Soft X-ray Scanning Transmission Microscopy End-station at MAX IV

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In this presentation, our progress on the development and commissioning of the SoftiMAX STXM end-station at the 3GeV ring of MAX IV synchrotron facility will be shown. High-resolution scanning transmission X-Ray microscopy (STXM) is a powerful technique that helps to bring insight into the structural, compositional, and electronic properties of samples from different research fields such as material science, environmental science, catalysis, and biology.

The end-station – with some modifications and adaptations performed at MAX IV – follows the ALS conceptual design with an interferometric sample positioning control scheme [1,2]. This scheme allows for very accurate closed-loop sample positioning, both in 2D imaging and point spectroscopy modes of operation and helps to suppress the position error caused by thermal drift and piezo stages creep. It is designed to routinely achieve direct spatial resolution down to 20 nm using a Fresnel zone plate for focusing and can operate over the entire photon energy range of the beamline, from 275 eV to 2500 eV.

The transmitted light is detected either using an x-ray photodiode (Opto Diode Corp AXUV20HS1) or a photomultiplier tube (Hamamatsu H3164-10) with a coupled light guide, the accepting end of which is currently covered by a dispersed layer of P43 scintillator powder. Besides the main STXM mode of operation, which is now in commissioning, further techniques are foreseen, including Ptychography and X-ray fluorescence mapping. To that end, an Amptek X123 silicon drift detector as well as two commercial 2D detectors, Andor Zyla 5.5 and a deeply modified [3] Tucsen Dhyana 95 are going to be commissioned soon. The commissioning of a commercial electro-chemistry flow cell and a MEMS heating cell (both Norcada) is also planned, which will offer a microliter liquid sample environment with the possibility of heating up to 800 ºC, respectively. A 100 nm thin Si_3N_4 window separating the end-station from the beamline allows for backfilling of the end-station with noble (or inert) gases to a few mbar, e.g. for energy calibration or further control of the sample environment.

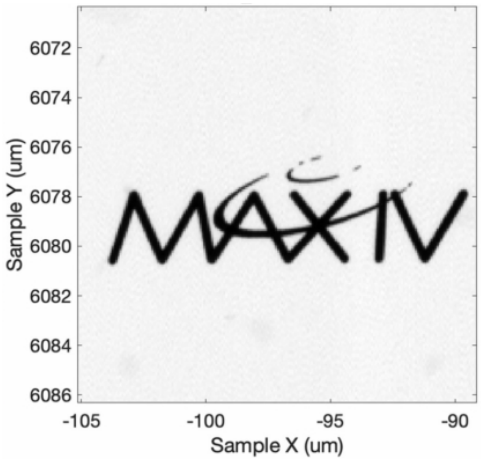

Figure 1 One of the first STMX images taken with 50nm outer width zoneplate (B. Rössner, PSI) at the SoftiMAX beamline, an Au test pattern (XRnanotech GmbH).

The SoftiMAX beamline and its STXM end-station began commissioning in 2020. The first obtained images (Fig. 1) demonstrate a high mechanical stability of the entire system. Overall, our first commissioning results show that the level of mechanical and electrical noise of the entire setup is low and should not pose any restrictions on operations even in the sub-10 nm range. More details on the end-station design and the latest results of the commissioning will be presented.

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[3] K. Desjardins, et al, AIP Conference Proceedings 2054, 060066 (2019).