EFFECT OF THERMOMECHANICAL TREATMENT ON TENSILE PROPERTIES AND FATIGUE STRENGTH IN 7012 Al ALLOY

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INTRODUCTION

The effects of final thermomechanical treatment (FTMT) on fatigue crack growth resistance and tensile properties of 7012 (Al-Zn-Mg-Cu-Zr) aluminium alloy were investigated. The as received material was in T6 condition, which is a solution heat treatment followed by an artificial ageing. This material was then subjected to the following treatment: a) solution treatment at 470°C for 1 h followed by fast quenching; b) 6 h ageing at 105°C; c) 10% deformation at room temperature; d) second ageing at 120°C for 13 h. The FTMT is intended for products where it is requested to raise the level of tensile strength associated with the standard T6 temper with acceptable decrease of some properties, such as fracture toughness, and with small variations in other properties such as stress corrosion cracking resistance (1).

In this paper the effects of this new thermomechanical treatment on tensile and fatigue crack growth resistances of 7012 alloy were investigated at room temperature. The analysis were performed by comparing tensile properties and fatigue crack growth rates (FCGR) both measured in the reference material (T6 treatment) and in the same material subsequently subjected to the final thermomechanical treatment. With respect to T6 temper, the FTMT produces an increase of tensile properties with a small decrease of ductility that in the measured fatigue crack growth rate tange, from 10^{-6} to 10^{-2} mm/cycle, leads to a small decrease of the fatigue crack growth resistance of the alloy in the L-T direction.

EXPERIMENTAL AND DISCUSSION

Tensile properties and fatigue crack growth resistance were measured in specimens with both L-T orientations. The experimental results showed that the FTMT produces a strong increase of the yield strength and of the UTS in both orientations with a small decrease of ductility only in L-T orientation. No decrease of ductility was observed in the T-L orientation (Tab.1.).

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FCGR were measured in both orientations on servo-hydraulic machine with triangular waveshape, load control, at a frequency

TABLE 1. Tensile properties of the 7012 Al alloy

	T6		FTMT	
specimen	L-T	T-L	L-T	T-L
UTS, MPa	528	495	590	560
R, MPa	575	521	620	601
R, (%)	11	7.5	8.5	7.5

of 10 Hz with two R ratios (0.05 and 0.5). The tests were performed in air and in vacuum (10^{-2} Pa). Crack advances were measured by means of a travelling telescope and FCGR were correlated to the stress intensity factor range K determined from the expression given by Brown and Srawley for this geometry (2).

Fatigue crack growth data showed that, for a given K, the FTMT produces a decrease of anisotropy of the crack growth resistance in the L-T and T-L orientations and a small increase of FCGR in the L-T orientation (Fig.1). No crack resistance variation were observed in the T-L orientation.

The effect of R ratio on FCGR was investigated in air and in vacuum (Fig. 2 and 3). The FCGR increase when R is increased from 0.05 to 0.5 and the effect is more pronounced in FTMT than in T6 specimens. In FTMT specimens, the R influence is greater in air than in vacuum, indicating that corrosive mechanisms are operative. The influence of R ratio on FCGR is strongly reduced when K effective is considered.

For FTMT material vacuum FCGR are lightly lower than air FCGR as shown in Fig.4. In vacuum the data concerning T6 and FTMT materials are similar indicating that the difference in air FCGR is mainly due to environment influence during fatigue tests.

The scanning electron microscope fractographic examinations showed transgranular fractures with ductile striations in all examined cases.

REFERENCES

(1) Di Russo, E.: Proc.Aluminium Alloys in the Aircraft Industry, Technicopy Ltd, Stonehouse, 1976, p. 71-85.

(2) Brown, W.F. and Srawley, J.E.: ASTM-STP No.410, 1966.

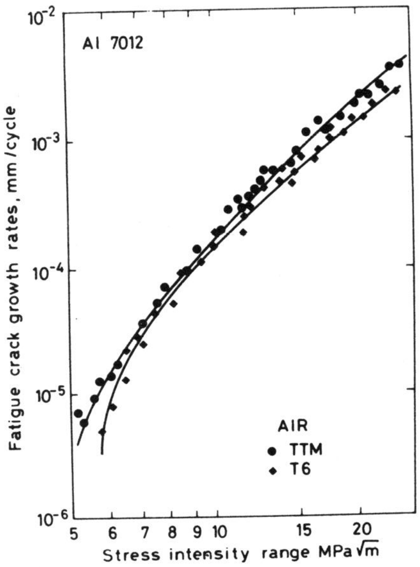

Figure 1. Air FCGR in the T6 condition and after FTMT.

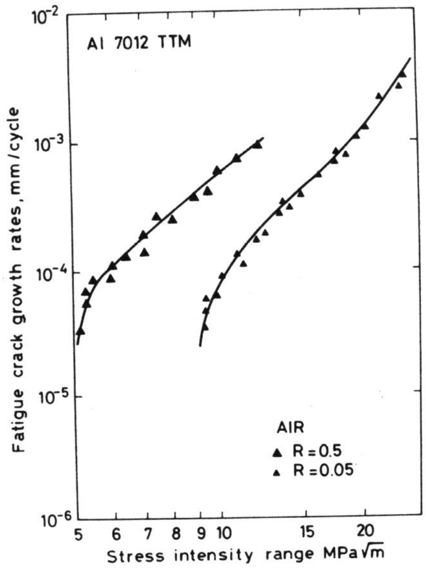

Figure 2. Effect of R ratio on air FCGR .

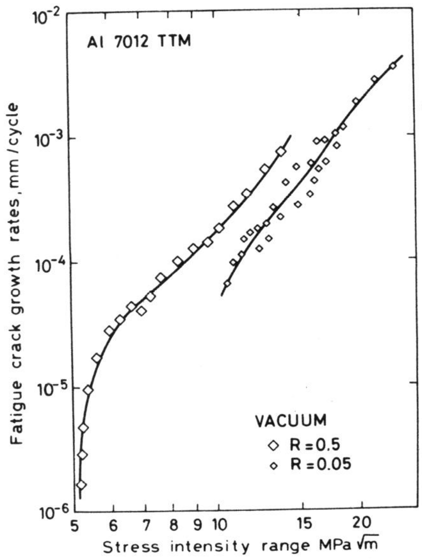

Figure 3. Effect of R ratio on vacuum FCGR.

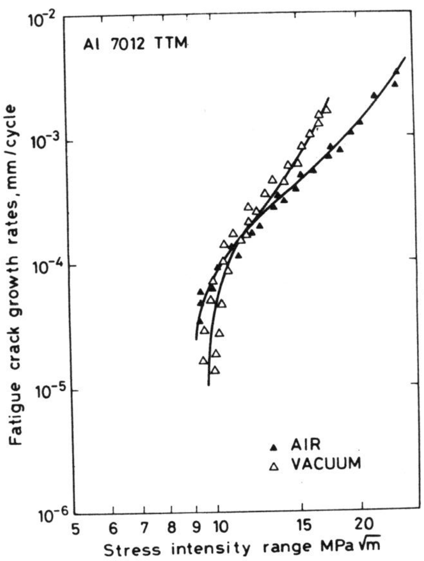

Figure 4. Comparison between air and vacuum FCGR.