**Benchmarking Membrane Electrode Assembly Inks with Transparent Conductive Oxides for Proton-Exchange Membrane Water Electrolysis**

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A central challenge in solar hydrogen production is replacing high-performance, stable noble metal catalysts in water electrolyzers and photoelectrocatalytic systems with non-noble metal alternatives. Unlike noble metals, which often require no or minimal support, non-noble metal catalysts are prone to degradation and typically demand suitable chemical environments for prolonged operation due to their dynamic behavior.[1] Identifying stable, conductive, and chemically resistant supports for the oxygen evolution reaction (OER) is thus crucial. TCOs are attractive catalyst support candidates. While doped TCOs offer good conductivity, minimizing ohmic drop in real applications, dopant corrosion can lead to gradual performance loss. Metal oxidation and anodic dissolution further complicate stability, particularly during the OER.[2]

We have successfully employed TCO-coated anode supports, specifically ITO and FTO, in the evaluation of non-noble molecular pre-catalysts.[3-6] These supports offered the experimental flexibility and high reproducibility needed for *operando* and post-catalysis tests, clearly elucidating changes in molecular pre-catalysts and the role of side reactions during the OER at a laboratory scale in 3-electrode or H-cells.

More recently, we began investigating TCOs as ink constituents for membrane electrode assembly (MEA) fabrication in proton-exchange membrane (PEM) single water electrolysis cells. In these setups, TCO particles are mixed with the catalyst, Nafion solution, and other additives in varying ratios, undergoing different treatments to produce catalyst ink spray-coated onto the PEM. Developing such ink compositions is a complex and laborious optimization challenge. Our current work utilizes commercial, uniform FTO-, ITO-, and ATO-coated support electrodes to study the potential-dependent behavior and interaction with ink components like Nafion. Crucially, this research aims to benchmark the adsorption stability, distribution, charge transfer resistance, and overall catalytic performance, including degradation onset potentials, of various Fe- and Ni-containing molecular pre-catalysts before their incorporation into MEA inks.

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