Applications with the Incoatec Microfocus Source IµS

IµS for Small Angle X-ray Scattering

Grazing Incidence SAXS of thin films

The development of Bruker’s NANOSTAR with integrated IµS allows measurements, which usually need synchrotron facilities, to be performed in the home-lab. The figures show the results of a Mo/IµS multilayer measured with the NANOSTAR and the synchrotron beamline BW4 of the HASYLAB. Both measurements clearly show three Bragg sheets. In comparison the NANOSTAR results have a higher background and a thus lower resolution. However, all features required for data processing are visible. This striking result gives the opportunity to plan future experiments without the restriction of beamtime. Due to the IµS the NANOSTAR now enables a more efficient use of synchrotron beamtime and gives the opportunity to envision e.g. time- or temperature-resolved long-term experiments.

In-situ GISAXS with liquid samples

For rapid GISAXS measurements of liquid samples our IµS was combined with a Dectris Pilatus detector. Silver particles on a Langmuir film were analyzed at different surface pressures which were applied by means of a reduction of the surface area. It was possible to study the formation process from unordered island to ordered layers by increasing the pressure on the surface.

Measurement details:
- angle of incidence: 0.2°deg
- measurement time: 180 sec
- aperture 350 µm
- the surface was pressed with 0 up to 26 mN/m

Unpressed surface: islands of nanoparticles are swimming on the surface without connection (top) Increasing surface pressure: intensity increases, islands coalescence (right) at 26 mN/m: “crystal” peaks appear, vertical formation of polygonal layers

IµS for Texture Measurements

Sample: BaHfO₃ nanoparticles (10-20 nm) in a YBCO matrix (thin film on SrTiO₃)

Experimental: Cu/IµS + collimating optics in a Bruker D8 GADDS with euclerian and VANTEC2000-detector total measuring time < 50min.

Result: the majority of the nanoparticles are randomly incorporated in the YBCO matrix. Nevertheless, it was possible to measure a (1 1 0) pole figure of the epitaxially grown BaHfO₃ fraction, which has a fourfold-symmetry similar to the YBCO-film. With this set-up it is possible to carry out a complete pole figure measurement in less than one hour.

Pole figure of the YBCO (0 0 4) reflex (left) and BaHfO₃ (1 1 0) reflex (middle). Frame (right) at 26 mN/m: “crystal” peaks appear, vertical formation of hexagonal layers.

IµS for Scanning Microdiffraction

A painting in a medieval manuscript was investigated using a Mo-IµS with focusing optics. Within 30 seconds exposure time frames were recorded using a Smart 1000 detector (Bruker AXS) to identify the color pigments. Such investigation allows statements on repairing, reprinting or falsification of art objects. With this setup it was possible to scan in an overnight measurement on an area of several square millimeters with a resolution of 150 µm. (Data courtesy of F. Vannmeert and K. Janssens, University of Antwerp, Belgium)

Integration of the IµS in Different Systems

Liquid Metal Jet X-ray Source

Liquid metal jet sources use a new technology and have already shown intensities superior to the best microfocus rotating anodes. The maximum power load that can be applied to standard solid metal anodes is in the first instance limited by the thermal properties of the anode material and by the heat dissipation mechanism. In liquid metal jet X-ray sources, however, X-rays are generated by an electron beam that is focused on a jet of a liquid metal melt, such as Ga (Kα = 9.2 keV), In (Kα = 24 keV) or Sn (Kα = 25.3 keV; see schematic). Such a liquid target allows for power loads of hundreds of kW/mm² in a spot size of < 20 µm. In order to preserve the extreme source brightness, a dedicated synchrotron-class optic was designed for Ga-Kα radiation (9.25 keV). With this optics, the METALET source is the brightest home-lab X-ray source, delivering intensities of > 4×10¹⁰ photons/s (m²) for a focused beam (FWHM = 70 µm). With a parallel beam Montel optics, a flux of > 3×10¹⁴ ph/s has been observed, giving a superb performance for small angle X-ray scattering.

Setup for the measurements in transmission geometry (right) and book painting with indicated colors and diffraction pattern of green and red colored regions respectively (left, Mo-IµS, 30 s exposure time each).

Working principle of a liquid metal jet anode.