

## Pretreatment Effects on the Corrosion Protection Provided by Trivalent Chromium Process Coatings on AA2024-T3

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### Abstract

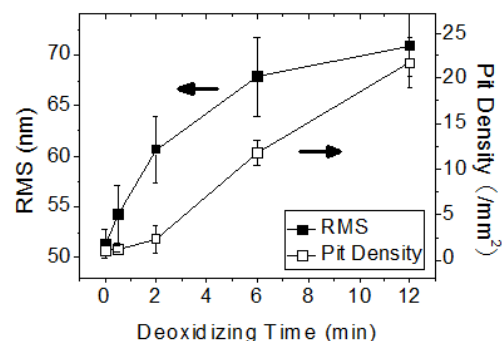
Conversion coatings are widely used as corrosion protective layers on aluminum alloys in the aerospace industry. However, contaminants and smuts can prevent the assembly and adhesion of a uniform conversion coating. A non-uniform coating can result in localized cathodic or anodic regions.<sup>1</sup> Such coating inhomogeneity makes the alloys vulnerable to pitting corrosion. Surface cleaning and pretreatment, in theory, produce a contaminant-free, uniform, and controlled surface for formation of a conversion coating.

The trivalent chromium process (TCP) coating is a viable alternative to the toxic chromate conversion coating (CCC).<sup>2</sup> The TCP coating has a biphasic structure including a  $ZrO_2 \cdot nH_2O$  top layer and a  $K_xAlF_{3+x}$  interfacial layer on AA2024.<sup>3</sup> TCP forms a partially blocking barrier layer on the alloy surface that consists of hydrated channels and or defects. Prior to conversion coating formation, alloy surfaces are typically degreased and deoxidized (desmuted). The deoxidation step can be critical as not only is the surface oxide removed but the alloy is pitted. Optimization of the pretreatment conditions could be beneficial in terms of the TCP coating structure and level of corrosion protection. There has been little work reported on this topic so far. Guo and Frankel examined the effects of pretreatment on the alloy surface morphology and the chemical composition. They found that pretreatments with silicate had no significant impact on the surface condition and TCP formation.<sup>4</sup>

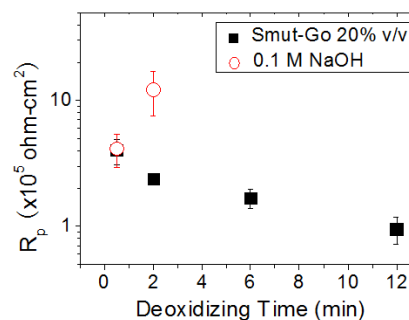
In this presentation, we will discuss the effect of pretreatment on the corrosion protection provided by TCP coatings on AA2024-T3. Specifically, we studied the effect of the deoxidation solution and treatment time. We tested the hypothesis that the deoxidizing time in the  $F^-$ -rich deoxidizer (Henkel Corp., Smut-Go 20% v/v) might affect the corrosion protection provided by TCP on the alloy. The  $F^-$  ions facilitate Al corrosion around the Cu-rich intermetallic compounds and this leads to a roughened alloy surface. The rougher the surface, the more defects the coating will possess and the lower the polarization resistance will be. This was tested by deoxidizing the AA2024 samples for various periods of time, 0.5 - 12 min at room temperature (RT). Profilometry data showed that the sample surface becomes rougher with a greater number of pits as the deoxidation time increases (Figure 1). This reduces the corrosion protection provided by the coating as evidenced by a 4× decrease in the polarization resistance ( $R_p$ ) (Figure 2).

Deoxidizing in an alkaline environment was also tested. This solution is effective at removing the surface oxide but is less corrosive to the alloy than is the commercial desmutter. Fewer pits were formed after deoxidizing in 0.1 M NaOH for 2 min and the coated samples exhibited an about 5× increase in  $R_p$  compared to

the samples coated after pretreatment in the  $F^-$ -rich deoxidizer for the same period of time.



**Figure 1.** Effect of the deoxidation time on the RMS roughness (■) and the pit density (□) of AA2024 at room temperature. Each datum is an average of 3 measurements.



**Figure 2.** Polarization resistance,  $R_p$ , of TCP-coated AA2024 after overnight aging at room temperature as a function of the deoxidation time in the  $F^-$ -rich (Smut-Go 20% v/v) or NaOH. Each datum is an average of 3 measurements.

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