Beyond OER: Organic Molecule-Assisted Water Electrolysis with Manganese-Based Catalysts

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Over the past decade, the rise in extreme climate events caused by greenhouse gas emissions has emphasized the need to decarbonize energy systems and adopt sustainable sources. However, the intermittency of renewables requires efficient energy storage solutions. Hydrogen production, hindered by the oxygen evolution reaction (OER), offers a promising path for decarbonizing the energy matrix [1]. Manganese oxide-based electrocatalysts (MnO_x) are a sustainable alternative to noble-metal OER catalysts like Pt, Ir, and Ru, due to their abundance, low toxicity, and catalytic activity in acidic media [2]. Although recent advances, such as combining Mn with Sb to reduce dissolution above 1.75 V_{RHE}, have improved stability, the high overpotential remains a major challenge for industrial applications. In this context, hydrogen-rich small organic molecules are attractive, as a proton source, offering overpotentials lower than OER for green hydrogen production [3]. This study investigates the activity, stability, and selectivity of MnO_x and $MnSbO_x$ for organic-molecule-assisted (methanol, ethylene glycol, and butane-2,3-diol)-OER using online inductively coupled plasma mass spectrometry (ICP – MS) and electrochemical infrared reflection absorption spectroscopy (EC-IRRAS) to identify reaction intermediates and gain mechanistic insights. In this presentation, we will discuss the aspects that control the stability and selectivity, mainly for the CO_2 or O_2 formation.

[1] IRENA - International Renewable Energy Agency, Green Hydrogen cost reduction scaling up electrolyser to meet the 1.5°C climate goal. 2020
[2] A. Li et al., "Stable Potential Windows for Long-Term Electrocatalysis by Manganese Oxides Under Acidic Conditions," Angewandte Chemie - International Edition, vol. 58, no. 15, pp. 5054–5058, Apr. 2019.
[3] Luke, Sibimol, et al. "Mixed metal–antimony oxide nanocomposites: low pH water oxidation electrocatalysts with outstanding durability at ambient and elevated temperatures." *Journal of Materials Chemistry A* 9.48 (2021): 27468-27484.