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# Operando Soft-Xray Spectroelectrochemistry at the MAX IV Laboratory HIPPIE Beamline

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HIPPIE is a high-flux, high-resolution soft x-ray beamline at MAX IV Laboratory (Sweden) with a new branchline primarily dedicated for operando studies of electrochemical interfaces. Such experiments utilize the dip-and-pull method to form a thin liquid meniscus on the surface of the working electrode in a three-electrode cell with a liquid electrolyte solution. Both the liquid film itself and the electrode-electrolyte interface can then be probed using X-ray photoelectron spectroscopy (XPS) or X-ray absorption spectroscopy (XAS) whilst maintaining full electrochemical control. The technique can be used to probe oxidation state changes, chemical shifts, electronic structure and electrochemical potentials in-situ.

In this talk we will introduce the capablilties of the beamline and endstation, focusing on spectroelectrochemical XPS/XAS experiments. We will include examples of dip-and-pull experiments at HIPPIE spanning topics including photo-electrocatalysis, battery interfaces and metal corrosion. The discussion will outline the experimental realities and challenges that any potential new user of the dip-and-pull method should be aware of. Finally, will also provide an overview of other types of experiment that are possible with this new instrument.

The HIPPIE beamline operates in the 250-2000 eV range, providing access to the L absorption edges of many transition metals and the K edges of light elements. The dip-and-pull XPS experiments are realized with an ambient-pressure hemispherical electron analyzer allowing measurements in vapor pressures up to 25 mbar. XAS can be measured in several modes, including total and partial electron yield or total florescence yield. The system is compatible with aqueous electrolyte solutions as well as some organic solvents, including many of those common in batteries. An argon/nitrogen atmosphere glove box can be attached to the measurement chamber such that air sensitive materials can be studied. Typically foils or thin films are used for the working electrode. This apparatus therefore provides one of the most flexible platforms for electrochemical studies using soft-X-ray spectroscopy.

## I plan to submit also conference proceedings

No

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