Oxide supported Pt nanoparticles for the electrochemical oxygen reduction reaction in fuel cells

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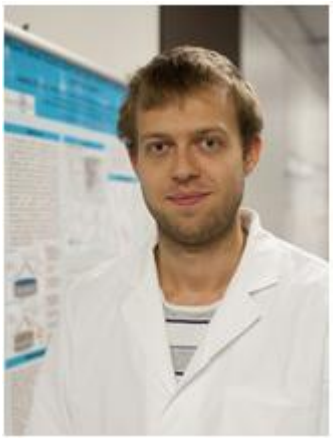

Project:

Electrocatalysts used in fuel cells are commonly based on Pt, because of its excellent catalytic activity concerning the sluggish cathodic oxygen reduction reaction, which limits the performance of a fuel cell. The use of Pt nanoparticles supported on carbon is the state of the art, because a high dispersion of the catalytically active substance can be achieved, which reduces costs and carbon also provides excellent electrical conductivity. The disadvantage in using carbon as a support is carbon corrosion under the harsh oxidative conditions in a fuel cell, which leads to detachment and agglomeration of the active Pt-nanoparticles. To overcome the drawback of carbon corrosion, nanostructured oxides can be used as support materials, because they are inert in oxidative environments. However, this approach is usually limited by their poor electrical conductivity, which therefore needs to be enhanced.

The oxide support materials I use are usually based on TiO_2 and SnO_2, which are doped with different transition metal ions to tune their electrical conductivity. Dopants are for example antimony, indium and niobium.
Interestingly, oxide support materials are not just more inert in oxidative environments, but also influence the activity of the catalysts. This might be due to changes in electronic properties of the reactive centres as well as due to bifunctional effects.

To characterize our catalysts we use cyclic voltammetry and linear sweep voltammetry at RDE, RRDE and stationary setups followed by Koutecky-Levich, Randles-Sevcik, Tafel and Cottrell analysis (Fig. 1) as well as electrochemical impedance spectroscopy. Furthermore I perform simulations of the measured electrochemical data based on classical diffusion equations to compare theory and practical results. To get further insight into the mechanism behind the support induced changes in catalytic activities we correlate data from electrochemical CO stripping with spectroscopic data generated by in-situ DRIFTS.

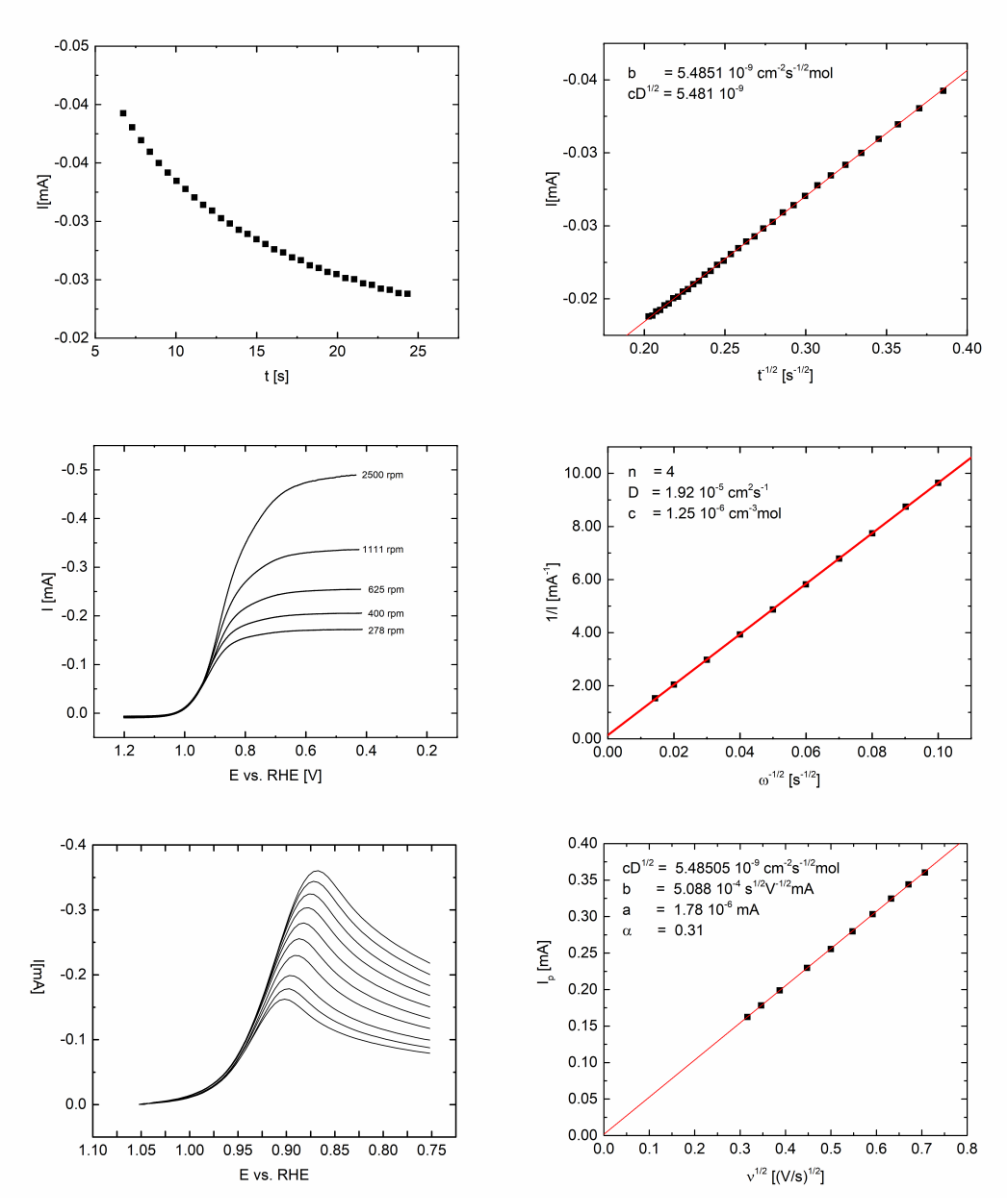

Fig. 1 Cottrell-Plot, Koutecky-Levich-analysis and Randles Sevcik analysis of a Pt catalyst for the oxygen reduction reaction in alkaline media.