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Turning the wetting behaviour of a solid surface from hydrophilic to hydrophobic by making morphological and chemical modifications has attracted great attention over the past few years due to the importance of these surfaces in fundamental research and industrial applications in particular for anti-corrosion purpose. In this work, a chemical etching-based

Young's equation:

(1) $cos\theta =$

where γ_{lg}, γ_{sl} and γ_{sg} are respectively the liquid-gas, the solid-liquid and the solid-gas interfacial tensions. The maximum contact angle that can be obtained on a at surface by reducing the surface energy is 120° [7]. In this concern, in order to reach an extreme CA it is obligatory to combine the low surface energy with a hierarchical rough structure [8]. Wenzel proposed a relationship between the surface roughness ratio (ratio of the rough surface area to the smooth surface one), and the ideal liquid contact angle (Ä), which is given as

(2) $cos\theta_w = rcos\theta$

where θ_w is the Wenzel's (or apparent) contact angle. According to this equation, by increasing the surface roughness, the hydrophilic surface becomes more hydrophilic and the hydrophobic surface becomes more hydrophobic. In the Wenzel state, the water droplets penetrate the rough surface cavities and show a high adhesion force. Such

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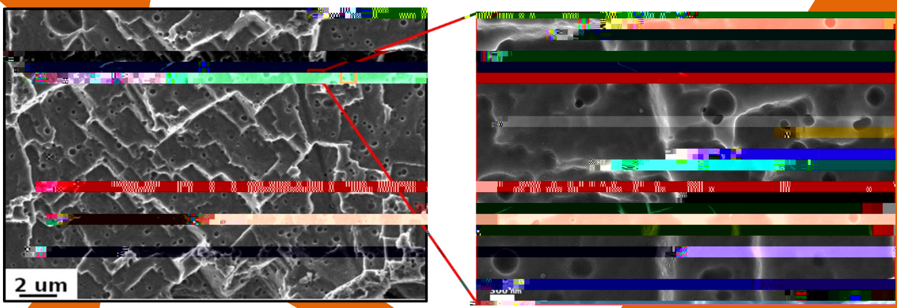
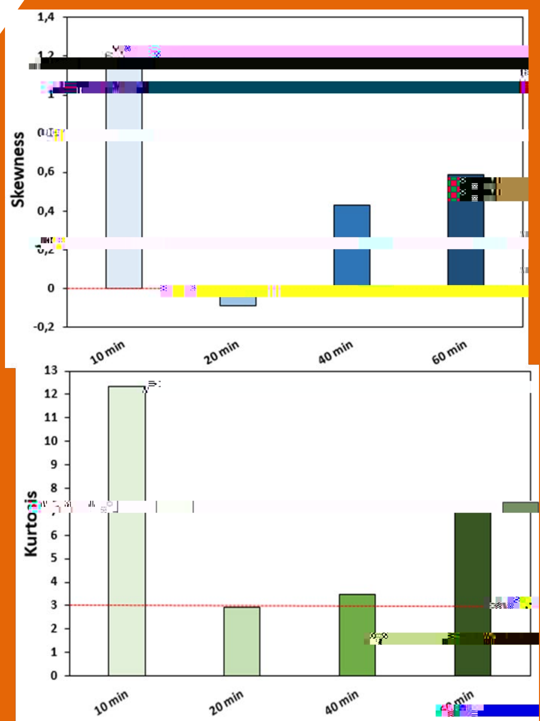


Fig.1



In order to better analyse the coatings’ surface morphology, AFM scanning was performed on all samples and the surface

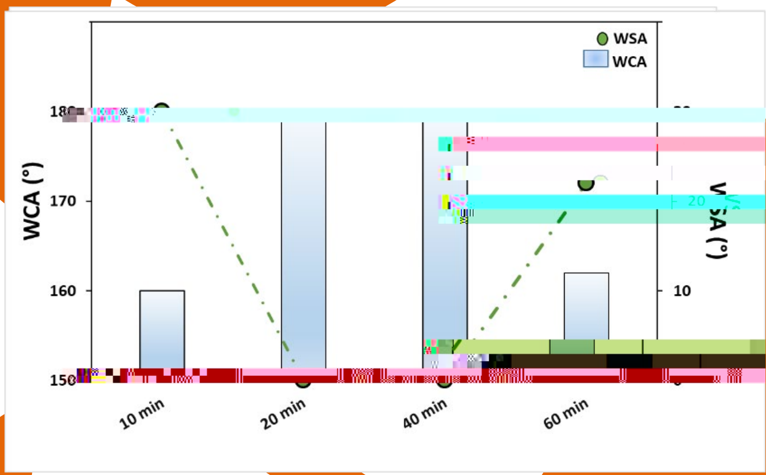


Fig.3 - Water contact angle (WCA) and water sliding angle (WSA) evolution with the etching time

Superhydrophobic surfaces with different water repellency behaviour were successfully elaborated. This reduction in the wettability of these surfaces may deeply affect their corrosion resistance. Thus, the corrosion resistance of the elaborated samples was investigated.

