Influence of heat treatment on the near-threshold fatigue crack growth behavior in high strength aluminum alloy 7010

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## *Abstract:*

In this study aluminum alloy 7010 was subjected to three different ageing treatments i.e., peak ageing (T6), over-ageing (T7451) and retrogression and re ageing (RRA) to study the influence of precipitate microstructure on the fatigue crack growth rate behavior. The microstructural modification was studied by using transmission electron microscope (TEM) to examine the change in the size and morphology of precipitates in the matrix and on the grain boundaries. The average size of the matrix precipitates were found to be of 16-20 nm in T7451, 5-6 nm in RRA and 2-3 nm in T6 conditions respectively. The grain boundary precipitate which was continuous in T6, was disintegrated in RRA and T7451 condition. The PFZ width was lower in RRA compared to T7451 condition. The standard compact tension (CT) specimens were fabricated and tested under constant amplitude fatigue crack growth rate tests to evaluate the influence of heat treatment on the fatigue crack growth rate properties. The tests were performed in a computer controlled servo-hydraulic test machine applying a load ratio, R=0.1 at a loading frequency of 10 Hz as per ASTM E647. The fatigue crack growth rate was measured by adopting compliance technique using a CMOD gauge attached to the CT specimen. The crack growth rate was higher in T7451 and lowest in RRA treated alloy. The RRA treated alloy also exhibits an increase in threshold stress intensity factor range ($\Delta K_{th}$). The $\Delta K_{th}$ measured was 11.1, 10.3 and 5.7 $MPam^{½}$ in RRA, T6 and T7451 alloys respectively. The fatigue crack growth rate in RRA treated alloy was nearly 2-3 times lower than that in T6 and was one order lower than that observed in T7451 condition. The surface roughness of RRA treated alloy was more pronounced when compared to the other conditions. The reduction in fatigue crack growth rate in RRA alloy was majorly due to the increase in roughness and partially due to increase in spacing between the matrix precipitates. The reduction in crack growth rate and increase in threshold stress intensity range is expected to benefit the damage tolerant capability of aircraft structural components under service loads.

***Keywords:*** *Damage tolerance, Fatigue, Heat treatment, PFZ, RRA.*

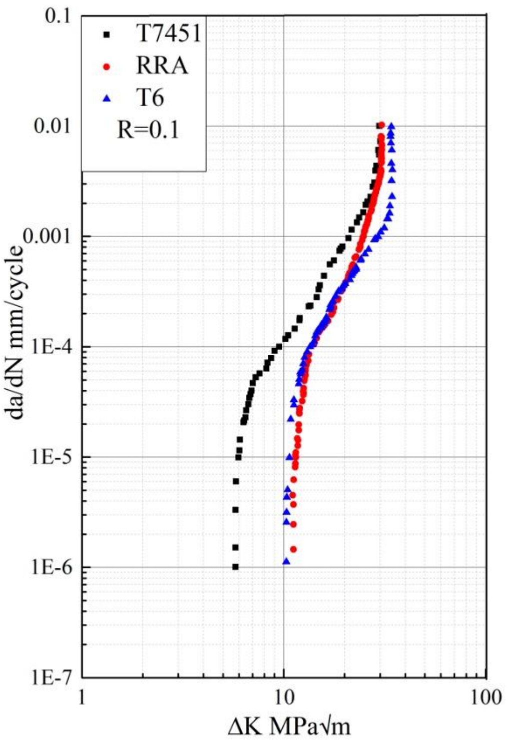


*Figure 1. Fatigue crack growth rate curves for aluminum alloy 7010 in T7451, RRA and T6 conditions*

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