Operando potential-induced strain heterogeneity of a breathing Pt nanoparticle
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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: Electrode potential influence on surface strain

2: strain - displacement relationship