Durability of PEMFC Electrodes and Reduction of Pt Loading

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A particular challenge related to low temperature polymer electrolyte fuel cells (PEMFC) is to maintain high performance and long-term durability concurrently with the further reduction of Pt loading. These are conflicting goals because of a direct correlation of Pt surface with activity and Pt amount with durability. Moreover the lack of common procedures to reliably determine voltage loss rates leads to severe difficulties in the comparison of results obtained by different institutions or projects. Accordingly, special attention is devoted to the discrimination between irreversible and reversible voltage losses [1].

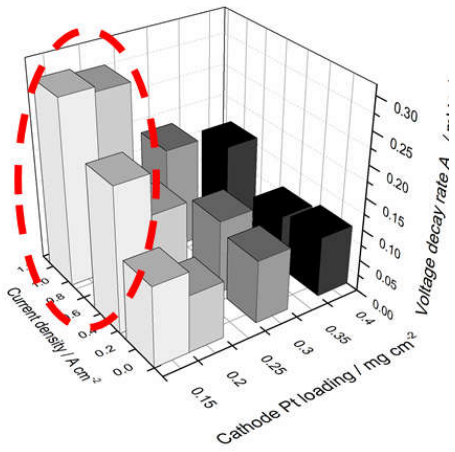

Fig. 1: Irreversible voltage decay rate as a function of current density and cathode Pt loading.

Regarding the influence of Pt loading on PEMFC performance and durability our recent rainbow stack study [2] performed in dynamic operation shows that for Pt/C based cathodes a sudden drop of performance is observed for loadings <=0.2 $mg_{Pt}cm^{-2}$ and current densities >1 Acm^{-2}. A similar threshold value is found for the increase of irreversible voltage losses which lead to a reduction of PEMFC durability for cathodes with <=0.2-0.3 mg_{Pt}/cm^2 (see Fig. 1). Another durability issue at cathodic loadings <0.4 mg_{Pt}/cm^2 is the acceleration of reversible degradation leading to a significant voltage drop at continuous fuel cell operation. The results show that the Pt loading of Pt/C based electrodes cannot be reduced below 0.2-0.3 $mg_{Pt}cm^{-2}$ by just varying the thickness of the catalyst layers without suffering durability issue. To go below 0.2 $mg_{Pt}cm^{-2}$ new electrode designs are needed. A special combination of coating techniques is also considered as promising approach to solve this issue.

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References:

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[2] P. Gazdzicki, J. Mitzel, A. M. Dreizler, M. Schulze, K. A. Friedrich, Fuel Cells, DOI: 10.1002/fuce.201700099