CATALYTIC PROPERTIES OF Ni-Mo COATINGS IN ALKALINE ELECTROLYSIS OF WATER

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Most recent research has been focused on the search for new energy sources. In this regard, the development of hydrogen energy holds great promise. High-purity hydrogen can be produced by electrolysis of alkaline electrolyte solutions. Monopolar electrolyzers with high energy consumption are used for water electrolysis. To reduce the cell voltage, it is necessary to select an electrode material that simultaneously acts as a catalyst for the hydrogen evolution reaction (HER) and exhibits low cathodic overpotential. Nickel has a low overpotential for HER and is less expensive compared to precious metals. Adding molybdenum to nickel facilitates the HER: molybdenum improves charge transfer, while nickel ensures the structural integrity of the coating.

The study compares Ni-Mo coatings obtained by galvanostatic and pulsed electrolysis. At a constant quantity of electricity (300 C), deposits were obtained at 80 and 150 mA/cm^2. In pulsed electrolysis, deposits were obtained at a peak current density of 400 mA/cm^2, with pulse/pause alternation in different ratios: 3 ms/7 ms (6000 cycles), 5 ms/5 ms (3600 cycles), and 7 ms/3 ms (2571 cycles) on various substrates: AISI 304 steel, a nickel plate, and AISI 304 steel with a nickel coating. The electrolyte used for deposition contained $NiSO_4$, Na_2MoO_4, and $Na_3C_6H_5O_7$. Energy-dispersive X-ray diffraction (EDX) was used to determine the composition of the resulting coatings, including their nickel and molybdenum content. Increasing the growth pulse duration increased the molybdenum content in the deposit.

Catalytic properties were evaluated by analyzing the polarization curves of hydrogen reduction from a 1 mol/L NaOH solution, which were converted into coordinates of the Tafel equation. The coating with the smallest value of the constant ***a*** in the Tafel equation was recommended as the electrode material.

The HER is a heterogeneous chemical reaction, so high catalytic properties will be demonstrated by a coating with a larger active surface area. The catalytic surface area was estimated from the shift in the polarization of the hydrogen bonds on the smooth surface and on the coating at a current density of 200 mA/cm^2 (S_{act}), and from the cyclic voltammogram (CVA) analysis near the equilibrium potential (S_{ECSA}). The electrochemically active surface area (S_{ECSA}) was always greater than Sact due to the abundant hydrogen evolution, which resulted in the shielding of part of the electrode surface.

Under constant current, coatings obtained at 150 mA/cm^2 exhibit higher catalytic activity. In pulsed electrolysis on all substrates, the constant ***a*** is lower at a pulse/pause ratio of 3 ms/7 ms. Coatings obtained under galvanostatic conditions at 150 mA/cm^2, and those deposited by pulsed electrolysis onto a steel substrate at a pulse/pause ratio of 3 ms/7 ms, have a larger electrochemically active surface area.