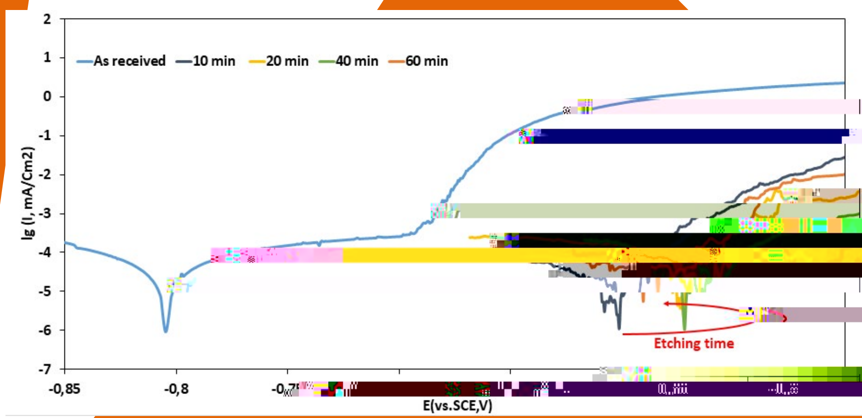


Fig.4 - Polarization curves of as received aluminium alloy and the superhydrophobic surfaces in seawater at room temperature

The electrochemical polarization test is a useful tool for assessing the corrosion behaviour of a solid surface. In a typical polarization curve, a high corrosion potential (E_{corr}) and a low corrosion current density (I_{corr}) corresponds to a good corrosion resistance.

The potentiodynamic polarization curves recorded for the as received aluminium alloy and superhydrophobic aluminium surfaces, having different WCA and WSA, in seawater (3.5 wt% NaCl solution) are presented in Fig.4 The corrosion potential (E_{corr}) and the corrosion current density (I_{corr}) were calculated using the Tafel method.

As shown in Fig.4, the corrosion potential of the as-received sample is 805 mV vs. SCE. Following the surface modi cation, the corrosion potential E_{corr} shifted toward positive direction. In fact, E_{corr} positively increases from 805 mV to 601 mV for 10 min sample, to around -570 mV for both 20 min and 40 min samples and then decreases again to reach -589 mV for the 60 min sample. However, the surface treatment of the aluminium surface does not show signi cant modi cation of the corrosion current density. These results are consistent with the wettability states. Indeed, the best corrosion results were obtained with the superhydrophobic surfaces following the Cassie-Baxter state (20 min and 40 min samples), thus, the super-hydrophobic interface that reduces the interaction between the solution and the aluminium alloy surface enhances the corrosion resistance of the samples. The trapped air on the hierarchical micro/nanostructures of the superhydrophobic aluminium surfaces acts as an "air cushion" inhibiting the penetration of corrosive ions (Cl^-) and leading to an improved corrosion protection [14].

CONCLUSIONS

Superhydrophobic surfaces were fabricated on aluminium alloy 6082 by coupling the modi cation of surface roughness, got by chemical etching, and the decrease of surface energy obtained by silane coating. The wettability state of these superhydrophobic surfaces varies with the etching time. In fact, the Cassie-Baxter state (WCA 180° and WSA 0°) was achieved by a chemical etching for 20 and 40 minutes. On the other hand, a Wenzel state was obtained for the lowest and the highest etching times (10 min and 60 min). Thus, the wetting transitions from Wenzel to Cassie-Baxter can be managed by modifying the etching time. The wetting state alteration is based on the distribution of the roughness peaks and valleys. In addition, the as-modi ed aluminium surfaces revealed a good corrosion resistance behaviour in seawater compared with the as received one and the best results were obtained on the Cassie-Baxter surfaces. Thus, a normal distribution of peaks and valleys, especially in the nanostructure, is the key factor for obtaining the Cassie-Baxter state and thus for improving the wetting and the corrosion behaviour of the aluminium alloy.

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