THREE-DIMENSIONAL Au(NiMo)/Ti CATALYSTS FOR EFFICIENT HYDROGEN EVOLUTION REACTION

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In this study, gold-nickel-molybdenum 'Au(NiMo)' coatings have been studied as catalysts for hydrogen evolution reaction (HER). The catalysts have been deposited on a titanium surface using electroplating and galvanic displacement techniques. The electrocatalytic performance of those fabricated catalysts was investigated for HER by using Linear Sweep Voltammetry at different temperatures ranging from 25 up to 75 ℃. Scanning electron microscopy and Inductively Coupled Plasma Optical Emission Spectroscopy were used for the characterization of catalysts morphology and composition. Moreover, the stability of prepared catalysts was evaluated by Chronoamperometric measurements. It was found that the Au(NiMo)/Ti-3 and NiMo/Ti-3 catalysts with the highest metal loadings demonstrate the lowest overpotential of 252 mV and 288 mV respectively for HER to reach the benchmark current density of 10 $mA \cdot cm^{-2}$. The current densities for HER increase 1.1-2.7 times with an increase in temperature from 25 ℃ to 75 ℃ using the prepared 3D binary or ternary catalysts. The highest mass electrocatalytic activity of 1.53 $mA \cdot \mu g^{-1}$ for HER has been achieved on the Au(NiMo)/Ti-1 coating with a metal loading of 23.9 $\mu g_{metal} \cdot cm^{-2}$ at 25 ℃.

Table 1. Composition of the electrochemical bath.

Catalysts	Concentration in $mol \cdot dm^{-3}$	
	Ni^{2+}	Mo^{6+}
NiMo/Ti-1	0.1	0.03
NiMo/Ti-2	0.2	0.03
NiMo/Ti-3	1.0	0.03

Table 2. The metal loading in the catalysts as determined by ICP-OES analysis.

Catalyst	Ni loading ($\mu g_{Ni} cm^{-2}$)	Mo loadings ($\mu g_{Mo} cm^{-2}$)	Au loadings ($\mu g_{Au} cm^{-2}$)	Total metal loading ($\mu g_{metal} cm^{-2}$)
NiMo/Ti-1	23.43	4.9		28.3
NiMo/Ti-2	29.6	5.3		34.9
NiMo/Ti-3	99.5	6.7		106.2
Au(NiMo)/ Ti-1	18.3	4.4	1.2	23.9
Au(NiMo)/ Ti-2	25.4	4.6	1.7	31.7
Au(NiMo)/ Ti-3	81.4	6.0	5.2	92.6