KFM 6: Instrumentation and Methods for Micro- and Nanoanalysis

Time: Monday 11:05–12:25 Location: H7

KFM 6.1 Mon 11:05 H7

Sub-nm Control of Radioactive Isotope Incorporation at Surfaces and Interfaces using Ultra-Low Energy Ion Implantation: The ASPIC and ASCII Vacuum Chambers — •Koen van Stiphout, Leonard-Alexander Lieske, Manuel Auge, and Hans Hofsäss — Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

The use of radioactive tracer isotopes has a long history of providing unique insights into magnetic interactions, electric environments and crystal structures of materials at the atomic scale. Experimental techniques such as perturbed γ - γ angular correlations or emission Mössbauer spectroscopy require the incorporation of radioactive isotopes into the crystal lattice. However, as more research focuses on ever-smaller nano-scaled systems such as atomically thin 2D materials, precise and reproducible incorporation becomes challenging. One way of overcoming these difficulties is the introduction of ultra-low energy (ULE) ion implantation (10 - 100 eV), which enables sub-nm control of the implanted probe's location at the first few monolayers of the sample.

We present the refurbishment, design and application of two vacuum chambers that will soon be installed in the ISOLDE experimental hall of CERN: the *apparatus for surface physics and interfaces at CERN*(ASPIC), an experienced ultra-high vacuum chamber dedicated to surface characterization and modification, and the new *ASPIC's ion implantation* (ASCII) chamber, designed for ULE ion implantation of radioactive probes.

KFM 6.2 Mon 11:25 H7

Combined X-ray Raman Scattering Spectroscopy and X-Ray Diffraction on Shock-Compressed Vitreous SiO_2 — •Lena Bussmann[1], Mirko Elbers[3], Christian Albers[2], Johannes Kaa[2], Martin Sundermann[4], Hlynur Gretarsson[4], Nicola Thiering[2], Christian Sternemann[2], Sindy Fuhrmann[1], Thomas Schlothauer[1], and Gerhard Heide[1] — [1]TU Bergakademie Freiberg, Institut für Glas und Glastechnologie/Institut für Mineralogie, D-09599 Freiberg — [2]TU Dortmund, Fakultät Physik/DELTA, D-44221 Dortmund — [3]Universität Potsdam, Institut für Geowissenschaften, D-14467 Potsdam-Golm — [4]DESY, D-22609 Hamburg

Vitreous SiO_2 is a suitable model material for dynamic compression experiments: Many of its pressure-related properties are fairly well known, yet, several questions remain unsolved. Vitreous silica has been shock-compressed in the "Reiche Zeche" mine in Freiberg and investigated at the P01 beamline of PETRA III at DESY via X-ray Raman spectroscopy (XRS) and X-ray diffraction (XRD). XRS allows to classify the shock effects on a short scale, while XRD reflects the intermediate-range structure. Results are compared to crystalline SiO_2 modifications. The combination of both methods hence allows to analyse the samples in terms of the effective shock pressure achieved. Furthermore, time-resolved XRD acquisition revealed a structural 'relaxation' process in the shock-compressed samples induced by the X-ray irradiation. This process is studied for different heat-treated glass samples as a function of time and temperature, and characterized by collating the XRD and XRS results.

KFM 6.3 Mon 11:45 H7

X-ray diffraction with micrometer spatial resolution for highly absorbing samples — Prerana Chakrabarti[1,2], Anna Wildeis[1], Markus Hartmann[1], Robert Brandt[1], Giovanni Fevola[2], Christina Ossig[2,3], Michael Stuckelberger[2], Jan Garrevoet[4], Ken Vidar Falch[4], Vanessa Galbierz[4], Gerald Falkenberg[4], and •Peter Modregger[1,2] — [1]Universität Siegen — [2]CXNS, DESY, Hamburg — [3]Universität Hamburg — [4]DESY, Hamburg

We report on a novel goniometer-based setup for X-ray diffraction at high photon energies with micrometer spatial resolution, which was implemented at the P06 beamline of PETRA III. The 6-axes goniometer features 3 translations with 1 nm accuracy and 3 rotations with 0.1 μrad accuracy and allows for 5D scans: 2 in direct and 3 in reciprocal space. Utilizing X-ray focus sizes of 1 μm at a photon energy of 35 keV provided by P06, enables us to characterize the strain field of a 1 mm thick, poly-crystalline martensitic steel sample with micrometer spatial resolution. Further, we experimentally demonstrate the assessment of elemental distribution by fluorescence simultaneous with diffraction for high-Z materials in a ACIGS thin film solar cell. Future plans include the extension of multimodal experiment including ptychography or XBIC and improving spatial resolutions to 200 nm.

KFM 6.4 Mon 12:05 H7

How Silicon Crystals are Used to Disseminate the SI Base Units Mole and Kilogram — •Axel Pramann and Olaf Rienitz — Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig, Germany

It is explained how the SI base units mol and kilogram are disseminated in practice using the X-ray-crystal-density (XRCD) method *counting* silicon atoms in single-crystalline silicon spheres [1-3]. Few practical examples and the status are given how the revision of the SI base units impacts the application of such quantities in chemistry and physics. In case of the XRCD method, the availability of macroscopic single crystalline silicon spheres highly enriched in 28Si is emphasized and the method of the dissemination is shown in detail with regard to the experimential mass spectrometric procedures. [1] K. Fujii et al., Metrologia, 53, A19 (2016). [2] B. Guettler, O. Rienitz, A. Pramann, Annalen der Physik, 1800292 (2018). [3] R. J. C. Brown, P. J. Brewer, A. Pramann, O. Rienitz, and B. Guettler, Anal. Chem. 93, 12147 (2021).