Intergranular Corrosion Morphology and Growth Kinetics in AA7075 and AA7178

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Intergranular corrosion has been found to be one of the primary forms of corrosion in high strength Al alloy airplane wingskins. To formulate accurate predictive models, it is important to understand the corrosion kinetics as a function of environment, alloy, microstructure, etc. In this study, the intergranular corrosion kinetics in NaCl solution have been measured by the foil penetration technique [1] on rolled AA7075 and AA7178 plates. The results show strong anisotropic corrosion kinetics in different orientations, which is a result of the microstructural anisotropy of the rolled materials.

Figure 1 shows the intergranular corrosion kinetics of AA7075-T6 in 1 M NaCl with O_2 bubbled at a potential of –725 mV SCE. The corrosion rate in the S (through thickness) direction is very slow because the intergranular corrosion path is meandering, which is confirmed by the cross-section (Figure 2a). The corrosion rate in the L (longitudinal or rolling) direction is similar to that in the T (transverse) direction when samples are very thin. However, the corrosion rate in the T direction becomes slower when the sample thickness gets larger. The difference in kinetics for thicker samples is possibly caused by a longer intergranular corrosion path in the T direction for thick samples, due to jogs at grain intersections. The similar corrosion rate in the L and T directions for thin samples is likely because the intergranular corrosion path is likely of length close to the dimension of one grain. Figures 2b and 2c show that the intergranular corrosion path in T direction involves more grains than in L direction. The intergranular corrosion morphology is selective grain attack under the conditions described above. However, the attack is in the form of sharp fissures for a pretreated sample exposed to a humid environment. [2] Figure 3 shows an unetched cross-section of an AA7075 sample that was first exposed at a constant potential in sodium chloride solution and then put in air at high humidity for a few months. Region A shows selective grain attack, which was created during the pretreatment in sodium chloride solution, and region B shows sharp fissures created in a humid environment. Similar intergranular fissures were found on real airplane wingskins. [3] Therefore, a method to measure the kinetics of sharp fissures is needed for a predictive corrosion model on airplanes.

A new approach has been developed to quantify the growth rate of intergranular fissures in a humid environment. Samples were first pretreated in sodium chloride solution by the foil penetration technique to induce corrosion damage, but for a time shorter than that for penetration of the samples. They were moved to a humidity chamber to continue sharp fissure growth after pretreatment. Digital photography was used to track the penetration time of the sharp fissures. By determining the fissure depth as a function of time, the kinetics of the sharp fissures can be achieved.

References
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2. X. Zhao, G.S. Frankel, B. Zoofan, and S.I. Rokhlin, *Corrosion*, **59**, 1012 (2003)
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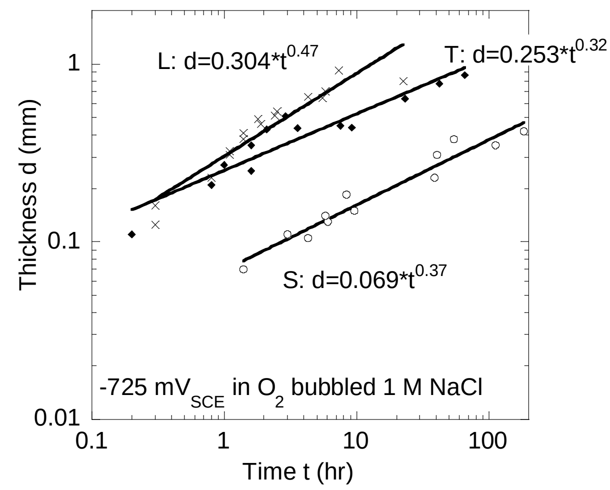

Figure 1. Intergranular corrosion kinetics of AA7075-T6 in O_2 bubbled 1 M NaCl at a potential of –725 mV SCE.

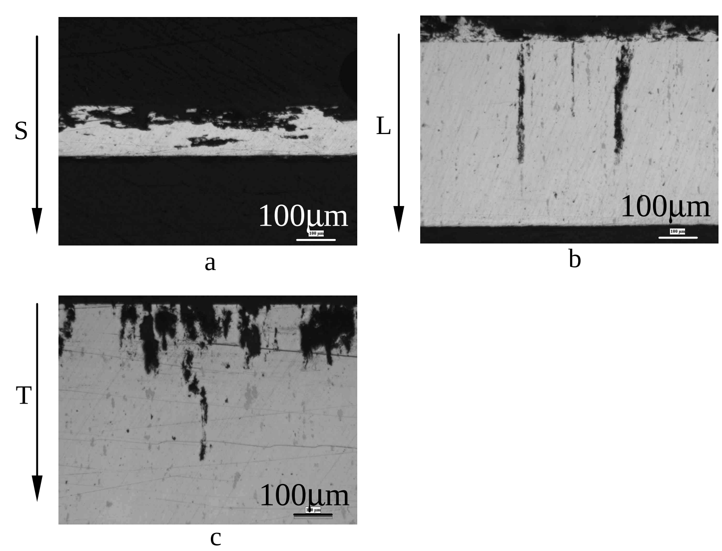

Figure 2. Unetched cross-sections of AA7075-T6 foil penetration samples having corrosion growth direction in various orientations (a) S, (b) L and (c) T.

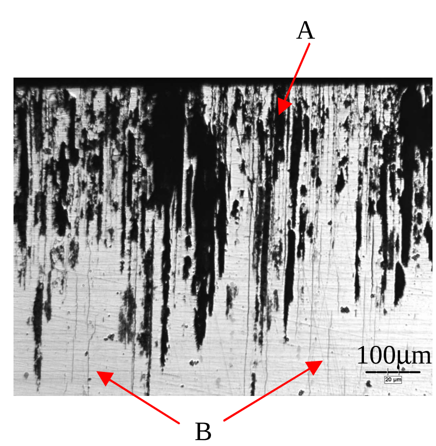

Figure 3. Unetched coss-section of an AA7075-T6. Region A: selective grain attack from electrochemical pretreatment. Region B: sharp fissures from high RH exposure.