KFM 5: Microscopy and Spectroscopy with X-rays, Ions and Positrons (joint session KFM/CPP)

Chair: Enrico Langer (TU Dresden)

Time: Monday 15:00–17:40 Location: TOE 317

KFM 5.1 Mon 15:00 TOE 317

Single-Shot Phase-Contrast Microscopy of Laser-induced Cavitation at MID/EuXFEL — •Johannes Hagemann[1], Malte Vassholz[2], Hannes Höppe[2], Markus Osterhoff[2], Juan Rosello[3], Robert Mettin[3], Andreas Schropp[1], Christian Schroer[1,4], and Tim Salditt[2] — [1]DESY, Notkestraße 85, 22607 Hamburg — [2]Institut für Röntgenphysik, Friedrich-Hund-Platz 1, 37077 Göttingen — [3]Drittes Physikalisches Institut, Friedrich-Hund-Platz 1, 37077 Göttingen — [4]Department Physik, Universität Hamburg,Luruper Chaussee 149, 22761 Hamburg

X-ray free electron lasers offer unique opportunities for imaging of ultra-fast processes on smallest length-scales paired with the penetration power of hard X-rays. One of these processes is laser-induced cavitation in water. The dynamic nature of the processes under study is incompatible to scanning schemes for image acquisition thus we chose propagation-based near-field imaging as full-field imaging scheme. The illumination with high intensity, fs-short X-ray pulses enables imaging with single pulses which yield a still image of the cavitation bubble without motion blur. In this contribution we will present a pump-probe imaging experiment conducted at the MID instrument at the European XFEL. The experiment has been carried out at 14/17.8 keV photon energy. The X-rays have been focused by aberration corrected Be-compound refractive lenses down to 100 nm focus-size. The fluctuating nature of the SASE-process poses some challenges for the data analysis. We present our approach to the data-processing, phase-retrieval and results.

KFM 5.2 Mon 15:20 TOE 317

Latest developments in multi-modal scanning X-ray microscopy — •Michael Stuckelberger — DESY, 22607 Hamburg, Germany

Scanning X-ray microscopy is challenged not only by the ever-smaller structures requiring higher resolution, but also by the increasing complexity of in-situ and operando environments of functional materials. Given that relevant information about micro- and nanostructures is typically extracted from the point-by-point correlation of different properties, the same spot needs to be in the same condition for all measurements. Often, this is not possible without the simultaneous evaluation of all critical measurement modalities.

At the leading X-ray nanoprobe endstations in the US and in Europe, we have set up experiments for multi-modal X-ray microscopy. Involving up to 5 different modalities, the measurements allow the simultaneous evaluation of composition by X-ray fluorescence, structure by X-ray diffraction and ptychography, and of the electrical and optical performance by X-ray beam induced current and X-ray excited optical luminescence.

In this contribution, we will demonstrate the application of multi-modal scanning X-ray microscopy to nanoscale semiconductors and electronic devices, and discuss detector arrangement and compatibility with different scan modes and samples. Beyond state-of-the-art measurements, we will give an outlook to new opportunities and challenges at X-ray nanoprobe endstations of 4th generation synchrotrons that will see light in the coming years.

KFM 5.3 Mon 15:40 TOE 317

Experimental optimization of geometry for propagation based phase contrast X-ray imaging — •Hanna Dierks and Jesper Wallentin — Synchrotron Radiation Research, Lund University, Sweden

Propagation-based phase contrast imaging (PB-PCI) with an X-ray lab source is a powerful technique to study low-absorption samples, e.g. soft tissue or plastics, on the micrometer scale. The choice of the propagation distance and magnification is crucial for the performance, and a trade-off in terms of resolution, contrast and noise is always necessary. Theoretical optimization strategies based on Fresnel propagation have been reported, and here we systematically test these experimentally using a setup with a Cu X-ray tube and a detector with 0.55um effective pixel size. The source-detector distance was between 25 and 40cm and magnification ratios were varied from 1 to 1.3. We verify the key conclusions from the proposed models. The experiments show that the theoretical optimization approach is very sensitive to system parameters such as the X-ray source spot size and detector resolution. Moreover, the energy dependence of the refractive index needs to be taken into account when modelling the polychromatic illumination of an x-ray tube. Finally, the sensitivity of TIE based phase retrieval algorithms on the image noise and contrast are studied.

KFM 5.4 Mon 16:00 TOE 317

Multiscale Mapping and Quantification of Elastic Stress and Domain Size in Bulk Ferroelastic Systems by Dark-Field X-Ray Microscopy — •Jan Schultheiss[1,2], Lukas Porz[1], Lalitha Kodumudi Venkataraman[1], Marion Höfling[1], Semen Gorfman[3], Jürgen Rödel[1], and Hugh Simons[4] — [1]Department of Materials and Earth Sciences, TU Darmstadt, Germany — [2]Department of Materials Science and Engineering, NTNU Trondheim, Norway — [3]Department of Materials Science and Engineering, Tel Aviv University, Israel — [4]Department of Physics, DTU, Denmark

Twinned domains in ferroelastic systems are intimately coupled to local strain fields. Problematically, in complex oxides this coupling often spans over several orders of magnitude of length scale. State-of-the art characterization techniques, however, either lack spatial resolution or their sensitivity is limited to the surface.

