Electrodeposited High-Entropy Alloy/CNT Electrocatalyst for Enhanced Hydrogen Evolution Reaction

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Hydrogen is considered one of the most promising energy carriers of the future owing to its high energy density and carbon-free nature. Although hydrogen production via electrochemical water splitting is recognized as an environmentally friendly and sustainable approach, the sluggish kinetics and high overpotential of the hydrogen evolution reaction (HER) necessitate the development of highly efficient electrocatalysts. Despite their excellent HER activity, noble metal-based catalysts are limited by their high cost and scarcity, prompting extensive research into alternative catalyst materials. In this context, high-entropy alloys (HEAs) have emerged as promising electrocatalysts because of their multicomponent compositions, superior corrosion resistance, tunable electronic structures, and synergistic interactions among constituent elements, commonly referred to as the “cocktail effect”. In this study, a FeNiCoMn high-entropy alloy electrocatalyst was synthesized by electrodeposition from an aqueous electrolyte containing a complexing agent. Furthermore, the catalyst was deposited in the presence of conductive carbon nanotube (CNT) supports to enhance the electrochemically active surface area, and its electrocatalytic performance was compared with that of the unsupported HEA. Electrodeposition was selected as the synthesis method due to its low cost, simplicity, and ability to precisely control the properties of the deposited coatings. The HER performance of the synthesized FeNiCoMn HEA electrocatalysts was evaluated using linear sweep voltammetry (LSV), cyclic voltammetry (CV), and electrochemical impedance spectroscopy (EIS). LSV was employed to determine the overpotential and reaction kinetics, CV was used to evaluate the capacitance of the electrocatalysts, and EIS was performed to investigate the charge-transfer resistance. The results demonstrated that the CNT-supported HEA exhibited enhanced HER activity compared with the unsupported HEA, which was attributed to its increased catalytically active surface area.

Keywords: Electrocatalysis, Hydrogen evolution, HEA, electrodeposition.