Multipurpose high vacuum diffractometer for tender x-ray diffraction and spectroscopy at the SIRIUS beamline (Synchrotron SOLEIL)

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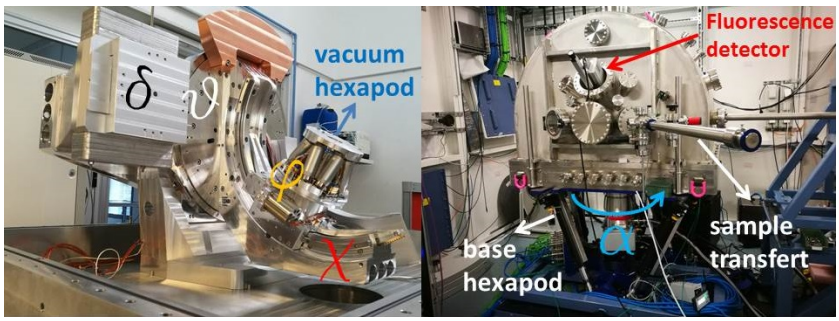
We present a new high vacuum multipurpose diffractometer recently installed at the tender x-ray SIRIUS beamline of Synchrotron SOLEIL. The instrument consists of a four-circle Eulerian diffractometer (ϑ, δ, χ, ϕ) with a limited χ circle ($\sim$ 100 deg) incorporated in a vacuum chamber and of two hexapods. The first large base-hexapod works in air, holding the entire vacuum vessel; its vertical axis rotation α provides an additional circle arc (+/- 10 deg) while the other five axes are used to align the diffractometer center on the different possible positions of the incident beam. The second hexapod is mounted in vacuum on the ϕ circle and is used to precisely align the sample surface. This choice allows one to work either in the classical four-circle geometry for bulk XRD or in the z-axis geometry for surface XRD, the latter requiring to use the hexapod axis α as incidence angle, χ=90 deg and a one (two) dimensional detector mounted on the δ circle. The absence of windows (suitable XRD detectors are mounted in vacuum on the δ arm) allows direct connection to the storage ring vacuum, enabling experiments down to the energy of 1.2 keV. Moreover, the chosen geometry leaves enough space on the side opposite to the mechanics for the installation of a detector for fluorescence mode XAS. The diffractometer nicely fits the characteristics of the SIRIUS beamline which, mounted on a HU36 undulator and equipped with a prototype multilayer grating monochromator, provides high flux in the SOLEIL range of excellence (1.2–5 keV). This new instrument allows us to perform unprecedented diffraction anomalous fine structure (DAFS) experiments in the tender x-ray, also around non-specular reflections, covering large reciprocal space volume. It enables simultaneous DAFS and XAS measurements in addition to resonant XRR and GISAXS. The access to the tender x-ray opens the way to resonant investigations around the L-edges of second transition raw elements (Sr, Y, Zr, Nb, Ru, Mo, etc.) which are constituents of functional oxide materials. It also enables access to several edges of interest for semiconductors (Al, Si, In, Sb, etc.). Various sample environments will be mounted on the in-vacuum hexapod for *in situ* studies; moreover, the instrument will benefit from the characteristics of the upgraded SOLEIL ring for coherent diffraction imaging. Finally, the control architecture based on synchronized Delta-Tau units opens exciting perspectives for improvement of the four-circle sphere of confusion by hexapod corrections. The diffractometer, manufactured by the Symétrie company and funded by a joint agreement with the MAX IV Synchrotron and by an Ile de France region project, has been commissioned and the results of the first experiments will be shown.



High vacuum diffractometer installed at SIRIUS; left: inner view; right: outward view