4th International Symposium on
Energy Challenges & Mechanics
- working on small scales

11-13 August 2015
Aberdeen, Scotland, UK

Cathodes of carburized Ni and 316L stainless steel for alkaline water electrolysis

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Accepted for publication on 14th April 2015

The presence of carbon in electrodeposited nanocrystalline Ni-Fe-C and Ni-Mo-C cathodes renders a high electroactivity for hydrogen evolution reaction (HER) in hot alkaline solutions. In the present work carbon was introduced into cathode materials by low-temperature plasma treatment to obtain hard layers with carbon being dissolved in the metal lattice. Nickel and austenitic 316L stainless steel were plasma carburized at 470 ºC for 15 h. Carbon entered 316L steel to the depth of about 30 μm and formed a solid solution with 6.6 at.% C at the surface. Carbon is hardly miscible with nickel, nevertheless it was introduced by this method to the depth of about 0.5 μm. Some amount of carbon remained on the surface as a soot. The materials were examined in 25% KOH at 80 ºC. Surface analysis was performed with XPS.

Carburisation resulted in an increase of hydrogen evolution rate on nickel almost by an order of magnitude, whereas electroactivity of 316L steel increased only slightly. During cathodic polarization, deposits were formed on cathode surface (possibly from admixtures in the electrolyte), and the electroactivity increased to a steady value.

Hydrogen evolution after removal of carbon soot from the surface was only slightly lower than that with the soot. This shows that carbon affects the HER not only by enlarging the cathode surface area, but also by exerting a true electrocatalytic effect.

Keywords: water electrolysis, carburized cathodes, nickel, 316L steel