

Nanostructured surface pre-treatment based on Self-Assembled Molecules for corrosion protection of Alclad 7475-T761 aluminium alloy

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Abstract – Nanostructured surface pre-treatment based on the Self-Assembled Molecules (SAM) prior to coatings was investigated as potential replacement for yellow chromate conversion coatings (CCC) on aircraft aluminium alloys, due to their serious environmental problems. This work presents the electrochemical behavior of the Alclad 7475-T761 aluminium alloy, after surface pre-treatment with SAM, and the results were compared with CCC. The electrochemical tests were undertaken in naturally aerated 0.5 mol L⁻¹ Na₂SO₄ solution, acidified to pH 4. The results showed better corrosion protection of the SAM, in comparison with CCC, suggesting that the pre-treatment with SAM could replace CCC processes.

Chromate conversion coatings (CCC) have been largely used as pre-treatments for aluminium alloys, especially those used for aircraft. The most used among these processes are those that contain hexavalent chromium, Cr(VI), that provide many advantages; but also cause large environmental and health related problems, because the Cr(VI) compounds have several toxic effects. Therefore, there is a growing interest in the development of highly effective corrosion protection methods for different metals that are also environmentally friendly. There has been an upsurge of interest in the corrosion prevention of aluminium alloys using nanostructured surface pre-treatments based on Self-Assembled Molecules (SAM) [1]. The increase restrictions concerning the environment have encouraged researches in the development of alternatives of lower toxicity than yellow chromating conversion coating.

The purpose of this work is to investigate the effect of Alclad 7475-T761 alloy surface pre-treatment with SAM on its corrosion resistance in 0.5 mol L⁻¹ Na₂SO₄ electrolyte, pH adjusted to 4, by means of linear voltammetry (LV), electrochemical impedance spectroscopy (EIS), and salt spray test.

Results of the present study pointed out that for reaching high efficiency of the SAM pre-treatment the growth of the oxide film on the alloy surface must be favored, and this was carried out by immersion of the Al alloy samples in boiling water for 30 minutes prior to pre-treatment with SAM. The electrochemical results suggested that the artificially grown oxide film was responsible for increasing the Al alloy corrosion resistance. However, the literature [2] reports that, hydrated oxide layer is of fundamental importance for SAM adsorption. Surface analysis carried out in the present study with Al alloy samples that had been immersed in the electrolyte for three days supports the literature remarks [2]. Molecules remained on the alloy surface even after three days of immersion in the electrolyte whereas they were easily removed when the SAM was applied on naturally grown oxide. The electrochemical results also indicated corrosive attack of the surface oxide with immersion time in the electrolyte whereas the CCC was stable with time. However, for one day of immersion the impedance of the Alclad 7475-T761/SAM samples was still higher than that associated to the Alclad 7475-T761/Cr(VI) and Alclad 7475-T761/untreated samples, as showed in Figure 1. These results suggest that the SAM pre-treatment might be considered as a viable alternative for replacement of CCC on Alclad 7475-T761 aluminium alloy. The salt spray tests with pre-treated samples coated with a polyester layer showed comparable corrosion performance for both pre-treatments, SAM and CCC.

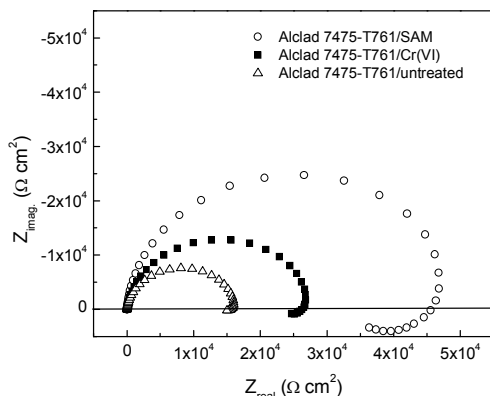


Figure 1: Nyquist diagrams of Alclad 7475-T761/SAM, Alclad 7475-T761/Cr(VI) and Alclad 7475-T761/untreated samples after one day in naturally aerated 0.5 mol L⁻¹ Na₂SO₄ electrolytic solution (pH 4).

References

1. I. Felhosi, J. Telegdi, G. Palinkas, and E. Kalman, *Eletrochim. Acta* 47 (2002) 2335.
2. F.M. Reis, H.G. de Melo, and I. Costa, *Eletrochim. Acta* 51 (2006) 1780.