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► To cite this version:

Frédéric Maillard, Clément. Atlan, Corentin Chatelier, Isaac Martens, Maxime Dupraz, et al.. Imaging the evolution of strain in platinum nanoparticles under electrochemical control. 74th Annual Meeting of the International Society of Electrochemistry, International Society of Electrochemistry, Sep 2023, Lyon, France. hal-04206616

HAL Id: hal-04206616

<https://hal.science/hal-04206616>

Submitted on 13 Sep 2023

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Imaging the evolution of strain in platinum nanoparticles under electrochemical control

Frédéric Maillard¹, Clément. Atlan^{1,2,3}, Corentin Chatelier^{1,2}, Isaac Martens², Maxime Dupraz^{1,2}, Arnaud Viola³, Steven Leake², Tobias Schüllli², Joël Eymery¹, Marie-Ingrid Richard^{1,2}

¹ Université Grenoble Alpes, CEA Grenoble, IRIG, MEM, NRS, 17 rue des Martyrs, F-38000 Grenoble, France. mrichard@esrf.fr

² ESRF - The European Synchrotron, 71 Avenue des Martyrs, F-38000 Grenoble, France. leake@esrf.fr

³ Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, Grenoble INP, LEPMI, 38000 Grenoble, France. frederic.maillard@grenoble-inp.fr

The fundamental relationship between surface strain and the rate of a (electro-)catalytic reaction was pioneered by Hammer and Nørskov using density functional theory (DFT) calculations^[1,2]. They proposed that the rate of the sluggish oxygen reduction reaction (ORR) would be enhanced on Pt-based catalysts binding *OH species *ca.* 0.10 - 0.15 eV weaker than Pt(111),^[1,2] later experimentally verified using a Pt₃Ni(111)-skin surface^[3]. Nevertheless these predictions did not translate to Pt-based nanocatalysts, in part because these feature present multiple catalytic sites with a range of binding energies. Moreover, DFT calculations consider catalytic surfaces in vacuum, *i.e.* in the absence of water molecules and electric field. Hence, an *in situ* picture of how strain is distributed on Pt-based surfaces is still lacking.

In this contribution^[4], we took benefit of recent advances in Bragg Coherent Diffraction Imaging (BCDI)^[5,6] and of the fourth generation Extremely Brilliant Source of the European Synchrotron (ESRF-EBS, Grenoble, France) to map strain over Pt nanoparticles in electrochemical environment. Our results reveal that strain is heterogeneously distributed between highly- and weakly-coordinated surface atoms, and propagates from the surface to the bulk of the Pt nanoparticle as (bi)sulphates anions and water molecules adsorb on the surface.

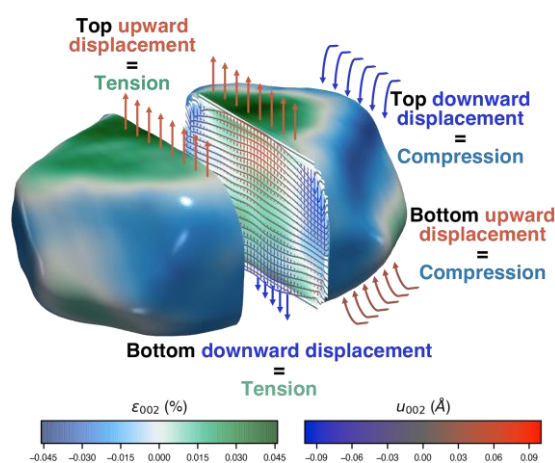


Figure 1 – Representation of the distribution of strain distribution in a Pt nanoparticle under potential control. 0.05 M H₂SO₄.

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