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In situ/Operando X-ray spectroscopy coupled to electrocatalysis

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Electrochemical energy conversion systems will become increasingly popular in the next decades, because of their strategic importance in converting, storing and releasing the energy gathered from renewable sources. Batteries, supercapacitors, electrolyzers or fuel cells all attract much attention in both applied and fundamental research, with the aim of improving their performance/cost ratio. In order to reach high efficiencies with environmental and social impacts as low as possible, a fundamental understanding of the functioning – and failure – of these devices under operating conditions is required. Because of the high penetration depth and the energy tunability of X-rays photons, Synchrotron-based techniques have emerged as ideal tools for this purpose.[1]

In this presentation, we will give an overview of the X-ray based techniques that can be coupled with electrochemical reactions under *in situ* or *operando* conditions, in order to gain insight in the local and electronic structure of electro-active materials, as well as their morphology. We will briefly describe instrumental aspects pertaining to these types of experiments (see figure 1) and provide examples of applications. A specific focus will be given on electrocatalytic reactions related to energy storage, such as the Oxygen Evolving Reaction (OER), the Hydrogen Evolving Reaction (HER) or the CO_2 Reduction Reaction (CO_2RR). Specific example will be detailed, which focuses on the study of molecular electrocatalyst that are active for the CO_2 reduction reaction[2] and perspectives for the future of the field will be given.

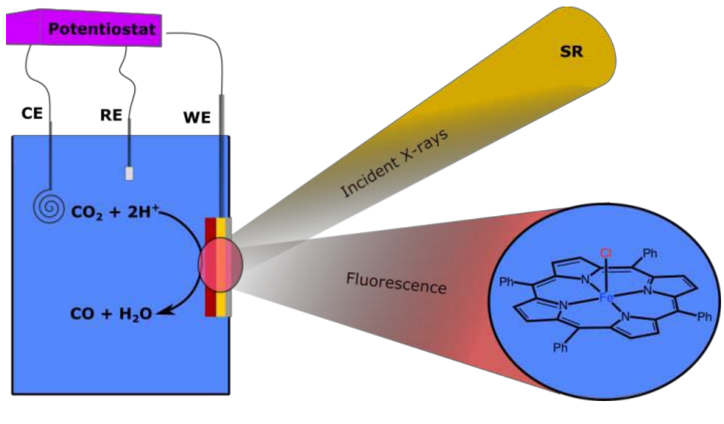

Figure 1. Simplified scheme of an *in situ / operando* X-ray spectroelectrochemical experiment.

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References

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2. S.-T. Dong, C. Xu, B. Lassalle-Kaiser, Chem. Sci. 14 (2023) 550.