

Localized Coating Failure on AA2024-T3 in Different Electrolyte Environments

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In situ Confocal Laser Scanning Microscopy (CLSM) on bare aluminum alloy 2024-T3 allowed to study in depth the different forms of corrosion morphologies, and to elucidate the role of galvanic coupling, local dissolution rates, metastable pitting and local pH [1]. The aim of this paper is to correlate these findings with the localized corrosion processes taking place in underfilm corrosion, notably blister formation and growth, on AA2024-T3. These processes were studied with CLSM and by electrochemical techniques, in part using microelectrodes [2]. Local chemical and electrochemical techniques were applied to study the compositions of the solutions occluded within the blisters.

For CLSM, AA2024-T3 panels were polished to a mirror finish, and spincoated with an epoxy-polyamide coating. Final dry coating thickness was 10-13 μm . The samples were exposed to solutions of 0.5 M NaCl and to solutions of 0.1 M $\text{Na}_2\text{SO}_4 + 0.005$ M NaCl of different pH. Electrochemical experiments were conducted on unpolished samples. The area exposed was much larger than in CLSM studies (31 cm^2 instead of ~ 4 mm^2).

Especially in near-neutral solutions of high chloride content localized corrosion was observed to take place within the blister. Pit formation at IMC sites as well as within the matrix was observed. Some of the pits repassivated and did not grow during the remaining immersion time, while new pits formed at other locations within the blister. This is shown in Figure 1 and 2 for an IMC particle incorporated into the blister during its growth. Corrosion initiated at the outer edge of the particle, similar to trenching observed on the bare alloy. Later on, the entire particle and a large region of the surrounding matrix were consumed by extensive pitting corrosion.

Even in acidic solutions, pitting was observed parallel to initial blister formation. However, blister growth as well as the formation of new blisters close to the original blister site involved more uniform corrosion. Not only the pH, but also the type of anion had a large impact on the rate and mode of coating failure. As shown in Figure 3, the impedance modulus decreased much more rapidly in mildly acidic sulfate solution, as compared to a more acidic chloride solution. CLSM revealed, that in acidic sulfate solution the coating delaminated very soon after immersion, even before general corrosion could be seen.

References

1. G. O. Ilevbare, O. Schneider, R. G. Kelly, J. R. Scully; *J. Electrochem. Soc.*, accepted.
2. O. Schneider, R. G. Kelly; *Corrosion Engineering, Science and Technology*, 38, 119 (2003).

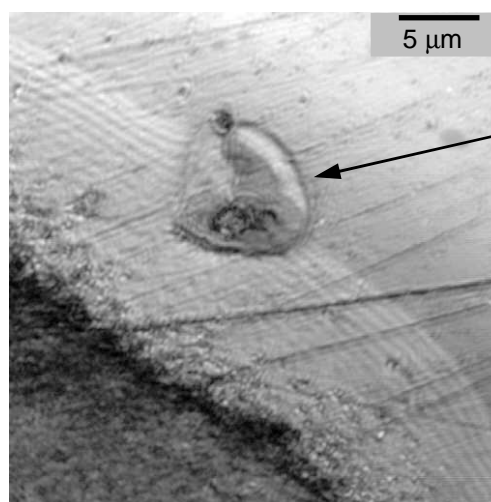


Figure 1: Intermetallic particle at the edge of a coating blister on AA2024-T3, immersed in 0.5 M NaCl. There is no sign of corrosion yet at the particle, whereas the region of severe corrosion within the blister is less than 10 μm apart.

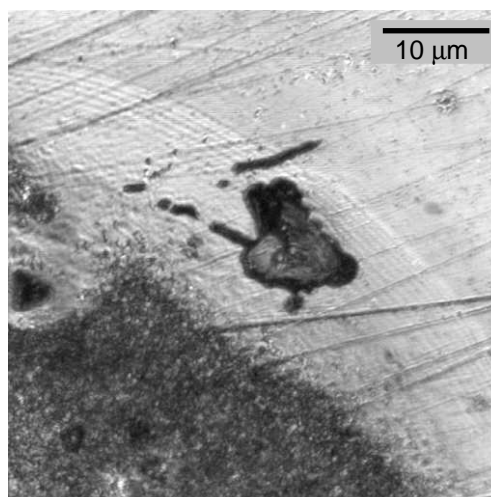


Figure 2: Particle from Figure 1 after another 10.5 h of immersion. Localized corrosion and pit initiation at and close to the particle site can be seen.

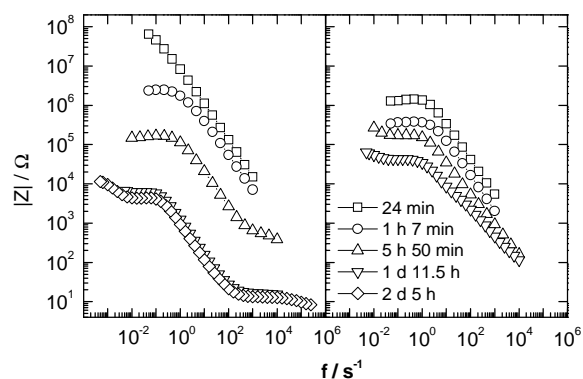


Figure 3: Change in the impedance modulus with time of epoxy-coated AA2024-T3 panels exposed to 0.1 M Na_2SO_4 , pH = 3.5 (left) and 0.5 M NaCl, pH = 2.5 (right).