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Stress Corrosion Cracking of an Advanced Al-Cu-Li-Ag-Mg Alloy at Various Electrical Potentials

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The Stress Corrosion Cracking (SCC) Susceptibility of Alloy 2195 (Al-Cu-Li-Ag-Mg) at T3 was investigated by m eans of Slow Strain Rate (SSR) Technique. The SCC susceptibility of the alloy understudy with various applied potentials was discussed by means of metallogrphy observation and ductility ratio (% elongation in the NaCl solution to % elongation in air). The results show that different applied potentials have significant influences on the Corrosion and SCC behaviors of Alloy 2195.

In search for the most efficient, light, and structurally competitive materials for aerospace applications, development work has produced a range of aluminum lithium based. **S**CC behavior of Al-Li alloys has been studied and a variety of mechanisms have been proposed to explain SCC of Al alloys, one of these mechanisms the anodic dissolution[1-8] at grain and subgrain boundaries and the second is the hydrogen embrittlement.[8] The main objective of this study is to investigate the SCC behavior of the 2195 Alloy as a function of the applied potentials used.

The alloy used in this study was rolled plate of Al-Cu-Li-Ag-Mg alloy (2195-T3). The fractographic and metallographic studies of the SCC specimens are done using Optical Microscopy and Scanning Electron Microscopy (SEM). The SSR Specimen used in this study was reported elsewhere.[4] Each SCC specimen was mounted in a test cell in the SSR machine and was designed to permit total immersion in 3.5% NaCl solution and application of Potentials to the specimen. All procedures were mentioned elsewhere.[4]

The microstructure of the as r eceived 2195 alloy is a typical unrecrystallized pancake grain structure. Dispersion particles surrounding grains and subgrain structures are observed as was reported by other studies, such as Al_2CuLi, Al_3Li, AlLi, Al_6CuLi_3, Al_2MgLi, Al_3Zr, Ω, and Al_7Cu_2Fe.[9-10] The tensile properties of the alloy as tested in air are shown in Table 1. Table 2 shows selected ductility data derived from SSR tests on the alloy at potentials of 0 mV, -600 mV and -1750 mV). Ductility ratio was used as one measure of environmental degradation. A ductility ratio of one implies that the alloy will perform equally well in both air and the 3.5% NaCl solution. This condition held for the alloy for applied potentials over the range of about (-750 mV) to (-1100 mV). This range coincides roughly with the passivation region observed on the polarization curves for most of the Al-Li alloys.[4,7,11] At all other applied potentials, however, the ductility ratio fell below unity. The lower the ductility ratio, the worse the performance. Raising the potential beyond the passivation range caused severe anodic attack in the alloy, which is consistent with other work on Al-Li alloys.[4,7,11] No SCC was observed in the cathodic potential; however, in the anodic regime SCC was evident as can be seen in the longitudinal view of the gauge length of the broken SSR specimen and cross section of the same specimen under the same applied potential (-600 mV), Figure 1. It is clear that SCC occurred along grains and subgrain boundaries. The effect of applied potential is very clear and is far greater than that of slow straining as was reported by other investigators.[4,7,11] In SSR specimens tested in the cathodic regime, the attack took the form of pitting. In its most severe form, this resulted in an overall reduction in diameter. In the anodic regime, the attack took place primarily along the grain boundaries

It was found that the microstructure has both grains and subgrain boundaries, with particles dispersed on the boundaries. The alloy is immune in the dry air, with 0 potential, and between -1100 to -750 mV (SCE), but SCC cracking was evident when the applied potentials exceed -700 mV (SCE), however, when the applied potential was less than -1200 mV (SCE), pitting corrosion was evident.

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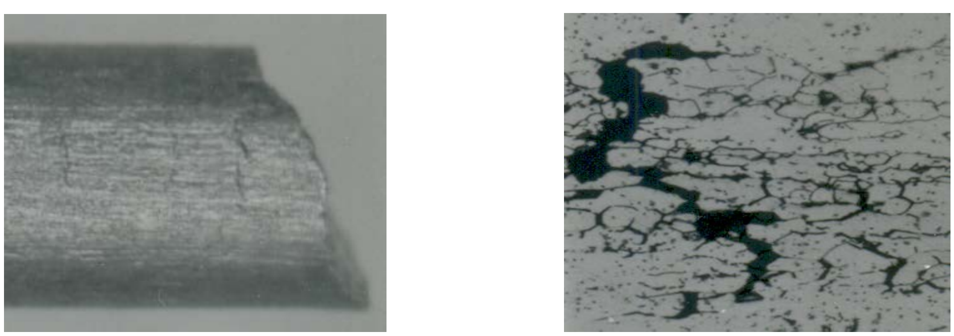
Table 1. Tensile data for the alloy (in air)

Proof stress((0.2%)	UTS (MPa)	Ductility
405	460	9.5

Table 2. Ductility at strain rate ($7.6x10^{-6}$)

Potential (mV)	Ductility
0	9.6
-600	4.7
-1750	8.5



(a) (b)

Figure 1. (a) Optical Macrographs of gauge length of broken SSR specimens at an applied potential of -600 mV (SCE), at strain rates of 7.6×10^{-6} s^{-1}, (b) Cross Section of the same specimen (500X)

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