<table>
<tr><td>ESRF</td><td>Experiment title:
µ-tomography of heavy Z material by means of high energy synchrotron radiation</td><td>Experiment number:
MI-297</td></tr>
<tr><td>Beamline:
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<tr><td>Shifts:
18</td><td>Local contact(s):
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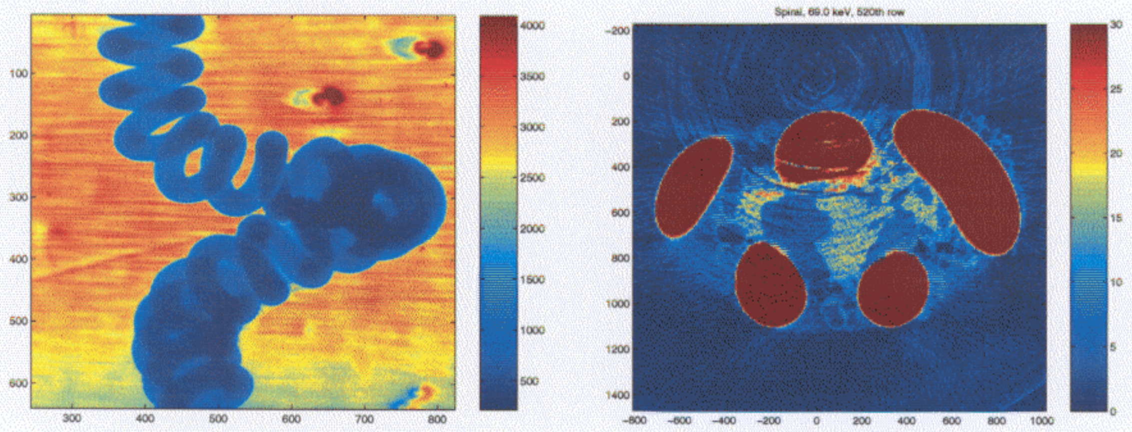
Report:

µ-tomography with very hard X-rays has already been shown to be valuable tool in the investigation of the distribution of U in dense matrices [1]. In these experiments a fixed-exit monochromator selects energy bands above and below the corresponding K-edge and a resolution of ~ 50 µm was achieved.

During the experiment MI-279 we evaluated for the first time the new CCD detector setup at ID15a. It consists of a Sensicam detector head with 1280x1024 pixels with a nominal size of 6.7x6.7 μm^2. The head is coupled via a 1:1 objective to the screen, which converts the high energy photons into visible light. In order to combine high resolution and high efficiency we used an optically transparent YAG crystal in which the light scatters less than in the usual powder screens [2]. The projection of the crystal thickness onto the CCD limits now the lateral resolution. On the other hand the efficiency decreases with thickness due to reduced absorption. By differentiation of the edge spread functions from edge scans of a sharp structure and consequent interpolation the lateral resolution was determined. For a 200 µm thick YAG-crystals 11.4 µm (FWHM) were achieved with little variation on the crystal thickness. Especially thinner crystals did not improve the resolution and it is therefore assumed that the resolution was determined by imperfection of the photo objective. The part of the proposal concerning further improvement of lateral resolution using a divergent beam method and placing the sample closer to the monochromator could not be tested, because no suitable monochromator was available. The camera itself was controlled by a beamline computer. Tomography scans were started on the beamline computers using SPEC and data were stored on the PC. In between samples the data had to be dumped onto Silver due to limited disk space.

We have investigated several samples containing tungsten and gold. It was aimed to demonstrate high resolution in the tomography scans and furthermore to investigate to what extent one is able to enhance or to reduce contrast for the heavy element from the image. Therefore tomography scans directly below and above the K-edge or in a large energy interval were carried out, respectively. In the later case two energies below (63.96 keV) and above (115 keV) the W K-edge were chosen, were the absorption coefficient μ(E) was equal. It was unfortunately obtained that the lateral resolution of the detector slightly deteriorated at 115 keV and the scans therefore cannot be compared with those below the K-edge. Especially the W samples were rather thick (one was a 300μm wire and the other a 1000μm massive pen-ball) and the high absorption directly above the K-edge made tomography scans impossible. Directly below the edge and far away from it we observed a very good contrast.

Results from the imaged objects show that the obtained resolution was preserved thoughout the tomography scans and reconstruction process. As an example we show here the results for an electron filament, which is a 300 μm W wire wound up in a spiral and having an additional bent shape leading to the electron emitting source. The filament has in addition to the wire a Ba containing paste, which reduces the electron work function. The distribution of this paste and especially its distribution on the wire surface are of interest. The figures show the lateral projection of the filament (left) and a reconstructed horizontal slice in the lower part of the filament (right).



In the first figure one easily recognizes inhomogenities in the beam profile due to optical elements in the beam path. They do depend only little on the photon energy. In the second panel several pieces of the W filament are seen and inbetween them the paste is obtained. A structure of the paste with large ‘bubbles’ can be found. The question, if these bubbles also occur also at the filament center, could not be solved, because the high absorption in this area (several wires in certain directions during tomo-scan) reduced further the available dynamic range of 12 bit. For future studies 16 bit would be benefitial.

[1] Th. Materna et al., J. Synchrotron Rad. **6**, (1999) 1059-1064