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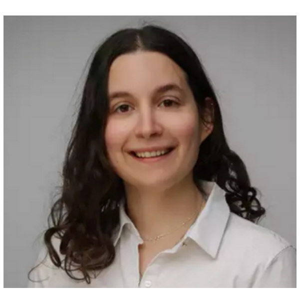
Stability of 2D oxide and chalcogenide nanomaterials under synthesis and application conditions

Two-dimensional (2D) nanostructures are widely regarded as promising materials for energy applications such as energy storage and electrocatalysis for green hydrogen production. Despite their outstanding properties, these nanomaterials can suffer from degradation during both their synthesis and application. In this talk, the degradation mechanisms of model 2D metal oxide and chalcogenide nanomaterials will be explored with electron microscopy and in-operando electrochemical methods. On the first hand, the origins of a coupled phase/morphology transformation of the 2D $Fe_xMn_{1-x}O_2$ nanomaterials during synthesis will be addressed[1]. An oxidative mechanism dependent on the equilibrium of Fe^{3+} and Mn^{2+} ions revealed by electron energy loss spectroscopy (EELS) was found responsible for the transition of 2D δ-$Fe_xMn_{1-x}O_2$ nanomaterials towards γ-$Fe_xMn_{1-x}O_2$ nanocones, which correlated to a loss of capacitive performance. On the second hand, the stability of 2D MoS_2-based hydrogen evolution reaction (HER) nanocatalysts for water splitting electrolyzer application will be discussed[2]. A combination of scanning flow cell – inductively coupled plasma mass spectroscopy (SFC-ICPMS) and identical location scanning transmission electron microscopy (IL-STEM) was used to gain insights in the corrosion suffered by the 2D catalysts during HER and open-circuit potential (OCP) conditions. These techniques allowed to compare the effect of dopants and crystal phases not only on the activity but also the degradation of 2D MoS_2-based nanocatalysts. These results and methodology shed light on the mechanisms behind the instability of 2D nanomaterials, thus contributing to build the synthesis-structure-property relationships required for the design of functional nanomaterials.

1. *R. Aymerich-Armengol; P. Cignoni; P. Ebbinghaus; J. Linnemann; M. Rabe; K. Tschulik; C. Scheu; J. Lim, Journal of Materials Chemistry A, (2022), 10, 24190.*
2. *R. Aymerich-Armengol; M. Vega-Paredes; A.M. Mingers; L. Camuti; I. Efthimiopoulos; R. Sahu; B. Lotsch; M. Rabe; C. Scheu; J. Lim; S. Zhang, To be submitted*



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