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Electrochemical Characteristics of AISI D2 Steel Coated with Multilayered WC-$Ti_{1-x}Al_xN$ coatings

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Abstract

Multilayered coatings are a new kind of coating that belong to a more plentiful family of materials. In the present work, multilayered coatings with alternated layers of WC-Ti and WC-$Ti_{1-x}Al_xN$ were deposited to be used as wear resistant and corrosion resistant surfaces. A Ti and TiN base layer is deposited above the substrate prior to multilayer. WC-$Ti_{1-x}Al_xN$ coatings of changing Al content (i.e. Al target power density) were deposited on steel substrate (high speed steel, HSS) by high-ionization sputtered PVD method. The Al content could be controlled by using evaporation source for Al and fixing the evaporation rate of the other target sources. Four kinds of WC-$Ti_{1-x}Al_xN$ coatings were prepared (WC-$Ti_{0.60}Al_{0.40}N$, WC-$Ti_{0.53}Al_{0.47}N$, WC-$Ti_{0.5}Al_{0.5}N$, and WC-$Ti_{0.43}Al_{0.57}N$). The corrosion behaviors of WC-$Ti_{1-x}Al_xN$ coatings in deaerated 3.5% NaCl solution were investigated by electrochemical corrosion tests and surface analyses. Particular attention was paid to the effects of Al content on the coating properties related to the corrosion behavior.

The measured galvanic corrosion current between coating and substrate present a low value. The results of potentiodynamic polarization tests showed that the WC-$Ti_{0.43}Al_{0.57}N$ coating with the lower porosity revealed corrosion resistance. In electrochemical impedance spectroscopy measurements, the WC-$Ti_{0.43}Al_{0.57}N$ coating showed two time constant and decreased a charge transfer resistance of coating (R_{ct}).

Multilayered coatings were analyzed by EDS and XRD analysis was performed to evaluate the crystal structure and compounds formation behavior. Surface and cross-section morphologies of the films were observed using SEM. Scratch test was performed to measure film adhesion strength.

Keywords : multilayered coating, galvanic corrosion test, EIS, zero resistance ammeter, porosity, residual stress.