrated in Figures 1 and 2, which show the uranium concentration in a target containing five natural crystallites.

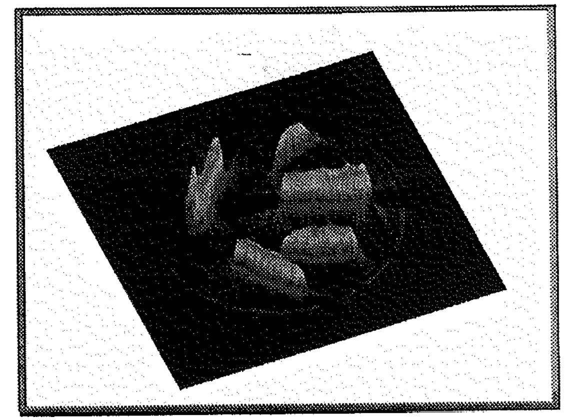

Figure 1: The uranium content (proportional to height) in a 50 µm thick layer of a 16mmx16mm wide sample containing five crystallites.

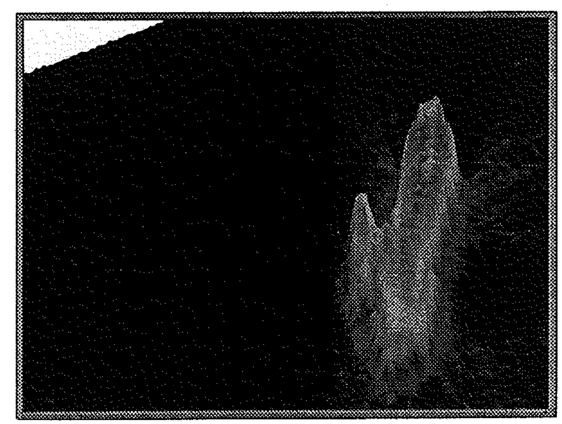

Figure 2: A zoom onto the upper left crystallite.


[I] M. Bertschy, J. Jolie, W. Mondelaers, Applied Physics A62 (1996) 437.