Filiform Investigations on Aluminum Alloy 2024-T3

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The advancement of filiform corrosion (FFC) on aluminium alloys under polymer coatings is not yet fully understood. In order to increase our understanding of the various roles of conversion coatings, pigmented coatings and intermetallic particles in the alloy matrix, we have investigated corroded and uncorroded surfaces as well as active filiform corrosion filaments.

Surfaces free of coatings were examined through Scanning Electron Microscopy (SEM), Scanning Kelvin Probe Force Microscopy (SKPFM), X-Ray Spectroscopy (XPS) and Time-of-Flight Secondary Ion Mass Spectroscopy (TOF-SIMS) analysis. It is shown that the Sanchem pre-treatment did not entirely remove all intermetallic particles and that those remaining contain primarily iron. However, the Sanchem process, in combination with a pigmented coating, was very effective at reducing the extent of corrosion. Pigments alone were shown to deposit on copper-containing particles in active FFC filaments, thereby interrupting the formation of deep pitting corrosion, but not extensive, shallow FFC. Chromate conversion coatings also slowed down the onset of FFC, but were not completely preventative. We suspect that the coating pigments have a greater mobility than the chromate source in the conversion coating and therefore are more likely to inhibit the electrochemical reactions promoting filiform corrosion.

One aspect requiring further research is the intermetallic particles within the Al alloy matrix, which serve to propagate filiform corrosion. To this end, we have developed Al-Cu model samples, consisting of regularly spaced copper particles on a pure aluminium sheet. The model samples have been characterised through SEM, Auger Electron Spectroscopy (AES) depth profiling, Atomic Force Microscopy (AFM) topography and SKPFM. A broadening of the Cu-Al interface could be induced in these model samples through heating. The result was an improvement in the Cu-Al interfacial conductivity and evidence of galvanic corrosion of the aluminium around the copper cathodic sites. Initial attempts to initiate filiform corrosion produced mixed results. In some cases, the characteristic corrosion threads were observed, while in others the corrosion appeared as scattered ‘spots’ on the sample. The need for subsequent studies on these samples is evident.

Studies presently in progress include an *in-situ* examination of FFC using confocal microscopy and SKPFM with a variety of coatings.

Figure 1: Extensive FFC on a polished, Sanchem-pretreated AA2024-T3 sample, Epoxy coating

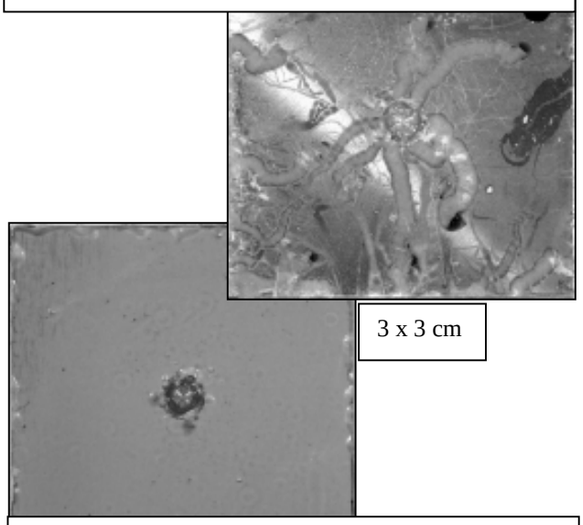

Figure 2: Near absence of FFC on a polished, Sanchem-pretreated AA2024-T3 sample, Epoxy coating containing $SrCrO_4$ pigments

Figure 3: TOF-SIMS Chromium distribution around a FFC filament head, 300 x 300 μm scan area

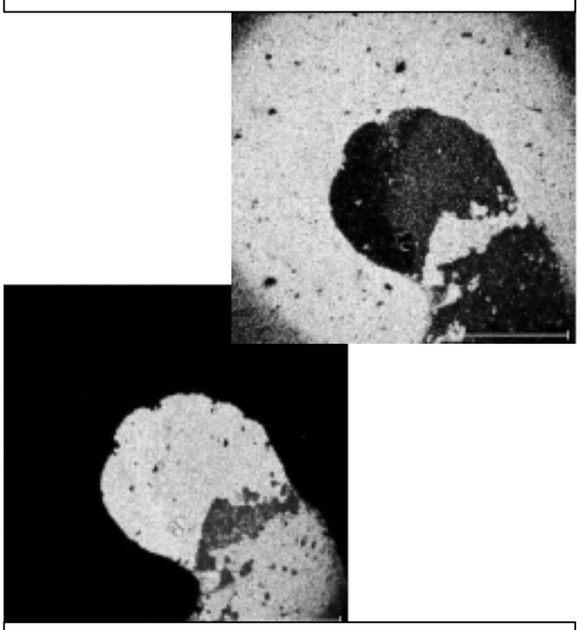

Figure 4: TOF-SIMS Alumimum distribution around a FFC filament head, 300 x 300 μm scan area