Tailored Bimetallic NiCo Electrocatalyst for Dual Green Hydrogen and Formate Production From Seawater

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Electrochemical seawater splitting is one of the most promising methods for sustainable hydrogen production. However, its major challenge is the simultaneous chlorine evolution reaction (CER) and oxygen evolution reaction (OER), which are energy-intensive, can cause explosion risks, and lead to severe catalyst and membrane degradation. In this work, I inhibit chlorine and oxygen evolution by replacing these reactions with the kinetically and thermodynamically favorable methanol oxidation reaction (MOR). This methanol-assisted strategy enables safe and energy-efficient hydrogen production while generating value-added formate as a co-product. As a direct consequence of suppressing chlorine and oxygen formation, the need for expensive ion-exchange membranes is eliminated. Herein, I develop a novel, cost-effective porous NiCo-based electrocatalyst supported on nickel foam (NiCo@NF) via chrono-potentiometric electrodeposition at room temperature, completed within 5 minutes. The SEM showed porous growth of interconnected macro- and nanosheets. EDX and XRD confirmed the presence of Ni and Co with high purity and well-defined phase structure. The optimized NiCo@NF catalyst required only 60 mV overpotential, which is comparable to the benchmark platinum-based catalysts currently available in the market. Furthermore, the optimized electrode required 210 mV less potential for methanol-assisted seawater splitting compared to traditional seawater splitting, demonstrating significantly improved energy efficiency. This technique enables cleaner, safer, and more efficient green hydrogen production from seawater, advancing the transition toward sustainable and scalable fuel technologies.

Awards Won:

Third Award of $1,200