**Electrochemical diagnostic methods: model-based and data-driven analysis**

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Electrochemical impedance spectroscopy (EIS) is the most popular technique for analysing and diagnosing different types of degradation mechanisms in various electrochemical devices such as fuel cells, water electrolysers or batteries. However, EIS often fails to separate the contributions of individual processes to the overall performance degradation due to the coupling of dynamic phenomena with similar time constants. For this reason, the use of EIS as a diagnostic tool for different electrochemical devices could lead to misinterpretations of the mechanisms causing specific degradations. In this talk, I show that further dynamic methods based on the exploitation of nonlinearities in the system response (Nonlinear Frequency Response Analysis (NFRA) [1,2]) or data-driven analysis (Loewner Framework [3]) could provide additional information for understanding electrochemical conversion processes. I also show that nonlinearities in the system response can influence the selectivity towards certain products. This is of particular importance in the field of electrosynthesis, where the selectivity of unmodified electrodes is usually an issue. We have recently shown that the selectivity of the $CO_2$ reduction reaction towards CO can be tuned under dynamic conditions [2]. Our current examples relate to the study of the $CO_2$ reduction reaction and water electrolysis using polymer electrolyte membranes.

References

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