MI 10: Poster: Microanalysis and Microscopy

Chair: Enrico Langer (TU Dresden), Hartmut S. Leipner (Martin-Luther-Universität Halle-Wittenberg)

Time: Wednesday 15:00–17:30 Location: Poster B

MI 10.1 Wed 15:00 Poster B

Ion Beam Analysis in a Helium Ion Microscope — •Nico Klingner, René Heller, Gregor Hlawacek, Stefan Facsko, and Johannes von Borany — Helmholtz-Zentrum Dresden-Rossendorf, Germany

Helium ion microscopes (HIM) have become powerful imaging devices within the last decade. Their enormous lateral resolution of below 0.3 nm and the highest field of depth make them a unique tool in surface imaging. So far the possibilities to identify target materials (elements) are rather limited.

In the present contribution we will show concepts as well as preliminary studies on the capability, efficiency and the limits of applying (Rutherford) Backscattering Spectrometry (RBS) within a HIM device to image samples with target mass contrast and to analyze target compositions. We will present different concepts of how to realize RBS in a HIM and point out mayor challenges and physical limitation.

MI 10.2 Wed 15:00 Poster B

Investigating Atomic Contrast in Atomic Force Microscopy and Kelvin Probe Force Microscopy on Ionic Systems using Functionalized Tips — •Leo Gross[1], Bruno Schuler[1], Fabian Mohn[1], Nikolaj Moll[1], Niko Pavliček[1], Wolfram Stuerer[1], Ivan Scivetti[2], Konstantinos Kotsis[2], Mats Persson[2], and Gerhard Meyer[1] — [1]IBM Research – Zurich, 8803 Rüschlikon, Switzerland — [2]University of Liverpool, Liverpool, L69 3BX, United Kingdom

We used chlorine vacancies in NaCl bilayers on Cu(111) as a model system to investigate atomic contrast as a function of applied voltage, tip height, and tip functionalization. The local contact potential difference (LCPD) acquired with Kelvin probe force microscopy showed the same qualitative contrast for all tip terminations investigated, which resembled the contrast of the electrostatic field of the sample. We find that the frequency-shift contrast, typically measured by non-contact atomic force microscopy, stems mainly from electrostatic interactions but its tip dependence cannot be explained by the tip dipole alone. With the aid of a simple electrostatic model and by density functional theory we investigate the underlying contrast mechanisms. [1]

[1] L. Gross et al. Phys Rev. B 90, 155455 (2014)

MI 10.3 Wed 15:00 Poster B

Material sensitive coherent diffractive imaging employing a gas discharge plasma EUV source and phase grating for wavelength selection — •Raoul Bresenitz[1], Jan Bussmann[1], Denis Rudolf[1], Michal Odstrcil[2], Detlev Grützmacher[1], and Larissa Juschkin[1,3] — [1]Peter Grünberg Institut 9, JARA-FIT,Forschungszentrum Jülich, 52425 Jülich, Germany — [2]Optical Research Centre, University Southampton — [3]RWTH Aachen University, Experimental Physics of EUV, JARA-FIT, Steinbachstrasse 15, 52074 Aachen, Germany

In diffraction limited microscopy, the resolution scales with the wavelength of the probe, which explains the current interest in EUV and X-ray microscopy. Moreover, many materials exhibit strong absorption edges in this spectral region, which results in elemental contrast. Coherent diffractive imaging (CDI) does not rely on conventional optics which map each point of the sample on a detector, but recovers the shape from its diffraction pattern using phase retrieval algorithms. Due to the required coherence, most CDI experiments were performed at synchrotron and free electron laser facilities. Only few laboratory based experiments, employing either a high harmonic or a soft X-ray laser source, were conducted so far. We discuss the feasibility and prospects of a gas discharge plasma EUV source for CDI experiments in general. In a second step, a phase grating for wavelength selection and monochromatisation will be used. We aim to combine high resolution and elemental contrast in the spectral range between 17 nm and 25 nm.

MI 10.4 Wed 15:00 Poster B

CUDA Accelerated Framework for Phase Reconstruction in X-ray Imaging Using SciPAL — •Johannes Hagemann[1], Stephan Kramer[2], and Tim Salditt[1] — [1]Institute for X-ray physics, G. A. U. Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen — [2]MPI for biophysical chemistry, Am Faßberg 11, 37077 Göttingen

The work horses for phase retrieval in coherent x-ray imaging are iterative projection algorithms (GS, HIO, RAAR). The increasing number of pixels in current detectors (up to 4k x 4k) fosters the need for faster implementations. Based on our SciPAL library [1] and our work on phase holography [2,3] we have developed a C++ framework for projection algorithms. SciPAL offers an expression template based interface for mathematical expressions which enables seamless transitions between different parallelization tools like CUDA or OpenMP. By off-loading computations to the GPU it is capable of online phase retrieval.

[1] SciPAL: Expression Templates and Composition Closure Objects for High Performance Computational Physics with CUDA and OpenMP, S. C. Kramer and J. Hagemann, ACM TOPC (to appear).
[2] S. C. Kramer, J. Hagemann, D. R. Luke, Real-Time Phase Masks for Interactive Stimulation of Optogenetic Neurons, arXiv:1302.0120
[3] J. Hagemann et al. Opt. Express 22, 11552 (2014)

MI 10.5 Wed 15:00 Poster B

Sparsity Constraint for Phase Retrieval in X-Ray Imaging — •Anne Pein and Tim Salditt — University of Göttingen, Institute for X-Ray Physics, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

A powerful approach for phase retrieval in x-ray propagation imaging is to exploit prior information of the signal as for example a rough knowledge about the support of the object. Iterative algorithms then alternately project onto constraint sets based on this prior information and the measurement in order to approximate the wave-field directly behind the object.

