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Electrochemical Impedance Studies of Co-based Nanomaterials for Hydrogen Evolution Reaction

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ABSTRACT

The electrocatalytic activity for hydrogen evolution reaction (HER) of cobalt based nanomaterials synthesized by high energy mechanical milling was studied to use in PEM electrolyzers. X-ray diffraction, scanning electron microscopy and transmission electron microscopy were used to characterize the synthesized powders. Their composition was established by means of energy dispersive spectroscopy, showing the presence of iron which was caused by the wear of grinding medium. Analysis SEM and TEM showed the formation of agglomerates of 1-7 microns, constituted by particles close to 20 nanometers. The electrocatalytic activity of the materials $Co_{80}Ru_{20}$ and $Co_{80}Ru0_{15}Pt_5$ in acid medium was evaluated in 0.5 M H_2SO_4 at 25 °C using linear polarization technique and electrochemical impedance spectroscopy (EIS). From polarization curves was possible to determinate the mechanism of HER. Nyquist diagrams were obtained in a frecuency range from 100 kHz to 10 mHz at selected overpotentials in order to avoid the formation of bubbles on the surface of electrode, these diagrams were characterized by the presence of two semicircles, the diameter of the first one, at high frequency, remained constant at all overpotentials, while the diameter of the second one, at low frequency, decreased when overpotential increased. Electrical equivalent circuit 2-CPE was used for the purpose of explaining the electrochemical response. The kinetic parameters for HER obtained from analysis of polarization and impedance data showed that both materials exhibit good performance as electrocatalysts toward to HER. The material with the best performance was $Co_{80}Ru0_{15}Pt_5$.

Keywords: Impedance; linear polarization; hydrogen evolution reaction