Probing and controlling the electrochemical interphase

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The electrification of fossil-fuel processes in industry requires technologies that transform and store electrical energy into other forms. Such technologies include, for example, electrolysers where water is converted into hydrogen and oxygen. At an atomic level, the efficiency of such devices depends on our ability to control the junction between the solid electrode (e.g. a metal) and the fluid that contains the reagents (e.g. water). [1] However, monitoring and controlling the interphase in operation-like conditions is experimentally challenging. In this talk, I will discuss recent experimental developments for probing the electrochemical interface of photo-electrocatalytic transition metal oxides. Specifically, I will show that optical spectroscopy can be used to track the changes in the redox state of the electrode as a function of the applied potential and how in situ optical data can be used to construct electro-adsorption isotherms and estimate surface coverages. Using the oxygen evolution reaction as a model example, I will discuss how spectroscopic data can be used to infer plausible reaction mechanisms and probe changes occurring at the interface upon polarisation. I will emphasise the advantages and limitations of this experimental approach and stress the importance of using multiple complementary probes. [2] Finally, I will discuss strategies to exert control over the interphase to direct chemical transformations on demand.

[1] Bard, A. J., Faulkner, L. R. & White, H. L. In Electrochemical Methods: Fundamentals and Applications 3rd edn (Wiley).
[2] Pastor E. et al. Nat Rev Chem., **2024**, 8, 159–178