AN ENHANCED HYDROGEN EVOLUTION REACTION PERFORMANCE BY NICKEL-MANGANESE BIMETALLIC ELECTROCATALYSTS TOWARDS ALKALINE NATURAL SEAWATER AND SIMULATED SEAWATER SPLITTING

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In this work, 3D nickel-manganese (NiMn) bimetallic coatings have been studied as efficient and stable electrocatalysts towards the hydrogen evolution reaction (HER) in simulated seawater (1 M KOH + 0.5 M NaCl, @SSW) and alkaline natural seawater (1 M KOH + natural seawater, @ASW). These binary coatings have been electrodeposited on a titanium substrate using a facile electrochemical deposition method through a dynamic hydrogen bubble template technique. The as-deposited NiMn/Ti coatings with variable Mn concentrations produce typical globular and unique porous architecture with abundant pores of different sizes. The HER activity of these fabricated catalysts was investigated by using Linear Sweep Voltammetry (LSV) in alkaline seawater and simulated seawater at different temperatures, whereas, the morphology and composition were characterized by scanning electron microscopy (SEM) and inductively coupled plasma optical emission spectroscopy (ICP-OES). The NiMn/Ti-3, NiMn/Ti-4, and NiMn/Ti-5 were prepared using different chemical bath compositions, where Ni:Mn molar ratios were 1:3, 1:4 and 1:5, respectively.

The as-prepared NiMn/Ti-5 electrocatalyst exhibits excellent HER activity in simulated seawater with an ultra-low overpotential of 64.2 mV to reach the benchmark current density of 10 mA cm^{-2}. Notably, a current density of 10 mA cm^{-2} is also attained by the NiMn/Ti-5 electrocatalyst with a comparably low overpotential of 76.5 mV in alkaline natural seawater. The current densities increase ca. 1.75–2.35 times with an increase in temperature from 25 °C to 75 °C for HER in both electrolytes. This bimetallic catalyst has exhibited excellent long-term stability at a constant potential of -0.232 V (vs. RHE) and a constant current density of 10 mA cm^{-2} for 10 hours that convincingly pledged its higher durability and robust nature for real-life seawater splitting technology.