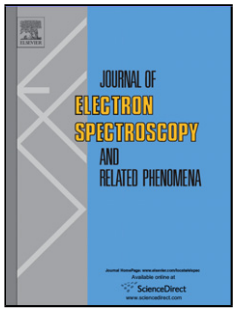

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Using soft x-ray absorption spectroscopy to characterize electrode/electrolyte interfaces *in-situ* and *operando*

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Abstract:

The interfaces between electrode and electrolyte play a vital role in various electrochemical systems. However, the understanding of such embedded interfaces and interfacial processes is still limited partly because of the short of proper characterizations tools, especially *in-situ*/*operando* techniques. In the past decade, substantial effort has been devoted in the development of *in-situ*/*operando* techniques to investigate the solid/liquid interfaces. One successful approach is the combination of *in-situ* liquid cells and soft x-ray absorption spectroscopy (sXAS). In this review, we showcased several recent examples using such liquid-cell-based *in-situ/operando* sXAS method to study different aspects of the electrode/electrolyte interface under reaction conditions, including the adsorption and deposition of solute species on electrode surface, morphological and chemical changes of electrode surface, and potential-dependent orientations of interfacial solvent molecules. These examples demonstrated capability of such *in-situ/operando* sXAS techniques in providing element- and chemical-sensitive interfacial information. This *in-situ/operando* sXAS technique also opens the way to the investigation of various solid/liquid interfaces in other important heterogeneous reactions.

Key words: solid/liquid interface; electrochemical double layer; soft X-ray absorption spectroscopy; in-situ/operando; liquid cell

Motivation:

The consumption of traditional fossil fuel has serious environmental impact on the global level, which has become more serious in recent years. Thus, there have been tremendous interests and demands to develop next-generation

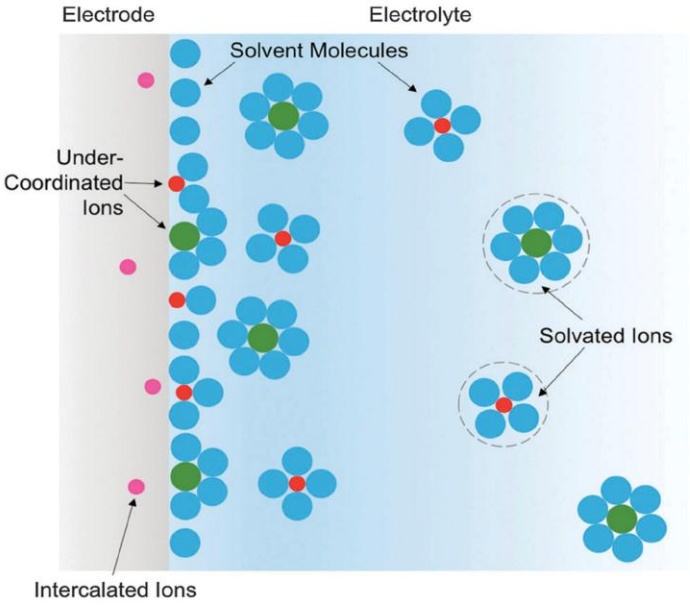

Figure 1. Schematic illustration of the electrochemical double layer (EDL). Reprinted with permission from [11]. Copyright (2015), Royal Society of Chemistry.