Preparation and Characterization of a Bilayer Cr-C/Ni-P Coating on Aluminum 5052 as Bipolar Plates

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Aluminum alloy materials, with their light-weight and low-cost characteristics, are considered to be some of the most suitable materials for use as bipolar plates (BPPs). In this study, a chromium-carbon/nickel-phosphorus (Cr-C/Ni-P) bilayer coating is deposited on aluminum alloy 5052 (AA5052) to improve the corrosion resistance and interfacial contact resistance. An electroless Ni-P layer is initially deposited on the AA5052 to form an undercoat, onto which a Cr-C coating is subsequently deposited by electroplating from a trivalent chromium bath. The surface morphology and chemical composition of the prepared coatings were investigated using scanning electron microscopy (SEM) and electron probe X-ray micro-analyzer (EPMA) techniques. The surface morphology of the Cr-C coating that formed with a plating time of 10 min is smooth and crack- and pinhole-free; however, cracks and pinholes are clearly observed in deposits that have been plated for a longer plating time. Therefore, the potentiodynamic test results indicate that the coating prepared at 10 A dm⁻² and 10 min possesses the best corrosion resistance ($i_{\text{corr}} = 6.7 \times 10^{-7} \text{ A cm}^{-2}$). The contact resistance of the Cr-C coating plated at 10 min is the lowest (8.2 mΩ·cm²). The aluminum BPPs that have a Cr-C/Ni-P bilayer coating exhibits great potential for PEMFC applications.

Keywords: Electroplating; Cr-C coating; Corrosion resistance; Aluminum bipolar plates; PEMFC

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