Recently, Loock and Plonka have proposed to use a priori knowledge that the exit wave-field is sparse in a certain representation system, i.e. that only a few representation coefficients are nonzero, and they have presented promising results with this method by numerical simulations [1]. This approach is implemented based on a shearlet frame system [2]. In this work we present an extensive numerical evaluation of this approach, including a quantitative comparison with other common constraints.

[1] S. Loock, G. Plonka, 'Phase retrieval for Fresnel measurements using a shearlet sparsity constraint', Inverse Problems 30 (2014).
[2] ShearLab 3D Toolbox from http://www.shearlab.org

MI 10.6 Wed 15:00 Poster B

Femtosecond speckle and coherence experiments at the CHG short-pulse facility at DELTA — •Christian Gutt[1], Mario Reiser[1], Sebastian Warsow[1], Tushar Sant[1], Svenja Hilbrich[2], Maryam Huck[2], Shaukat Khan[2], Markus Höner[2], Carsten Mai[2], Arne Meyer auf der Heide[2], Robert Molo[2], Helge Rast[2], and Peter Ungelenk[2] — [1]Department of Physics, Universität Siegen, Walter-Flex-Str. 3, Siegen, Germany — [2]Center for Synchrotron Radiation, TU Dortmund, Maria Goeppert-Mayer Str.2, Dortmund, Germany

The interaction of femtosecond laser pulses with relativistic electrons in an undulator can yield very short and coherent pulses of higher harmonic radiation (coherent harmonic generation, CHG). Using the CHG facility at the synchrotron radiation source DELTA; we performed single-pulse diffraction and speckle experiments with femtosecond pulses of optical and UV light of wavelengths of 400 and 200 nm, respectively. The properties of the speckle patterns allow to deduce the coherence properties of the CHG radiation on a shot-to-shot basis. We find a high degree of spatial and temporal coherence of the CHG-generated radiation compared to the coherence properties of the spontaneous undulator radiation.

MI 10.7 Wed 15:00 Poster B

Chaotic behavior in ASAXS formalisms — •Sören Gayer, Ulla Vainio, and Andreas Schreyer — Helmholtz-Zentrum Geesthacht, Germany

Structures of low scattering length density contrast are inaccessible for small-angle x-ray scattering (SAXS) measurements, even if the different phases are composed of different elements. Fortunately, resonant absorption athe the absorption edges leads to a large dispersion correction of the scattering length of the resonant atoms. This anomalous scattering process can be used to increase the previously low contrast

by a variation of the photon energies.

There exist a number of methods to solve the set of equations obtained by these anomalous SAXS (ASAXS) measurements at several photon energies. To test the behavior of three different methods in the presence of systematic measurement errors, numerical simulations of ASAXS signals of different structures were performed.

These simulations revealed threshold uncertainties in the absolute intensity scale for which the solutions, especially of the partial structure factor and Stuhrmann method, show chaotic behavior.

MI 10.8 Wed 15:00 Poster B

The dependency of an EBSD detectors exposure on electron beam current and primary energy — •Susanne Wolff, Michael Hietschold, Steffen Schulze, and Nathanael Jöhrmann — Technische Universität Chemnitz, Chemnitz, Germany

The investigation of solid samples with a scanning electron microscope (SEM) and a detector for electron backscatter detection (EBSD) is very important for the structural analysis. Here, the analysis of crystallites with less than 100 nm size creates challenges for EBSD analysis technique. Due to the small crystallite size the diameter of the electron beam has to be small enough and a low primary energy is necessary to ensure a small enough interaction volume with the sample. Both demands result in a small electron beam current. Consequently the resulting EBSD diffraction patterns are weak. Therefore, the exposure time has to be extended which is limited by stability of sample and instrument. For that reason the dependence of the EBSD screen exposure time on the settings of a scanning electron microscope has been studied in detail here.

MI 10.9 Wed 15:00 Poster B

Determination of the refractive index of casein micelles — •Sabrina Kröner, Steffen Nothelfer, Florian Foschum, and Alwin Kienle — Institut für Lasertechnologie in der Medizin und Meßtechnik, 89081 Ulm, Germany

Casein micelles are mostly found in dairy products. These micelles consist of α1-, α2-, β- and κ-casein proteins. The refractive index of casein micelles is not known, but constitutes a key parameter to enable the optical characterization of dairy products, like milk as a frequently used product in everyday life.

We determine the refractive index with three different setups and we use Mie theory for the theoretical description of the light scattering. First, with an optimized goniometer setup, single scattered photons were measured angularly resolved. The size distribution and the refractive index were derived from the experimental scattering phase function of the micelles. Second, a collimated transmission setup was used to obtain the extinction coefficient. Under specification of size distribution and concentration of the micelles we derived the refractive index as fit parameter. Third, with a spatially resolved reflectance setup we determine the reduced scattering coefficient and again fit the refractive index. For the measurements we used skim milk, because the protein in commercially available skim milk is expectedly similar to the protein which will be examined at industrial applications. The derived refractive indices show good agreement for all three independent methods.