UNIVERSITI TEKNOLOGI MARA

PREPARATION AND CHARACTERIZATION OF AL-NANOSTRUCTURED COATING ON MILD STEEL FOR CORROSION PROTECTION BY THERMAL EVAPORATION METHOD

ZAHIDAH BTE OTHMAN

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ABSTRACT

One way to protect mild steel from corrosion is by coating it with nanostructured metal and alloys. The Al-nanostructured is one of the best protective coating layers than conventional Al coating expected to have high strength and resistance to corrosion which can be applied in industries. In this study, Aluminium nanostructured coatings were successfully coated on the mild steel substrate by Electron Beam Thermal Evaporator technique. The deposition experiments were carried out using prepared Al wire and Kapton tape controlled by the VPC-1100 physical model vacuum deposition system. There are 3 stages deposition process; in order to determine the optimum condition for the formation of Al-nanostructured coating includes the effect of time exposure fix current and followed the effect of current deposition fix times. Finally, the optimum structure sample is compared to the annealed samples to produce optimum Al-nanostructures. The optimum deposition was determined, and effect of annealing temperature was studied as well. Based on various adjustments on deposition time exposed and current deposition conditions, the best eight Al-nanostructures coating samples were chosen for investigation of their surface properties that could the affect the thickness and adhesion for corrosion protection through optimization of annealing temperature. Al-nanostructured coatings prepared on the mild steel substrate which obtained from time deposition fix current I = 60 A, *t* (2 min, 5 min, 8 min and 10 min) and current deposition fix times t = 5 min, *I* (55 A, 60 A, 65 A and 70 A) simplified as (1) $SI_{60A}t_{2min}$ (2) $SI_{60A}t_{5min}$ (3) $SI_{60A}t_{8min}$ (4) $SI_{60A}t_{10min}$ (5) $St_{5min}I_{55A}$ (6) $St_{5min}I_{60A}$ (7) $St_{5min}I_{65A}$ (8) $St_{5min}I_{70A}$. The morphology and structure of the nanostructured coating were characterized by using a field emission scanning electron microscopy with energy dispersive X-ray spectrometer (FESEM-EDX), an atomic force microscope (AFM) and X-ray diffraction (XRD). The optimum condition for the formation of homogeneous Al-nanostructured deposited uniformly with the best coating quality was identified. Morphological observation showed that samples produced uniform nano-sized grains structure covered the entire surface of the mild steel. The deposition current and time exposure parameters of thermal evaporator were presented by comparing the selective formation of nanostructures film coated on mild steel with different particle size. It was found that $St_{5min}I_{60A}$/ $SI_{60A}t_{5min}$ have strongly affected the physiochemical properties with high durability, good adhesion and long-term performance of the coatings. Corrosion rate measurements show that Al-nanostructured coatings with the compact arrangement, better adhesion and high diffusion offer good potential for corrosion resistance of the mild steel in 0.5 M sodium chloride solution. The presence of higher annealing temperature has greater corrosion protection for mild steel. The order of the corrosion resistance of the sample coatings in protection mild steel in 0.5 M NaCl is $St_{5min}I_{60A}Ta_{300\ °C}$ > $St_{5min}I_{60A}Ta$ > $St_{5min}I_{60A}Ta_{400\ °C}$ $St_{5min}I_{60A}Ta_{500\ °C}$.

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