



**HAL**  
open science

## Operando potential-induced strain heterogeneity of a breathing Pt nanoparticle

Clément Atlan, Corentin Chatelier, Arnaud Viola, Maxime Dupraz, Steven Leake, J. Eymery, Frédéric Maillard, Marie-ingrid Richard

### ► To cite this version:

Clément Atlan, Corentin Chatelier, Arnaud Viola, Maxime Dupraz, Steven Leake, et al.. Operando potential-induced strain heterogeneity of a breathing Pt nanoparticle: MS40 - Operando and in-situ crystallographic studies. ECM33 - 33rd European crystallographic meeting, Aug 2022, Versailles, France. hal-03760087

**HAL Id: hal-03760087**

**<https://hal.science/hal-03760087>**

Submitted on 24 Aug 2022

**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.

00381

# Operando potential-induced strain heterogeneity of a breathing Pt nanoparticle

## MS40 Operando and in-situ crystallographic studies

Clément Atlan <sup>1</sup>, Corentin Chatelier <sup>1</sup>, Arnaud Viola <sup>2</sup>, Maxime Dupraz <sup>3</sup>, Steven Leake <sup>4</sup>, Joël Eymery <sup>1</sup>, Frédéric Maillard <sup>2</sup>, Marie-Ingrid Richard <sup>1</sup>

<sup>1</sup>Univ. Grenoble Alpes, CEA Grenoble, IRIG, MEM, NRS - Grenoble (France),

<sup>2</sup>Univ. Grenoble Alpes, CNRS, Grenoble INP, Univ. Savoie Mont Blanc, LEPMI - Saint-Martin-d'Hères (France), <sup>3</sup>Univ. Grenoble Alpes, CNRS - Saint-Martin-d'Hères (France), <sup>4</sup>ESRF - The European Synchrotron - Grenoble (France)

### Abstract

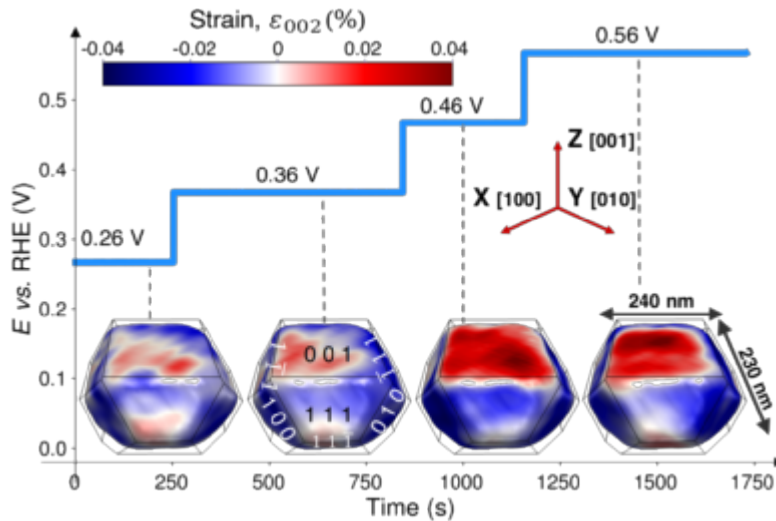
Pt nanoparticles and their alloys are frequently used as catalysts in a large number of (electro)chemical processes. Understanding how the structure of these catalysts evolve during the reaction is a major challenge to optimize their catalytic performance and activity. Since coherent X-ray diffraction imaging [1, 2] is a non-destructive technique, it allows for the *in situ* and *operando* 3D mapping of the structural response of single nanoparticles during electrochemical reaction (*i.e.* for different electrode potentials) and for different types of electrolyte.

Here, we show that the use of this technique allows to follow the 3D evolution of the strain of a Pt nanoparticle during an electrochemical reaction (see Figure 1). More precisely, we show evidence of heterogeneous and potential-dependent strain distribution between highly-coordinated ( $\{100\}$  and  $\{111\}$  facets) and under-coordinated atoms (edges and corners) as well as evidence of strain propagation from the surface to the bulk of the nanoparticle (see Figure 2). The heterogeneity of strain distribution depends on the electrode potential and reaches as large as 0.08 % at oxygen reduction reaction-relevant potential. These results provide dynamic structural insights to better simulate and design efficient nanocatalysts for energy storage and conversion applications.

### References

- [1] I. Robinson and R. Harder, Coherent X-Ray Diffraction Imaging of Strain at the Nanoscale, Nat. Mater. 8, 291 (2009).
- [2] J. Carnis, L. Gao, S. Fernández, G. Chahine, T. U. Schüllli, S. Labat, E. J. M. Hensen, O. Thomas, J. P. Hofmann, and M.-I. Richard, Facet-Dependent Strain Determination in Electrochemically Synthesized Platinum Model Catalytic Nanoparticles, Small accepted (2021).

1: Electrode potential influence on surface strain



2: strain - displacement relationship

