Corrosion Protection of Superhydrophobic PVDF-co-HEF/Al_2O_3 Coating for Aluminum Surfaces

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The interest in superhydrophobic coatings, which demonstrates high water-repellency, has recently increased dramatically because of its scientific and technological applications in many areas. In the present work, a simple one-step electrospinning method was used to prepare a composite of Poly(vinylidene fluoride-co-hexafluoropropylene) (PVDF-co-HEF) incorporated with aluminum oxide nanoparticles (Al_2O_3 NPs) as a coating for protection against corrosion of aluminum-based materials. The water contact angle (WCA) and the contact angle hysteresis (CAH) of the aluminum surface with and without PVDF-co-HEF copolymer with NPs were measured using OCA35 Dataphysics with a 4 µL distilled water. Furthermore, the effect of ultraviolet (UV) light irradiation on the wettability properties of the prepared composite coating was carried out using a UV weathering chamber operating at a power density of 1.5 W m^{-2} and 70 °C for 64 hr. The results showed that the WCA increased from 88 ± 2 to 152 ± 0.59 for the uncoated and the coated aluminum surface, respectively. The measured CAH was 2.5 ± 1for coated samples. For the UV irradiations tests, a slight change in the wettability properties for the coated surface were observed, where the WCA decreased to 149 ± 0.9 and CAH increased to 9 ± 0.9, keeping the superhydrophobicity behavior of the coating. The superhydrophobic composite coating was characterized using SEM and found to have a beaded fiber structure. In addition, Fourier transform infrared instrument (FTIR) was used to characterize the functional groups of the copolymer with and without the Al_2O_3 NPs. The topography and the surface roughness of the composite was characterized using atomic force microscope (AFM). The corrosion protection behavior of superhydrophobic coating was evaluated using many electrochemical techniques including the potentiodynamic polarization in 3.5% NaCl. The results showed that the corrosion current was decreased from ~ $10^{-}5$ in case of the uncoated Al sheet to ~10^{-8} A cm^{-2} i.e. a three orders of magnitude reduction in the corrosion current was achieved upon using the PVDF-co-HFP/ Al_2O_3 composite coating as shown in Fig. 1.

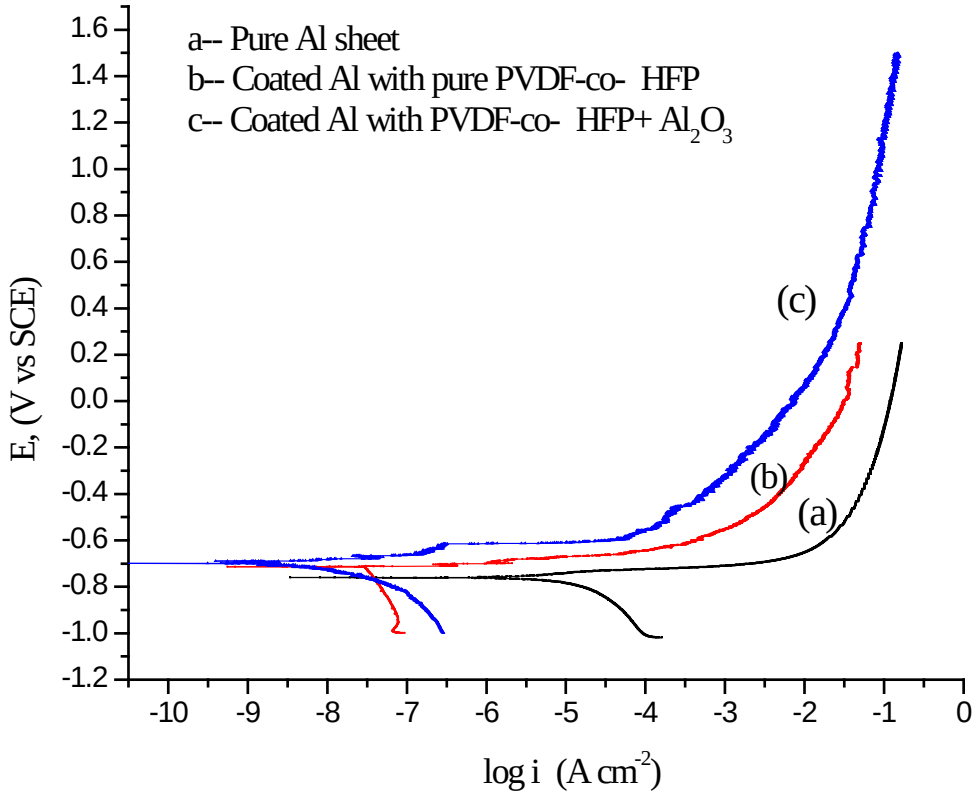

Fig 1. The potentiodynamic polarization curves of (a) Uncoated and (b) PVDF-co-HFP coated Al substrate, in 3.5% NaCl solution.