NASA TECH BRIEF

The Mechanism of Stress-Corrosion Cracking in 7075 Aluminum Alloy

An extensive theoretical and experimental investigation has resulted in a proposed new model or mechanism for the stress-corrosion cracking of 7075 aluminum alloy. This model is similar in some respects to the model proposed by E.H. Dix in the earlier literature on stress-corrosion cracking of metals. In the presence of a corrosive agent and a tensile stress, a continuous anodic path into the metal is preferentially attacked, and a stress concentration is set up at the tip of the resulting crevice. These stresses appear to exert a mechanical tearing which exposes fresh metal to rapid corrosion, thus leading to further stress concentration and further tearing of the metal. In the proposed new model for the 7075 aluminum alloy, the continuous anodic path consists of two phases ($MgZn_2$ and Al matrix) which alternate as anodes.

The following conclusions pertaining to stress-corrosion cracking in 7075 aluminum alloy are considered to be significant:

1. The stress-corrosion resistance is lowered by any factor that leads to the immobilization of dislocations, or to the inactivation of dislocation sources. Two such factors are plastic deformation and strain aging. Precipitate–dislocation interactions are much more important than dislocation–dislocation interactions in lowering the resistance.
2. The optimum combination of yield strength and stress-corrosion resistance can be achieved by work-hardening an overaged temper.
3. Calculation of the stress field around an edge dislocation near a grain boundary precipitate indicates that the tensile stress which acts normal to the precipitate–matrix can be as high as 250,000 psi. An interfacial stress-corrosion crack in the -T6 temper (i.e., aluminum alloy 7075 -T6) could conceivably initiate under a stress of this magnitude.
4. The basic difference between a susceptible temper such as -T6 and a resistant temper such as -T73 is in their respective capacities for plastic deformation at the tip of a stress-concentration crevice. A high stress concentration in -T6 is more likely to be relieved by mechanical fracture than plastic flow, whereas in -T73 plastic flow is a more likely mechanism.
5. A rapid intergranular stress-corrosion failure can be induced in a -T73 specimen through the introduction of a notch. With its capacity for plastic flow thus limited, the -T73 temper behaves somewhat like the -T6 temper.
6. A stress-corrosion failure in a -T6 specimen, or in a notched -T73 specimen, involves some plastic flow, as indicated by the dimpling observed in fractographs.
7. The slip characteristics of -T6 and -T73 are generally similar.
8. The effect of increasing stress is to prolong the time to failure of unnotched -T73 stress-corrosion specimens.
9. There may be a basis for the quantitative prediction of time to failure from mechanical property measurements or from a microstructural examination of alloy specimens.

Note:

Requests for further information may be directed to:

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