MI 6: X-ray Imaging, Holography and Tomography

Chair: Enrico Langer

Time: Wednesday 9:30–10:45 Location: H5

MI 6.1 Wed 9:30 H5

About the Potential of novel X-ray Contrast Modalities in Material Science and Non-Destructive Testing — •Friedrich Prade[1,2], Michael Chabior[1,2], and Franz Pfeiffer[1,2] — [1]Department of Physics, Technische Universität München, 85748 Garching, Germany — [2]Institute of Medical Engineering, Technische Universität München, 85748 Garching, Germany

Since its beginning X-ray imaging has attracted increasing interest in various research fields besides medicine, such as material science, non-destructive testing (NDT) and security screening. Furthermore, recent developments of new X-ray imaging techniques, such as grating interferometry, helped to improve the X-ray imaging contrast. In addition to the standard absorption contrast, differential phase-contrast imaging (DPC) yields information on the electron density, whereas dark-field contrast imaging provides further information about small angle scattering properties of the sample. While especially DPC has been extensively tested in biomedical applications, e.g. to improve soft tissue contrast, little effort has been made to adapt both DPC and dark-field imaging to material science or NDT applications. In this study we explore applications for these novel X-ray contrast modalities in material science and NDT and evaluate the additional information provided by these techniques. We primary focus on dark-field imaging to study micron sized pores and cracks as well as the micro-structure of fiber reinforced materials, since these structures show a strong scattering signal.

MI 6.2 Wed 9:45 H5

OMNY- An Instrument for Ptychographic Nano-Tomography — Mirko Holler, •Jörg Raabe, Ana Diaz, Manuel Guizar-Sicairos, Christoph Quitmann, Andreas Menzel, and Oliver Bunk — Swiss Light Source, Paul Scherrer Institut, 5232 Villigen PSI, Switzerland

OMNY (tOMography Nano crYo stage) is an instrumention project under way at the SLS aiming for 3D nanometric imaging. It uses ptychographic reconstruction of coherent diffraction patterns and tomography to acquire images in 3D. In the final implementation it will be used to image biomaterial, materials science and physics samples. A test-setup is installed at the cSAXS beamline to verify the performance of key components in air and at room temperature. It has produced 2D and 3D-data sets with < 50 nm resolution (2D). A laser interferometer stabilizes the position of the sample with respect to the beam (z) along the x- and y-axis. The position feedback provides a stability < 10 nm and compensates any long term drifts.

We present results on 2D lithographic test patterns to specify resolution, drift etc. and on integrated circuits to demonstrate the potential of the instrument.

MI 6.3 Wed 10:00 H5

Advanced image processing algorithms for coherent X-ray nanoCT — •Benedikt Daurer, Björn Enders, Andreas Fehringer, Marco Stockmar, Martin Dierolf, Irene Zanette, Franz Pfeiffer, and Pierre Thibault — Departement of Physics (E17), Technische Universität München, Germany

A recently developed coherent diffractive imaging technique named ptychography [1] provides the possibility to reconstruct tomographic volumes of nano-structured samples using hard X-ray beams [2].

Today's algorithms used for ptychography retrieve the accumulated complex-valued index of refraction behind an object for all tomographic angles individually. The total acquisition time for a full tomographic scan using ptychography is typically between 6 and 24 hours and thus the different projections are individually shifted due to limited mechanical accuracy and thermal drifts. This requires the use of advanced alignment procedures without fiducial markers [3], which is particularly challenging in the case of local tomography or limited-angle tomography. We will present a quantitative analysis of the different algorithms available and will describe newly developed strategies.

[1] Rodenburg, J. et al. (2007). Hard-X-Ray Lensless Imaging of Extended Objects. Physical Review Letters, 98(3), 034801.

[2] Dierolf, M. et al. (2010). Ptychographic X-ray computed tomography at the nanoscale. Nature, 467(7314), 436-439.

[3] Guizar-Sicairos, M. et al. (2011). Phase tomography from x-ray coherent diffractive imaging projections. Optics Express, 19(22), 21345.

MI 6.4 Wed 10:15 H5

3D validation of X-Ray Diffraction Contrast Tomography reconstructions of polycristalline materials by means of serial sectioning and EBSD analysis — •Barbara Lödermann[1], Andreas Graff[2], Andreas Trenkle[1], Melanie Syha[1], Mathias Reichardt[1], Michael Selzer[1], Daniel Weygand[1], Wolfgang Ludwig[3], and Peter Gumbsch[1] — [1]KIT, IAM ZBS, Karlsruhe, Germany — [2]Fraunhofer IWM, Halle, Germany — [3]ESRF, Grenoble, France

A cylindric strontium titanate specimen which has been subjected to repetitive X-Ray Diffraction Contrast Tomography (DCT) scans is investigated by means of Electron Backscatter Diffraction Analysis (EBSD). Therefor, 8 cross-sections of the sample in 3-10 microns distance have been prepared manually. Corresponding cross-sections of the reconstructed microstructures as obtained by DCT are identified and compared to EBSD characterizations. Moreover, a 3D reconstruction generated by a Voronoi segmentation algorithm of the destructive characterization is presented and aligned to the structure as obtained by DCT alongside with a direct comparison of the crystallographic orientation obtained for the individual crystallites. Focussing on the position and curvature of the grain boundaries, the results are discussed in the context of the spatial resolution and optimization potential of the diffraction data.

MI 6.5 Wed 10:30 H5

The Potential of Scatter-Free Pinholes for X-ray Analytical Equipment — •Andreas Kleine, Frank Hertlein, and Carsten Michaelsen — Incoatec GmbH, Max-Planck-Str. 2, 21502 Geesthacht, Germany

Parasitic scattering caused by apertures is a well-known problem in X-ray analytics, which forces users and manufactures to adapt their experimental setup to this unwanted phenomenon. Increased measurement times due to lower photon fluxes, a lower resolution caused by an enlarged beam stop, a larger beam defining pinhole-to-sample distance due to the integration of an antiscatter guard and generally a lower signal-to-noise ratio leads to a loss in data quality.

In this presentation we will show how the lately developed scatter-free pinholes overcome the aforementioned problems. We will show measurements performed at home-lab small angle X-ray scattering (SAXS) systems and at synchrotron beamlines which compare conventional pinholes, scatterless Germanium slit systems and scatter-free SCATEX pinholes.

We will further present the latest developments regarding the novel liquid metal jet X-ray source, a technology which has already shown intensities superior to the best rotating anode. The latest results of this new source technology in combination with scatter-free pinholes will be presented.