KFM 6: Instrumentation and Methods for Micro- and Nanoanalysis

Chair: Theo Scherer (KIT Karlsruhe)

Time: Monday 10:40–12:00 Location: EMH 025

KFM 6.1 Mon 10:40 EMH 025

Dynamical diffraction effects of inhomogeneous strain fields investigated by scanning convergent beam electron diffraction — •Laura Niermann, Tore Niermann, Frederik Otto, and Michael Lehmann — Technische Universität Berlin, Berlin

Strain fields have a large influence on optical and electronic properties of semiconductors. Several transmission electron microscopy (TEM) techniques exist to measure the strain with high precision on a nanometer scale. The models behind these techniques make the assumption that the strain is constant along the electron beam direction. However, if the strain is inhomogeneous in beam direction, the strong diffraction conditions required for the strain mapping cause a non-linear influence on the resulting diffracted electron beam. This effect in turn can also be used to characterize the three dimensional strain field in the specimen. We report on systematical investigations of dynamical diffraction at inhomogeneous strain fields in electron beam direction by using an inclined layer structure producing a continuous change in the depth of the strain field. The strain mapping was performed by means of scanning convergent beam electron diffraction (SCBED) using a fast pixelated detector to record the whole diffraction pattern for each scan position. By comparing the experimental results to calculated diffraction patterns using multi-beam simulations and including effects like surface relaxation and specimen bending, the observed intensity variations can directly be attributed to the dynamical diffraction behavior.

KFM 6.2 Mon 11:00 EMH 025

Planar Strain Tomography with X-ray Powder Diffraction — •Peter Modregger — Department Physik, Universität Siegen — Center for X-ray and Nano Science, DESY, Hamburg

The measurement of local strain and residual stress fields in polycrystalline engineering materials constitutes an essential tool of materials science engineering. In general, there are two types of methods available: X-ray diffraction with conical slits and energy dispersive X-ray diffraction - both featuring anisotropic gauge volumes with aspect ratios of 1:20 or worse. Here, we introduce planar strain tomography based on X-ray powder diffraction that utilizes a high energy pencil beam and iterative reconstruction. The gauge volume is defined by the size of the pencil beam with typical aspect ratios close to 1:1. We will demonstrate the feasibility with data collected in a pilot experiment at P21.2 at PETRA III. The sample was shot peened martensite and the measured strain and residual stress field distributions meet expectations. The results will be compared to energy dispersive X-ray diffraction collected with the high energy wiggler beamline P61A at PETRA III as well as laboratory measurements. We will further discuss limitations of the proposed approach in terms of stability of iterative tomographic reconstruction, suitable sample thicknesses (in the range of centimeters) and currently achieved strain sensitivity (in the order of 1e-4).

KFM 6.3 Mon 11:20 EMH 025

MULTIPAC, a versatile TDPAC spectrometer — •Björn Dörschel[1], Ian Yap[1], Thien Dang[1], Juliana Schell[1,2], Nicole De Lima[3], Magnus Hagelund[4], Bruno Correa[3], Arnaldo Filho[3], Alexandre Souza[5], and Doru Lupascu[1] — [1]Institute for Materials Science and Center for Nanointegration Duisburg-Essen (CENIDE), University of Duisburg-Essen, 45141 Essen, Germany — [2]Institute for Materials Science and Center for Nanointegration Duisburg-Essen (CENIDE), University of Duisburg-Essen, 45141 Essen, Germany — [3]Universidade de São Paulo, 158 Av. Prof. Luciano Gualberto, Brazil — [4]Institute of Material Science and Production, University of Aalborg, 9220 Aalborg, Denmark — [5]Idaho National Laboratory, 1955 N Fremont Ave, Idaho Falls, ID 83415, USA

MULTIPAC is a spectrometer that can perform γ-γ time-differential perturbed angular correlation (γ-γ TDPAC) experiments under controlled conditions such as an applied external magnetic field up to 8.5 T and temperatures ranging between 3 to 375 K. MULTIPAC differs from conventional γ-γ TDPAC spectrometers in the use of modern multi-pixel photon counters (MPPC), which offers advantage over the standard photomultiplier tubes, due to its compact size, resistance to magnetic fields, ease of maintenance, and requiring only low voltage. Additionally, the MPPC maintains the same quantum efficiency ($<$ 25%) and the high gain (*10^{5-6}) comparable to that of a photo multiplier tube. In addition, MULTIPAC also features a vibrating sample magnetometer (VSM) to leverage upon the field provided by its inbuilt superconducting magnet.

KFM 6.4 Mon 11:40 EMH 025

Emission Mössbauer Spectrometer from ILmenau (eMIL): An Update — Alice Kern[1], Juliana Schell[2,3], •Ian Chang Jie Yap[3], Thien Thanh Dang[3], Magnus Hegelund[4], Dmitry Zyabkin[5], and Peter Schaaf[5] — [1]Fakultät für Festkörperelektronik, Technische Universität Wien, AT-1040, Wien — [2]European Organization for Nuclear Research (CERN), CH-1211, Geneva — [3]Institute for Materials Science and Center for Nanointegration Duisburg-Essen (CENIDE), University of Duisburg- Essen, 45141 Essen, Germany — [4]Institute of Material Science and Production, University of Aalborg, 9220 Aalborg, Denmark — [5]Fakultät für Chemie, Technische Universität Ilmenau, 98693 Ilmenau, Germany

The advanced emission Mössbauer spectrometer, eMIL (Emission Mössbauer from Ilmenau) was built for the emission Mössbauer (eMS) collaboration at ISOLDE/CERN. The set-up is based on the emission geometry and combines on-line and off-line isotope implantation used to measure hyper-fine interactions in condensed matter materials. Using radioactive Mössbauer probes that are ion-implanted into the sample, eMIL has multiple advantages over the more common transmission or electron conversion setups. The versatility of the set-up is epitomized through five different lids: rotation, magnetic, powder, hot and cold lid. These lids can be easily interchanged, without the need for re-alignment, which makes eMIL extremely flexible during beam time. eMIL had its first successful run this year, which marked the first beam time for the Mössbauer collaboration since 2018.