Operando Spectro-electrochemical investigations of Pt and Pt-alloys as fuel cell catalysts

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Outlook

The ability to probe the electrode-electrolyte interface for Pt and Pt alloy catalysts and its relation to catalytic activity and stability hints at the immense potential of electrochemical XPS for the study of electrocatalysis. Once the challenge of a stable electrolyte film on the catalyst surface in a vacuum environment is overcome, X-ray spectroscopy becomes a very powerful and often highly surface sensitive tool, allowing us to follow different surface species in real-time via the different core levels they contain. In this regard, the conclusions presented in this thesis barely scratch the surface of the possibilities that the developed methodology offers.

In *Chapter 2,* we discussed our in house NAP-XPS and its versatility to incorporate a variety of reactions. Examples include biomass conversion, e.g. glucose oxidation on Pt, which is still in developmental phase in our lab and can offer an exciting start to my successor. In *Chapter 3,* we discussed the Pt oxidation under steady state and transient conditions. The same setup could be utilized to study surface degradation during accelerated stress tests (AST), surface structure changes under long term operation and the effect/lifetime of accumulated oxides formed during startup/shutdown stages. In *Chapter 4*, changes in catalyst properties due to subtle changes in catalyst structure in the Pt_3Ni alloy were discussed. Among many possible next steps in this project, one of the most promising seems to be the significantly higher HER activity in alloy catalysts, if conditioned properly. Spectroscopic examination of the surface/bulk structure responsible for the enhanced activity as well as log-term stability of this enhancement still need to be studied. Furthermore, other alloys such as Pt-Fe, Pt-Co and Pt-Au etc. could also be studied under similar conditions to paint a holistic picture of the effects of alloying under reactions conditions, contributing a significantly towards our fundamental understanding of alloy electrocatalysis.