Increasing Green Hydrogen Production Accessibility: Novel Synthesis of Maghemite Nanosphere Electrode for Bifunctional Alkaline Water Splitting

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Hydrogen has shown promise as the future of zero-carbon energy storage. However, partly due to the cost and synthesis complexity of electrocatalysts for Alkaline Water Splitting (AWS), 95% of hydrogen production continues to rely on fossil fuels. Given these considerations, this work demonstrates the synthesis of an inexpensive, novel maghemite nanosphere electrode for green hydrogen production. The electrocatalyst was prepared via a new process involving the aerobic transformation of a hydroxide precursor and the oxidation of a magnetite intermediate, resulting in the agglomeration of spinel structures, forming nanospheres. The electrode presented excellent activity in a KOH medium with low overpotentials, outperforming the standard RuO2 electrode at high rates in the Oxygen Evolution Reaction (OER) due to the effect of cation vacancies on anion intermediate binding energy. The electrochemically active surface area (ECSA) of the electrocatalyst was increased by 274% and 335% for the Hydrogen Evolution Reaction (HER) and the OER, respectively. Furthermore, the synthesized electrocatalyst demonstrated better stability over 120 hours than RuO2 and Pt due to the hydroxide precursor. Overall, this electrocatalyst has potential to increase the accessibility of green hydrogen generation worldwide via its extremely low cost, simplicity and industrial viability of synthesis, and globally available materials required, compared to other noble metal alternatives. This solvothermal method exhibits potential to be generalized to the synthesis of other transition metal oxide-based nanostructured materials. Similarly, the discovered pathway to produce magnetite from hydroxide in an aerobic environment has numerous applications in biomedical nanotechnology and inorganic synthesis.

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