Nanoscale Soft X-ray Coherent Imaging of Magnetic van der Waals materials at low temperature and under high applied magnetic fields

J. Llobet[1]
D. Pérez-Salinas[1], J. Pérez-Grau[2], X. Borrisé[3], P. Gargiani[1], A. Johnson[5], S. Wall[6], F. Büttner[7], F. Pérez-Murano[4], E. Navarro[2], M. Valvidares[1]
1- ALBA Synchrotron Light Source, 08290 Cerdanyola del Vallès, Catalonia, Spain
2- University of Valencia, Molecular Science Institute (ICMOL), 46980 Paterna, Valencia, Spain
3- Catalan Institute of Nanoscience and Nanotech. (ICN2) & BIST, 08193 Bellatera, Catalonia Spain
4- Institute of Microelectronics of Barcelona (IMB-CNM CSIC), 08193 Bellaterra, Catalonia, Spain
5- IMDEA Nanociencia, Madrid, Spain
6- Aarhus University, Denmark
7- University of Augsburg, 86159 Augsburg, Germany and Helmholtz-Zentrum Berlin, 14109 Berlin, Germany
jllobet@cells.es

We demonstrate lensless coherent x-ray magnetic nanoscale imaging in 2D van-der-Waals materials[1] at low temperatures and under large applied magnetic fields. By integrating flakes of 2D materials via deterministic transfer inside an inert-air glove box [2] onto clean-room nano-fabricated holography masks, we extend the application of x-ray holography to this novel class of materials, including air sensitive materials. Figure 1 summarizes the "*AMaChaS*¨ process development[3]. While the developped approach is generic, we showcase its application in the investigation of the intricate magnetic domains and non-collinear configurations in Fe_3GeTe_2 (FGT) and CrI_3, with high-spatial resolution (~30 nm) under variable temperatures down to 20K and high applied magnetic fields up to 2 Tesla. Holography-guided assisted phase retrieval imaging [4] is also applied, which would enable 5-10 nm resolution under proper conditions (i.e., a closer sample to detector distance). Moving forward, lensless coherent imaging approaches exploiting x-ray circular and linear constrast provide unique opportunities to deepen our understanding at the nanoscale of the magnetic and electronic properties of 2D magnetic materials and related devices.

References

[1] Eisebitt, S. et al. Nature, 432 (2004) 885–888
[2] Huang, B. et al. Nature 546 (2017) 270–273
[3] AMaChaS – *Advanced Materials Characterization System,* MSCA-IF EU project
[4] Battistelli, R. et al, Optica 11, (2024) 234-237

Figures

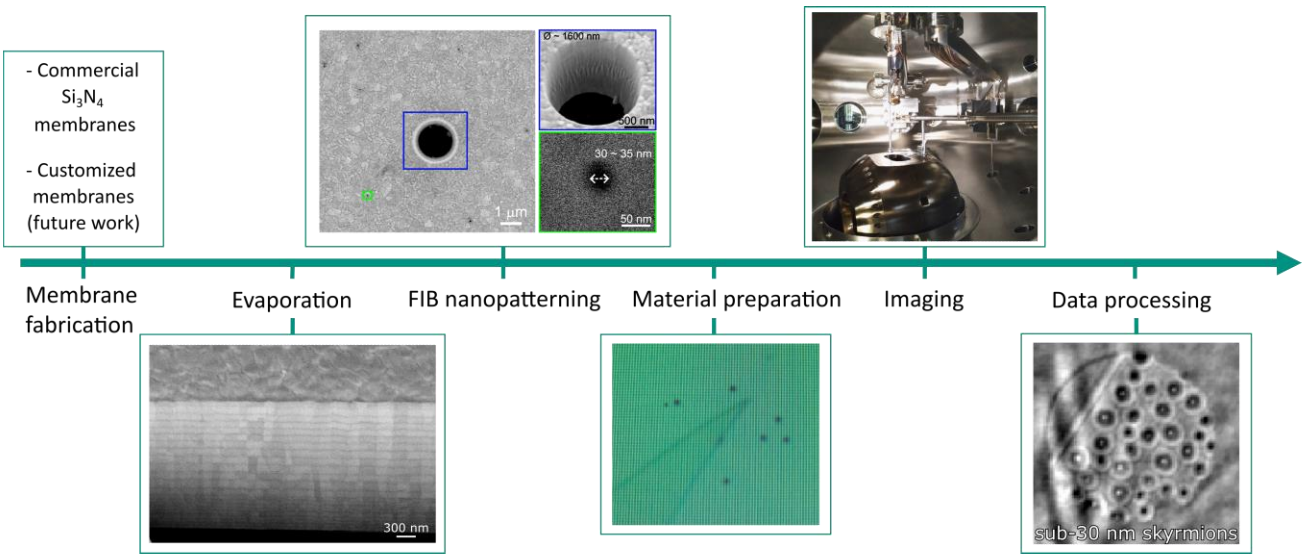

Figure 1: Characterization flow for magnetic domains to the nanoscale. Starting with Si_3N_4 membranes, evaporation of Au:Ti multilayers, FIB patterning, exfoliation and placement of the material of interest (CrI_3 or FGT in this work), characterization at Boreas Beamline, data processing.