From Measurement Reliability and Reproducibility to Electrocatalyst Design in Alkaline Media

The development of water electrolysis and fuel cell technologies requires highly active electrocatalysts. However, obtaining reliable and reproducible results for evaluating catalytic performance in aqueous alkaline solutions is challenging due to their lower purity compared to acidic media. Impurities can gradually adsorb on electrode surfaces, thereby affecting the accuracy of electrochemical measurements. This issue is particularly critical for well-defined model systems, such as single crystal electrodes.

To address this challenge, we assessed the cleanliness of the experimental setup and the reproducibility of electrochemical measurements in alkaline media using polycrystalline and single crystal Pt electrodes. Standard cyclic voltammetry (CV) profiles serve as benchmarks for clean conditions, as their shapes are highly susceptible to the presence of impurities. Long-term chronoamperometric experiments followed by XPS analysis demonstrate the presence of impurities on the Pt surface, originating from the electrolyte salts. By establishing benchmarks for contamination-free conditions, this work enables the reliable determination of catalytic activity in alkaline media by minimizing measurement artifacts related to impurities.

Recent advances in anion exchange membranes (AEMs) have created new opportunities for fuel cell technologies based on composite catalysts that combine inexpensive non-noble transition metals, such as nickel (Ni), with small amounts of highly active Pt. The second part of this talk focuses on the fabrication and characterization of Pt-modified nickel poly-oriented spherical single crystal (POSSC) electrodes for hydrogen evolution and oxidation reactions (HER/HOR) in alkaline media. EDS, XPS, and CV measurements confirm successful Pt nanoparticle deposition on the Ni POSSC. SEM imaging reveals the size and distribution of Pt nanoparticles on etched Ni low-Miller-index facets, indicating a facet-dependent Pt deposition. The catalytic activity toward HER/HOR is evaluated using linear sweep voltammetry (LSV) and steady-state polarization (Tafel) analysis.