

NONDESTRUCTIVE EVALUATION OF FATIGUE DAMAGE IN ALUMINUM 2024 BY X-RAY DIFFRACTION

by

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Aluminum alloys are widely used in the automobile and aerospace industries. This is due to their attractive low density-high modulus and low density-high strength characteristics. Unfortunately, cyclic stress-strain deformations alter the microstructure of aluminum alloys when they are placed into service. These structural changes can lead to fatigue damage and ultimately service failure. Since X-ray diffraction analysis is known to be a sensitive nondestructive indicator of structural changes due to deformations, this technique is being used to evaluate changes in the microstructure of cycled aluminum 2024 commercial alloys.

Line shapes, widths, and positions in an X-ray diffraction pattern depend on microstructural properties such as grain size, grain orientation, residual stress, microstrain, etc. Changes in the microstructure due to fatigue will appear as changes in the diffraction pattern. One parameter used to characterize a reflection in a diffraction pattern is the full width at half maximum (FWHM).

Preliminary X-ray diffraction results on cycled Al 2024 indicate that the (111) and (222) reflections of the matrix phase do not show any variations in the FWHM due to an increase in the fatigue cycles. However, the FWHM of the (200) and (400) reflections of the same phase unexpectedly showed a dramatic decrease. These results can be interpreted as due to the relaxation of some initial nonuniform residual stresses in the matrix phase lattice. Further work is in progress to evaluate the FWHM of the second phase of the cycled alloys.