MS13. New instrumentation, methods and approaches in inorganic crystallography

Chairs: Anton Meden, Damien Jacob

MS13-P1 Nano-diffraction in STEM and fluctuation electron microscopy of phase-change material

Manuel Bornhöft1,2, Tobias Saltzmann3, Julia Benke4, Paul M. Voyles5, Ulrich Simon6, Matthias Wuttig7,8, Joachim Mayer2,6

1. Central Facility for Electron Microscopy, RWTH Aachen University, Germany
2. Ernst Ruska-Centre, Forschungszentrum Jülich GmbH, Germany
3. Institut für Anorganische Chemie, RWTH Aachen University, Germany
4. I. Physikalisches Institut (IA), RWTH Aachen University, Germany
5. Department of Materials Science and Engineering, University of Wisconsin, USA
6. JARA - Fundamentals of Future Information Technologies, RWTH Aachen University, Germany

email: bornhoefft@gfe.rwth-aachen.de

We investigated the phase-change materials Sb2Te3 by nano beam diffraction in a scanning transmission electron microscope (nano-diffraction in STEM) and AgInSb2Te5 by fluctuation electron microscopy (FEM). Both methods rely on illuminating the areas of interest of the sample by a small (probe size is around 2 nm) and almost parallel (convergence angle of 0.54 mrad) electron probe. This creates nano diffraction patterns with the spatial resolution of the probe size. We also extract information about the nanometer scale medium range atomic order (MRO) of amorphous materials by calculating the variance out of 500-1000 nano-diffraction patterns of amorphous material. This technique is called STEM-FEM [1]. The nano diffraction in STEM is used to identify crystalline regions of Sb2Te3 samples. The FEM is used to gather information about the MRO of AgInSb2Te5 samples. To help to understand the reaction mechanism of the wet chemical synthesis of hexagonal Sb2Te3 platelets, we investigated Sb2Te3 intermediates of the reaction with nano diffraction in STEM. By scanning the intermediates with the electron probe and collecting nano diffraction patterns at the same time, it is possible to identify the crystalline areas of the intermediate. The investigation by nano diffraction helped to reveal part of the reaction mechanism of Sb2Te3 platelets in the wet chemical synthesis [2]. These platelets would have promising application in memory applications or as model systems. A deeper understanding of the crystallization kinetics of AgInSb2Te5 is needed, because the crystallization speed is the limiting factor of the writing speed of possible phase change memory devices using AgInSb2Te5 [3]. The MRO of the amorphous phase of AgInSb2Te5 could play an important role in the difference of crystallization speeds of as-deposited and melt-quenched AgInSb2Te5. The normalized variance is calculated by doing FEM in STEM in a STEM dedicated Titan.

References:

Figure 1. The boxes are marking the region scanned by nano-diffraction. The crosses are marking the actual positions of the electron probe. The nano-diffraction patterns shows, that the main body of the intermediate is amorphous. Only a small part of the bright core part of the intermediate is crystalline.

Keywords: Nano-diffraction, TEM, STEM, phase-change, FEM