Beamtime report on experiment SI-1970

We have performed a coherent diffraction experiment on ID13 on GaAs nanowires. The photon energy was 15.25 keV. The GaAs nanowires were mounted on a TEM grid and positioned at the focal plane of two cylindrical Si compound refractive lenses. The beam size was about 150 x 150 nm2 at the focus 13 mm behind the last lens. The sample position was adjusted by a set of piezo stages. In addition, the sample could be rotated around both axes perpendicular to the in-coming beam direction. Especially important was the rotation around the vertical axis which was scanned to sam-ple the diffracted intensity in a 3D volume around a Bragg peak.

A fluorescence detector was positioned close to the sample perpendicular to the beam. It was used to locate a single wire on the TEM grid, by mapping the combined fluorescence signal of Ga and As. Three isolated GaAs nanowires could be found. The coherent diffraction signal was recorded by a MAXIPIX detector with 256 x 256 pixels. The detector was positioned 520 mm downstream from the sample to record the forward scattering signal. A 1.5 mm wide beamstop was used to prevent damage to the detector from the direct beam. For the measurements of the Bragg peaks the detector was moved away from the optical axis. At an angle of $\alpha = 11.3°$ the [101] WZ Bragg peak was accessible. An example of a diffraction pattern measured in this geometry is shown in the figure below.

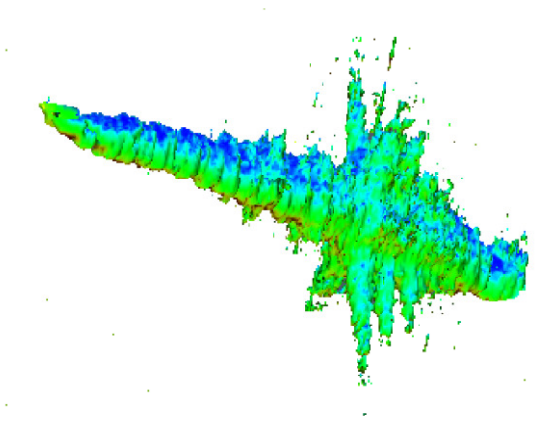

Figure 3 A 3D view of the Bragg peak in reciprocal space combined of 60 diffraction patterns.

We measured the diffraction signal around a WZ [101] Bragg peak for different angles θ of sample rotation, covering a range of 3 degrees with a step size of 0.05 degrees, see figure. During the scan the diffraction signal drastically changed depending on the angle of rotation. The Bragg peak was observed over a range of 3 degrees, in which the position of Bragg peak on the detector changed. The different positions of the Bragg peak in the detector correspond to different scattering vectors and is the sign of a crystal truncation rod (CTR) originating from the center of the Bragg peak. This gives rise to an elongated shape of the Bragg peak.

Due to instabilities during the measurements the contrast in the images and the number of available fringes was not sufficient to reconstruct the recorded diffraction patterns with conventional iterative phase retrieval methods. This has previously been performed for shorter, thicker and/or more uniform nanowires by other groups. The instabilities probably come from charging of the TEM grid. A complicated structure like the one studied here, with the existence of several independent domains has not yet been reconstructed successfully. It appears clear that the road forward for anything but forward scattering is to use nanowires fixed on a substrate, which allows much easier handling and orientation as well as greater stability.

The experiment has been written up as a short paper and send to Phys.Stat.Sol.B as presented at the recent XTOP meeting. It has also been presented as a poster at the Users Meeting.