Here we use Dark-field X-Ray Microscopy to map and quantify spatial variations of elastic stress and domain size from nm to several μm in a grain of a polycrystalline ferroelectric/ferroelastic (Ba,Ca)(Zr,Ti)O_3 model system as a function of the applied electric field. We find, that the electric field narrows the distribution of elastic stresses by 60%, while the domain size increases by 35%. The suggested methodology can be applied to multiscale correlations in emerging fields in complex oxides and twinned systems.

KFM 5.5 Mon 16:20 TOE 317

Soft X-ray Laminography adds a third dimension to STXM — Katharina Witte[1], •Andreas Späth[2], Simone Finizio[1], Claire Donnelly[1,3], Michal Odstrcil[1], Manuel Guizar-Sicairos[1], Mirko Holler[1], Benjamin Watts[1], Rainer H. Fink[2], and Jörg Raabe[1] — [1]Paul Scherrer Institut, Villigen, Switzerland — [2]FAU Erlangen-Nürnberg, Germany — [3]Department of Physics, University of Cambridge, United Kingdom

Scanning Transmission X-ray microscopy is a powerful tool for spectromicroscopic analysis of nanostructured thin-film specimens. While developments focused on organic soft matter for many years, STXM has meanwhile also contributed to imaging of magnetic nanostructures based on (XMCD) contrast. However, 3D imaging is so far limited to a narrow selection of suitable specimens and constraint experimental conditions. This is especially true for the implementation of tomography, since the full sample rotation perpendicular to the optical axis is usually not possible for geometric reasons. Laminography overcomes this limitation by inclining the sample rotation axis by the laminography angle $\theta < 90°$ so that it is no longer perpendicular to the incident X-ray beam. The major advantage is that the sample (and its support) can be laterally extended without further modification and without risking collisions during rotation. A new setup combines laminography and STXM using soft X-rays. We will present first 3D reconstructions of nanostructured objects from material science, biology and functional magnetic materials. Funding: BMBF grant 05K19WE2 and EU Marie Skłodowska-Curie grant No. 701647.

20 min. break

KFM 5.6 Mon 17:00 TOE 317

Detection system for transmission imaging in helium ion microscope — •Eduardo Serralta[1], Nico Klingner[1], Olivier De Castro[2], Serge Duarte Pinto[3], Cecilia Bebeacua[4], Stefan Findeisen[1], Olivier Bouton[2], Tom Wirtz[2], and Gregor Hlawacek[1] — [1]Helmholz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Luxembourg Institute of Science and Technology, Esch-sur-Alzette, Luxembourg — [3]Photonis Netherlands B.V, Ro-

den, Netherlands — [4]Eidgenössische Technische Hochschule, Zürich, Switzerland

Transmission imaging in the helium ion microscope allows to measure mass-thickness contrast and reveal crystallographic information. We recently customized a microchannel plate followed by a delay line readout structure especially for this application. This system can correlate the scanning transmission ion image to the angular distribution of the transmitted ions. An in-vacuum linear support is used to place the detector at different distances from the sample, adjusting the maximum collection angle. Post-processing allows the reconstruction of images for selected scattering angles. The first results show images with nanometer resolution, material contrast, and identification of subsurface features in biological tissues. This work has been supported by the H2020 Project npSCOPE under grant number 720964.

KFM 5.7 Mon 17:20 TOE 317

Positron Annihilation Studies using a Superconducting Electron Linac — •Maik Butterling[1], Andreas Wagner[1], Maciej Oskar Liedke[1], Eric Hirschmann[1], Ahmed G. Attalah[1], Reinhard Krause-Rehberg[2], and Kay Potzger[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstr. 400, 01328 Dresden, Germany — [2]Martin-Luther-Universität Halle, Institut für Physik, 06099 Halle, Germany

The Helmholtz-Center at Dresden-Rossendorf operates several user beamlines for materials research using different techniques for positron annihilation spectroscopy. Two of them are being operated at a superconducting electron linear accelerator producing positrons via pair production from electron-bremsstrahlung. While one of the sources uses bremsstrahlung to directly generate positrons inside the sample of interest, in the second source (MePS), monoenergetic positrons with energies up to to 25 keV are used for thin-film studies of porosity and defect distributions. The MePS beam line is currently complemented by a new in-situ end station (AIDA-2), where defect studies can be performed in a wide temperature range during thin film growth and ion irradiation. Developments as well as examples of recent experimental results at all facilities will be presented. The MePS facility has partly been funded by the Federal Ministry of Education and Research (BMBF) with the grant PosiAnalyse (05K2013). The AIDA facility was funded by the Impulse- und Networking fund of the Helmholtz-Association (FKZ VH-VI-442 Memriox) and through the Helmholtz Energy Materials Characterization Platform.