Boosting the performance of Ru nanocatalysts for hydrogen evolution reaction using metal-support interaction

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The use of water electrolysis (WE) powered by renewable energy sources is expected to become the leading method for the decentralized and carbon-neutral production of hydrogen. Green hydrogen has diverse applications across various industries, including metal treatment, chemical production, and as a versatile energy carrier. In WE systems, hydrogen is produced through the electrochemical hydrogen evolution reaction (HER). The efficiency of metallic catalysts for HER is primarily influenced by the hydrogen intermediate adsorption energy and the water dissociation barrier. By optimizing these key activity descriptors, it is possible to develop advanced HER catalysts that surpass the performance of Pt, the benchmark for HER activity.[1]

This study highlights the remarkable HER performance of a catalyst made of Ru nanoparticles supported on a titanium oxynitride-carbon matrix (Ru/TiON-C), featuring a notably low Ru loading of only 6 wt. %. In an alkaline electrolyte, the Ru/TiON-C composite exhibited significantly superior HER activity compared to its Ru/C and Pt/C counterparts and stands out as one of the top-performing Ru-based catalysts documented in the literature. The exceptional performance of the Ru/TiON-C catalyst can be attributed to the metal-support interactions (MSI) facilitated by the TiON support, which leads to two critical enhancements: (i) TiON induces the partial formation of a distorted face-centered cubic (fcc) Ru structure, which is known to improve water dissociation properties;[2] (ii) TiON influences the electron density rearrangements around Ru sites, optimizing the energy for hydrogen adsorption and desorption.[3]

These beneficial effects of TiON can be applied to a broad range of catalysts and various electrochemical reactions, potentially paving the way for significant advancements in the field of electrocatalysis.

References:

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