



Breathing Pt nanoparticle imaged using in situ BCDI

Clément Atlan, Corentin Chatelier, Isaac Martens, Maxime Dupraz, Steven Leake, Marie-Ingrid Richard, Arnaud Viola, Frédéric Maillard

► To cite this version:

Clément Atlan, Corentin Chatelier, Isaac Martens, Maxime Dupraz, Steven Leake, et al.. Breathing Pt nanoparticle imaged using in situ BCDI. ESRF User Meeting 2023, ESRF, Feb 2023, Grenoble, France. hal-04005440

HAL Id: hal-04005440

<https://hal.science/hal-04005440>

Submitted on 26 Feb 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Breathing Pt nanoparticle imaged using *in situ* BCDI

C. Atlan^{1, 2, 3}, C. Chatelier^{1, 2}, I. Martens², M. Dupraz^{1, 2}, S. Leake², M.-I. Richard^{1, 2},
A. Viola³, F. Maillard³

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 relationship between surface strain and the rate of a (electro-)catalytic reaction was unveiled 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 more weakly 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. Also, 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, we took benefit of recent advances in Bragg Coherent Diffraction Imaging (BCDI)^[4, 5] 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 adsorb on the surface.

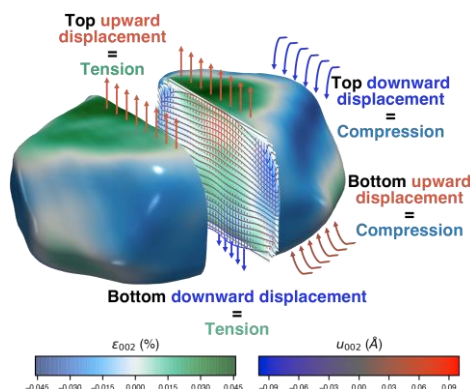


Figure 1: Representation of the strain distribution observed on a Pt nanoparticle under potential control. 0.05 M H₂SO₄.

References

- [1] B. Hammer, J. K. Nørskov, Surf. Sci. **343**, 211 (1995).
- [2] B. Hammer, Y. Morikawa, J. K. Nørskov, Phys. Rev. Lett. **76**, 2141 (1996).
- [3] V. R. Stamenkovic, B. Fowler, B. S. Mun, G. Wang, P. N. Ross, C. A. Lucas, N. M. Markovic, Science **315**, 493 (2007).
- [4] I. Robinson and R. Harder, Nat. Mater. **8**, 291 (2009).
- [5] J. Carnis, A. R. Kshirsagar, L. Wu, M. Dupraz, S. Labat, M. Texier, L. Favre, L. Gao, F. E. Oropeza, N. Gazit, E. Almog, A. Campos, J.-S. Micha, E. J. M. Hensen, S. J. Leake, T. U. Schüllli, E. Rabkin, O. Thomas, R. Poloni, J. P. Hofmann, and M.-I. Richard, Nat. Commun. **12**, 5385 (2021).