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# Effect of Platinum Oxides on Reversible and Irreversible Degradation in Polymer Electrolyte Fuel Cells

**Andrea Baricci (1), Matteo Zago (1), Thomas Jahnke (2), Andrea Casalegno (1)**
(1) Politecnico di Milano, Dipartimento di Energia
via Lambruschini 4, 20156 Milano/Italy
(2) German Aerospace Center (DLR)
38-40 Pfaffenwaldring, 70569 Stuttgart/Germany
Tel.: +39-02-2399-3840
andrea.baricci@polimi.it

## Abstract

At the current state of art in Polymer Electrolyte Fuel Cell (PEFC) technology, there is no competitive alternative to Platinum or Platinum alloys as electrocatalyst materials to promote sluggish oxygen reduction reaction (ORR). However, Platinum materials tend to form oxides above 0.70 V vs RHE, which are suspected to affect ORR electrochemical activity and long-term stability [1]. Several studies have been dedicated in the past to the analysis of Platinum oxides [2], suggesting a high level of complexity.
In the first part of this work, experimental analysis in membrane electrode assembly (MEA) is performed to get insight into the effect of Platinum oxides on ORR activity. First, experimental analysis is performed in inert environment (fully saturated Nitrogen). Oxides are formed via potential holding at 0.85V vs RHE or via potential cycling between 0.7V and 0.85V vs RHE, according to [3]. Oxide charge is quantified by linear sweep voltammetry in the potential range between 0.85V and 0.4V vs RHE. Results indicate the presence of two dominant families of Pt oxides. Additionally, a procedure is obtained to selectively form each type of oxide, by adopting potential holding or cycling. In a second step, the experimental setup is improved to quantify the effect of Platinum oxides on ORR activity and the following procedure is adopted. Oxides are formed in inert atmosphere, consequently air is enabled at the cathode side and potential is set to 0.85V. ORR current is recorded for 600s, after which the operation is switched to nitrogen again and oxides are measured via linear potential sweep. It is observed that oxide formation does not depend on oxygen concentration. Additionally, the selective effect of main oxide families on ORR is quantified.
In the last part of the work, different accelerated stress tests for electrocatalyst degradation based on potential cycling are compared, with the intent to distinguish the effect of each type of Platinum oxide on stability. Standard DOE test (triangular sweep between 0.6V and 1.0V at 50 mV $s^{-1}$) is thus modified for this scope.

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