

# Degradation Mechanisms of Oxygen Evolution Reaction Electrocatalysts: A Combined Identical-Location Transmission Electron Microscopy and X-Ray Photoelectron Spectroscopy Study

Fabien Claudel<sup>1</sup>, Laetitia Dubau<sup>1</sup>, Grégory Berthomé<sup>2</sup>, Lluis Sola-Hernandez<sup>3</sup>, Christian Beauger<sup>3</sup>, Laurent Piccolo<sup>4</sup>, and Frédéric Maillard<sup>1</sup>

<sup>1</sup> Univ. Grenoble Alpes, CNRS, Grenoble INP<sup>†</sup>, Univ. Savoie Mont Blanc, LEPMI, 38000 Grenoble, France

<sup>2</sup> Univ. Grenoble Alpes, CNRS, Grenoble INP<sup>†</sup>, SIMAP, 38000 Grenoble, France

<sup>3</sup> MINES ParisTech, PSL University, Centre procédés, énergies renouvelables et systèmes énergétiques (PERSEE), CS 10207 rue Claude Daunesse, F-06904 Sophia Antipolis Cedex, France

<sup>4</sup> Univ Lyon, Université Claude Bernard - Lyon 1, CNRS, IRCELYON - UMR 5256, 2 Avenue Albert Einstein, F-69626 Villeurbanne CEDEX, France

[fabien.claudel@lepmi.grenoble-inp.fr](mailto:fabien.claudel@lepmi.grenoble-inp.fr)  
[frederic.maillard@lepmi.grenoble-inp.fr](mailto:frederic.maillard@lepmi.grenoble-inp.fr)

Determining the degradation mechanism of oxygen evolution reaction (OER) catalysts is fundamental to design improved polymer electrolyte membrane water electrolyser (PEMWE) devices. In this study, we combined identical-location transmission electron microscopy, X-ray photoelectron spectroscopy and inductively coupled plasma mass spectrometry to determine the changes in morphology and composition of iridium nanocatalysts covered by a thin oxide layer ( $\text{IrO}_x$ ) in simulated PEMWE anode operating conditions. The results show that iridium valency increased rapidly during a conditioning step and in a softer manner after electrolysis. The catalysts containing initially metallic iridium were composed of a mix of Ir(III), Ir(IV) and Ir(V) after OER conditions while catalysts containing initially Ir(IV) solely had the same composition after OER. IL-TEM images show that Ir dissolution/redeposition and particle detachment occurred during electrochemical conditioning while agglomeration/coalescence and dissolution were observed after electrolysis. Iridium dissolution was quantified after a constant current electrolysis and we observed a direct relationship between the proportion of Ir(IV) in the catalysts and their stability in OER conditions.

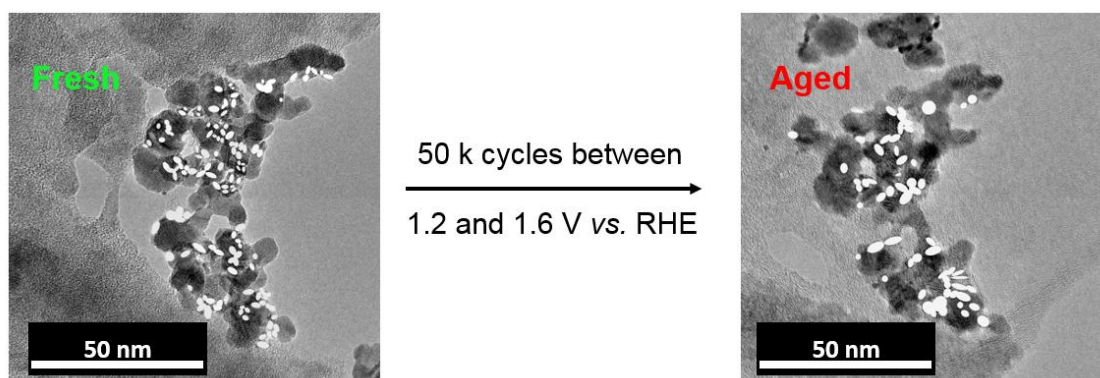


Figure 1: ILTEM images of  $\text{IrO}_x$  nanoparticles supported on antimony-doped tin dioxide aerogel before/after 50 k potential cycles between  $1.2 < E < 1.6$  V vs. RHE.

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## REFERENCES

1. F. Claudel, L. Dubau, G. Berthomé, L. Sola-Hernandez, C. Beauger, L. Piccolo, F. Maillard, submitted.