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FATIGUE DAMAGE STUDY IN ALUMINUM-2024 T3 ALLOYS

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Fatigue behavior accounts for a majority of service failures in ground, air, and sea vehicles. Cyclic stress-strain deformations may alter the microstructure of a material thereby leading to instabilities that determine the fatigue performance. Therefore, in order to understand fatigue properties in a fundamental sense, it is essential to characterize these materials on a microscopic level. The size, shape, and orientation of grains in polycrystalline materials are known to have profound effects on strength, residual stress, and magnetic behavior, respectively (ref. 1). Consequently, the purpose of this study is to investigate the grain structure of aluminum 2024, a commonly used commercial alloy, and to correlate these findings with the fatigue property of the material.

X-ray diffraction is a powerful method used to evaluate crystalline quality (ref. 2). A technique which is especially sensitive to crystal structure analysis is the x-ray rocking curve (XRC). The XRC is initiated by scanning the sample to find the Bragg angles. Subsequently, the sample is mounted on a goniometer at a particular Bragg angle and irradiated by a highly monochromatic x-ray beam while being rotated ("rocked") step by step about this angle. At each step, the reflection intensity is acquired and recorded by a computerized data system. A plot of the reflecting power as a function of the angle between the sample surface and the incident x-ray is the rocking curve. The degree of orientation and information on grain size is determined by the width, position, and smoothness of the XRC relative to the normal scan.

Samples of aluminum 2024 were polished and etched in different reagents. Optical micrographs (at 500X) of samples etched in Keller's reagent revealed grain boundaries as well as some particles present in the microstructure. Normal x-ray scans of samples etched for different intervals of time in Keller's reagent indicates no significant variations in diffraction peak positions; however, the width of the rocking curve increased with the time of etching. This results is consistent with the direct dependence of the width of the rocking curve on the range of grain orientation. Etching removes the preferred orientation layer of the sample produced by polishing; thereby, causing the width to increase.

Samples of aluminum 2024 which are currently being fatigued will be investigated.

REFERENCES

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