# FATIGUE PROPERTIES OF AA2024 FOR INTERMITTENT THERMAL HEALING AND ANALYSIS OF DAMAGE DEVELOPMENT USING POSITRON ANNIHILATION DOPPLER BROADENING TECHNIQUE

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## ABSTRACT

Recently it has been demonstrated by Lumley et al. [1,2] that the mechanical properties of age hardenable Al alloys can be improved by interrupting the normal temper in combination with intermitted ageing at a lower aging temperature. The observed improvement of the fatigue properties was attributed to the precipitation of free solutes at nanosized voids, thereby decreasing the void size, a process which can be referred to as self healing. In this work we present a fatigue lifetime study on AA2024-T3 sheet metal in which we imposed intermittent low temperature healing to reduce the early stage fatigue damage. The experimental procedure consisted of constant amplitude fatigue testing at four different stress levels each with a stress ratio of 0.1, combined with annealing periods of 24 hours at 65ºC. In contrast to the literature data, no difference between lifetimes for the tests with and without the healing periods was observed (Fig. 1). On the other hand, the intermittent healing treatment appears to reduce the scatter in lifetime data [3, 4].

The accumulation of fatigue damage and its potential reduction during the low temperature ageing has been studied by Positron Annihilation Doppler Broadening (PADB) technique. This technique allows the study of the deformation induced defects at the atomic and vacancy level in the specimens in a non destructive way, While the PADB technique has been shown to be capable of detecting damage evolution during plastic deformation in the AA2024-T3 material [5], no statistically relevant changes in PADB spectra were recorded during fatigue testing irrespective of the number of loading and healing cycles (Fig. 2). Only after failure differences between failed and non failed material were seen. The absence of improvement in fatigue lifetime and changes in the PADB signal is likely due to the initial T3 treatment resulting in too low a level of free solute atoms for the intermittent healing treatment to have a positive effect.

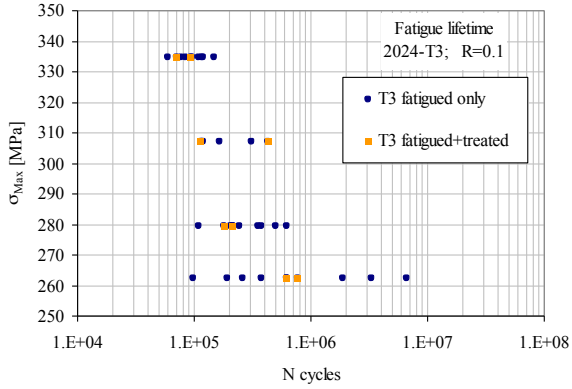


Figure 1: Lifetime results for R=0.1 for the modified and standard T3 material.

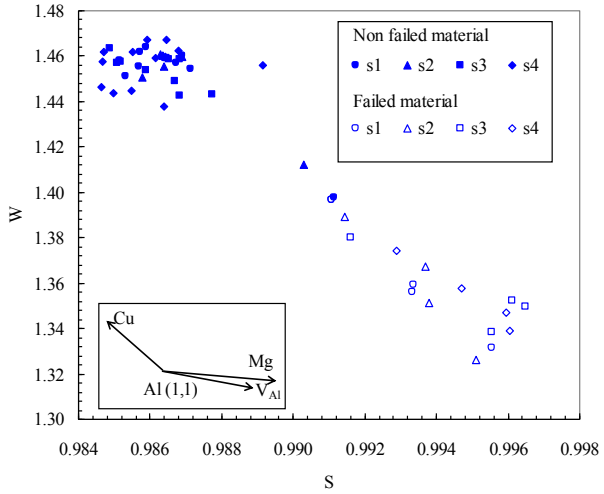


Figure 2: S-W plot obtained from Doppler Broadening tests.

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