Micro X-ray diffraction imaging of bulk polycrystalline materials

T. Wroblewski, HASYLAB, DESY, Hamburg, Germany
A.A. Bjeoumikhov, IfG, Berlin, Germany
B.Hasse, TU Berlin, Berlin, Germany

The Materials X-ray Imaging (MAXIM) method allows the imaging of polycrystalline materials using the diffracted radiation. It applies a bundle of parallel tubes in front of a position sensitive detector (PSD). These tubes suppress cross fire of the radiation diffracted at different sample locations. Therefore, an image of the radiation diffracted in the direction parallel to the tubes is obtained.

A dedicated instrument for MAXIM investigations was realized at HASYLAB beamline G3. The experimental setup consists of a micro channel plate (MCP) as collimator array in front of a directly illuminated CCD. The MCP currently used has a thickness of 4 mm and channels of 10 μm diameter with a center to center distance of 12.5 μm. The resulting angular acceptance is 2.5 mrad. The spatial resolution is given by this acceptance times the sample to CCD distance. At 5 mm (including the 4 mm MCP thickness) this resolution matches the pixel size of the CCD of 13 μm.

The MAXIM technique has been applied in several investigations of materials including the determination of strain and texture but also dynamical effects like recrystallization have been studied. With the setup realized at beamline G3 the usable X-ray energy range is restricted to energies below 12 keV by the limited absorption of both the CCD and the MCP. Therefore, in most materials only the near surface region can be investigated. Furthermore, the MCP/CCD combination can only be used in the wide angle scattering regime. At small angles the CCD would move into the primary beam due to the small sample to detector distance required for high spatial resolution.

Recently long bundles of glass capillaries became available opening the possibility to increase the sample to detector distance without loosing resolution. The polycapillaries used had a length of 300 mm and diameters of 30 μm and were arranged in a hexagonal array of 8 mm distance between opposing sides. First successful studies were performed at HASYLAB beamline G3 using the diffractometer usually applied for MAXIM investigations. They included small angle scattering on polymers at 8 keV and bulk diffraction on an Al-tube with a flat beam at 26 keV.

A dedicated instrument for bulk diffraction imaging and tomography (DITO) is planned at beamline W2 (HARWI II). The spatial resolution for the diffractometry images will be about 6 μm. Therefore, an array of polycapillaries with 6 μm inner diameter and 10 to 20 cm length will be used as essential part of the detector. It is followed by a CdWO₄ phosphor. The images produced in this phosphor are focused and magnified by an objective via a mirror on a CCD-camera.