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A combined IR and Soft-X-ray Beamline for Multimodal Interface Spectroscopy and Scattering

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Liquid-vapor and liquid-solid interfaces drive numerous important processes in the environment and technology. Our understanding of the physical and chemical properties of liquid interfaces under realistic environmental and operating conditions on the molecular scale still falls short of what has been achieved for solid-vapor interfaces over the past decades. The main reason for this situation is the often greater difficulty in (1) the preparation of liquid interfaces (compared to solids) with controlled properties and (2) their investigation with high interface specificity under realistic conditions.
The Enhanced Liquid Interface Spectroscopy and Analysis (ELISA) beamline at BESSY-II aims to address these scientific and technological challenges through a concept that tailors both beamline optics and endstation infrastructure to the specific requirements of liquid interface science [1]. The beamline combines soft X-ray and infrared (IR) radiation, both originating from the storage ring, which are incident on the sample surface at the same time and the same location. While core-level spectroscopy, in particular ambient pressure X-ray photoelectron spectroscopy (APXPS), provides information on the elemental and chemical composition as well as potential gradients at the interface, reflection-absorption IR spectroscopy (RAIRS) offers complementary information about the orientation and bonding of molecules at the liquid-solid and liquid-vapor interface, expands the pressure range of in situ and operando experiments, and provides an excellent method to monitor possible radiation-induced damage to the interface and surrounding media in X-ray based spectroscopies.

The future ELISA beamline at BESSY-II, which is anticipated to commence operations at the end of 2025, will cover a wide energy range across two branches, both in the X-ray (30-2500 eV) and IR domain (10-10,000 cm-1). The low energy branch is dedicated to in situ studies of functional interfaces, in particular those with relevance for batteries and (photo)electrochemical devices, and cover the far UV range (including the Li K edge) up to the transition metal L edges. The high energy branch is dedicated to the investigation of liquid-vapor interfaces, for both fast flowing (e.g., jets and droplet trains) and static liquids (e.g., in a Langmuir trough).

[1] S. Vadilonga et al., Synchrotron Radiation News 35, 67-72 (2022).

Figure 1: The new ELISA beamline will enable simultaneous IR and X-ray-based investigations at liquid interfaces from the same sample location.

I plan to submit also conference proceedings

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