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In Situ and Tomography Developments at Diamond's Hard X-ray Nanoprobe

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Hard X-ray nanoprobes offer access to a crucial experimental parameter space, with spatial resolutions and fields of view bridging between electron microscopies and larger scale studies. Through the use of different imaging modalities they provide an exciting opportunity to correlate chemical and structural information at the nanoscale. The combination of the penetrating power of hard X-rays with the high spatial resolution makes an ideal probe for studying systems in situ or in operando.
Beamline I14 is the hard X-ray nanoprobe beamline at Diamond Light Source, UK [1]. With a focussed X-ray probe of 50nm, and a scannable energy range of 5-20keV the beamline is optimised for nanoscale X-ray microscopy studies using a combination of X-ray fluorescence (XRF), X-ray absorption near-edge spectroscopy (XANES) and X-ray diffraction (XRD) mapping and imaging (DPC, ptychography) [2]. The novel delta robot based scanning system provides high stability and high precision scanning over a large range whilst the endstation is designed with the experimental flexibility to allow easy interchange of sample environments and mounts, [1, 3] creating new opportunities for in situ and in operando research. In addition to an overview of the technical capabilities, we will also showcase how these techniques have successfully been applied in electrochemical research across different systems and techniques. We use a 50 nm beam and a flexible open endstation to probe a wide variety of samples and sample environments at the nanoscale. Recent advancements at the beamline have included expanding the options for in situ experiments and adding tomography capabilities for 3D imaging at the nanoscale [4]. Adapting commercial in situ TEM holders, we have developed beamline compatible and correlative in situ MEMS based environments for both liquid and gas, with heating and biasing options available [5].

In addition custom made sample environments for battery, liquid cell and solar devices have been incorporated into the multipurpose endstation. These capabilities are regularly used by our user communities, with examples from perovskite, battery and biological research themes.
These science cases will be presented alongside an overview of the adapted in situ holders, highlighting how nanoprobe modalities can play an important role in multi length scales studies. The tomography capabilities have also been developed for X-ray fluorescence, differential phase contrast imaging and ptychography experiments. A workflow has been developed using hardware and software tools for sample mounting, alignment, data collection and processing to enable a user friendly experience. The processes and scientific highlights will be presented.

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I plan to submit also conference proceedings

Yes

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