

X-ray Absorption Spectroscopy at Diamond Light Source

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X-ray Absorption Spectroscopy (XAS) is a powerful technique that provides structural and electronic information on the local environment of an absorbing atom in a broad variety of systems, ranging across crystalline or amorphous solids, liquids or gases. Due to its broad applicability the technique is routinely used in many different scientific disciplines, from Chemistry and Catalysis to Environmental Science, Materials Science, Physics, Biology, Medicine, and Cultural Heritage. In recent years, photon-in/photon-out core-level spectroscopy has expanded the X-ray spectroscopy toolkit for investigating chemically specific electronic and geometrical structures, through the application of X-ray Emission Spectroscopy (XES), Resonant X-ray Emission Spectroscopy (RXES) and High Energy Resolution Fluorescence Detection XAS (HERFD-XAS). These novel techniques circumvent some of the shortcomings of traditional XAS.

In this talk I will introduce the techniques and will outline the capabilities of the Diamond spectroscopy beamlines [1] for XAS/XES through illustrative scientific examples. These will include 1. the study of structural defects in the superconducting magnets used in tokamak fusion reactors [1], 2. structural modifications in metal organic framework (MOF) materials upon gas adsorption [2], 3. the study of the structural changes on Fe-based Fischer-Tropsch catalysts under operando conditions [3]. Finally, I will also give a brief introduction to SWIFT (Spectroscopy WithIn Fast Timescales) the flagship beamline project that will be built as part of Diamond-II, the planned upgrade of the synchrotron.

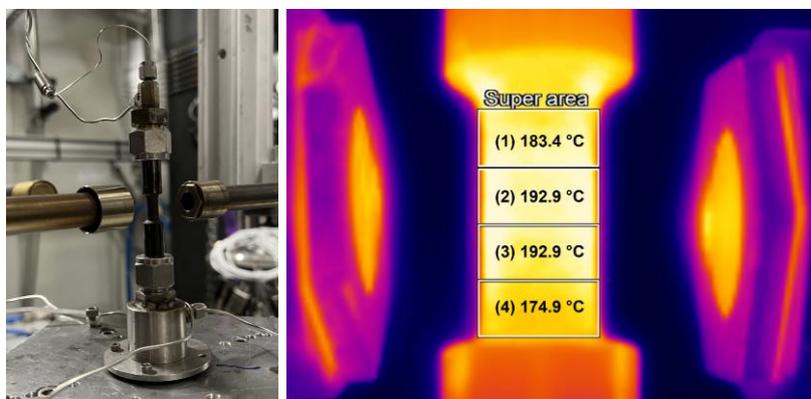


Figure 1. Reaction cell used during the study of the Fe-based Fischer-Tropsch catalyst under operation conditions. The right panel shows the infrared image of the temperature profile of the reactor when heated to 220 C.

[1] S. Diaz-Moreno et al. *J. Synchrotron Rad.*, **25**, 998 (2018)

[2] R. J. Nicholls et al., *Commun. Mater.* **3**, 52 (2022)

[3] R. Boada et al., *J. Phys. Chem. C*, **126**, 5935 (2022)

[4] T. A. Kathyola et al., *Review of Scientific Instruments*, **95**, 105122, (2024).

[5] <https://www.diamond.ac.uk/Diamond-II/New-Beamline-Proposals/first-proposals.html>