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Electrodeposition of Pt - Rare Earth Alloys as ORR Catalysts for Fuel Cells

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There is a strong need for improved catalysts for the cathode side of PEM fuel cells. With pure Pt, overpotentials of several hundred mV arise due to the sluggish kinetics of the oxygen reduction reaction (ORR). The high amount of Pt catalyst therefore required to power hydrogen fuel cell driven electric vehicles leads to costs too high for widespread market introduction. Polycrystalline Platinum - rare-earth metal (RE) alloys, on the other hand, show very promising catalytic properties for ORR, *e.g.* an increase in the kinetic current density by a factor of 3-5 compared to pure Pt [1-3], and a good stability [2]. Also for Pt-RE nanoparticles prepared in a cluster source, an enhanced mass activity was found [4].
Because of the low standard potentials of the RE metals and their high sensitivity to moisture and air it is a challenge to synthesize such nanoparticles with a scalable method, but this is mandatory in order to provide material for MEA fabrication and –later- industrial production. In this study, electrochemical deposition from ionic liquids (ILs) was selected as scalable method. ILs offer a wide electrochemical potential window and in literature successful deposition of selected pure rare-earth metals has been reported [5]. However, there are also reports showing fundamental obstacles for deposition of RE metals from some ionic liquids [6].
In this work, in preparation of alloy deposition, the electrochemical processes in ionic liquid based electrolytes containing Gadolinium salts were studied. Several ionic liquids and Gd precursors were investigated. As the transport properties in ionic liquids are strongly enhanced at elevated temperatures, also the influence of the temperature was researched. Applied methods comprise electrochemical techniques, partially in combination with the electrochemical quartz crystal microbalance (EQCM) technique, and ex-situ characterization of deposited layers by electron microscopy / EDS.

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