Studying nano-catalysts degradation with an identical location STEM approach

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The local structure and morphology of a material is usually modified when submitted to an electro-catalytic process depending on the cycling and potential used. One way to learn more about the effects happening on the material is by using identical location, that is, examining a specific region of interest of the material before and after the electrochemical process takes place. In this work, we show different examples using identical location analytical scanning transmission electron microscopy (IL-STEM) to track specific changes of the material by observing before and after states. In this way, it is possible to study degradation mechanisms directly in the region of interest. Since some of the changes are occurring at the atomic level, understanding them can shed some light on the structural-properties relationship, including the metal support interaction. Most of the analyses shown in this work correspond to Pt-based nanoparticles typically employed in fuel cells and electrolysers that have been submitted to a particular electrochemical cycling protocol. The structural and morphological information gathered from the initial and after states suggests the occurrence of dissolution from specific atomic columns and atomic sites as well as redeposition for different columns and sites. These observations can lead to the conclusion that certain facets may be affected more than others, or in other cases, as it will be shown, to reveal how the support interacts with the catalysts. In this regard, the analysis of regions that suffered modifications can give us certain clues on how degradation started or evolved. Hence, the incorporation of advanced electron microscopy analytical techniques coupled with electro-chemistry experiments can provide crucial insights for a better catalyst design, including stability and durability.

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