

Oxygen Evolution Reaction Investigation on Model Catalysts in Acidic Medium: electro-oxidation and catalytic activity of Ir(111), Ir(210) and nanostructured Ir(210)

Marion Scohy¹, Laetitia Dubau¹, Vincent Martin¹, Sofyane Abbou¹, Eric Sibert¹, Bruno Gilles², Frédéric Maillard¹

1. Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, Grenoble INP*, LEPMI, 38000 Grenoble, France

* Institute of Engineering Univ. Grenoble Alpes

2. Univ. Grenoble Alpes, SIMAP, F-38000 Grenoble, France CNRS, SIMAP, F-38000 Grenoble, France

marion.scohy@lepmi.grenoble-inp.fr

Proton exchange membrane water electrolyzers (PEMWEs) are perceived as one of the most promising technology for a clean hydrogen production but the sluggish oxygen evolution reaction (OER, anodic reaction) kinetics and the poor stability of the anodic material still limit their widespread development [1]. Iridium oxides (IrO_2) are ones of the most active electrocatalysts for the OER [2], able to maintain high OER kinetics over the long term in the harsh operating conditions of a PEMWE anode [3]. Considering the low abundance of iridium on the Earth's crust and its high cost, designing and synthesizing tailored OER nanocatalysts is an essential step. Switching from bulk surfaces to nanocatalysts requires investigations at atomically smooth model surfaces such as single crystals [4]. In this study, the effect of different crystal facets of Ir electrodes (Ir(111), Ir(210) and nanostructured Ir(210)) on the initial catalytic performance for the OER were compared. To go further, an ageing test consisting of applying 1.7 V vs. RHE for 2h was conducted to evaluate the stability of these surfaces. The amount of iridium dissolved was quantified by Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS) (Figure 1B). Atomic Force Microscopy (AFM) was used to study the surface morphologies and the chemical compositions were obtained by X-ray Photoelectron Spectroscopy (XPS). Although the surface structure (low-coordinated atoms and surface defects) and composition play a role on the initial catalytic performances, these differences vanish upon ageing (Figure 1A). By establishing the structure-activity-stability relationships, this fundamental study demonstrates the impact of low-coordinated atoms on the iridium dissolution and the correlation between the oxide composition and the OER activity. This study will help to improve the understanding of iridium electrocatalytic behavior upon OER and to design efficient catalysts for PEMWEs.

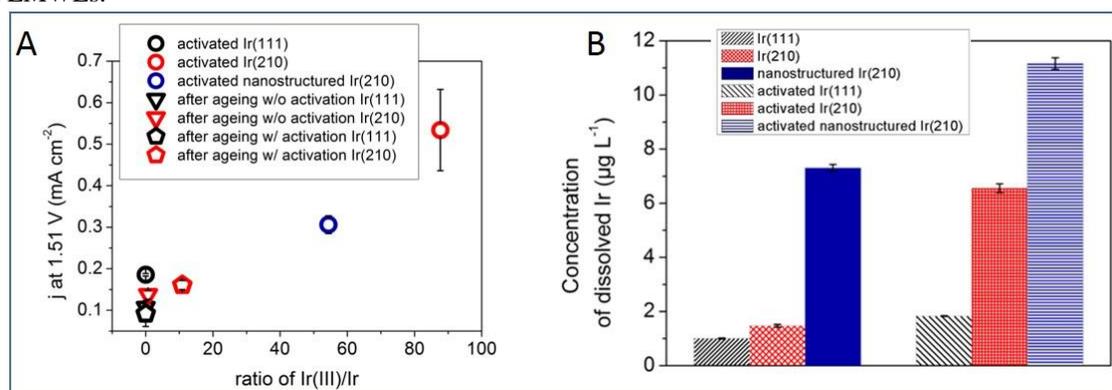


Figure 1: A) Relationship between current densities at 1.51 V vs. RHE in 0.05 M H₂SO₄ and ratio of Ir(III)/Ir calculated from XPS fittings. B) Concentration of dissolved Ir in the electrolyte after the ageing test (2h at 1.7 V vs. RHE)

References

- [1] A.S. Aricò, S. Siracusano, N. Briguglio, V. Baglio, A. Di Blasi, V. Antonucci, *J. Appl. Electrochem.*, 2013. doi:10.1007/s10800-012-0490-5.
- [2] S. Trasatti, *Electrochim. Acta.* 29 (1984) 1503–1512.
- [3] R. Hutchings, K. Müller, R. Kötz, S. Stucki, *J. Mater. Sci.* (1984). doi:10.1007/BF00980762.
- [4] N. Danilovic et al., *J. Phys. Chem. Lett.* (2014). doi:10.1021/jz501061n.