RESIDUAL STRESS ANALYSIS OF RETROGRESSION AND REAGED Al-Zn-Mg (7075) ALLOY

C.N Chandrappa[1], M.K. Muralidhara[1], G.M. Madhu[2]

1- Department of Mechanical Engineering, M. S. Ramaiah Institute of Technology,Bangalore- 54, India

2- Department of Chemical Engineering, M. S. Ramaiah Institute of Technology, Bangalore- 54, India

Introduction

Aluminium alloys are known for their excellent strength to weight ratio. As a result they find extensive applications in both automotive and aerospace industries. The mechanical properties of aluminium alloys can be further improved by subjecting them to heat treatment process such as solutionizing and age hardening. Several aluminium alloys are amenable to above heat treatment. Of these Al-Zn-Mg and Al-Si-Mg alloys readily respond to solutionzing and age hardening [1].

In the present work Al – Zn – Mg alloy having 6.131% zinc and 2.135% Magenisium and 1.895% copper was selected for the study. Pure aluminium has strength normally too low for engineering purposes. But by addition of magnesium, aluminium alloys with improved properties are obtained by the process of heat treatment involving precipitation treatment

Experimental

The alloyused for the present study was procured from Hindustan Aeronautics Limited, Bangalore. The samples cut from a large aerospace forging were subjected to solution heat treatment at 465^{o}C for 120 minutes, followed by water quenching. The as received 200 mm diameter and 300 mm length was machined such that the material developed characteristic grain orientation.

The residual stress was measured by X-ray diffraction for samples subjected to T6 (Solution heat treatment followed by an artificial aging treatment), Retrogression and reaging (RRA) [2][3] at 200^{0}C for different retrogression intervals and as received material.

Results and discussions

Residual stress analysis for as received material clearly shows that there exist tensile stresses in magnitude 25.13 Mpa. Figure 1 shows the intensity vs. 2θ and Figure 2 shows the 2θ Vs Sin^{2}Ψ using peak position method. Figure 1 shows the sample in the Ψ=0, 10, 20 and 30 orientation. The presence of tensile stress in the sample results in a Poisson's ratio contraction, reducing the lattice spacing and slightly increasing the diffraction angle, 2θ. If the X-ray is rotated through some known angleΨ, the tensile stress present in the surface increases the lattice spacing over the stress free state and decreases 2θ. Measuring the change in the angular position of the diffraction peak for at least two orientations of the sample defined by the angle Ψ enables calculation of the stress present in the sample present in the sample surface lying in the plane of diffraction, which contain incident and diffracted X-ray beam.

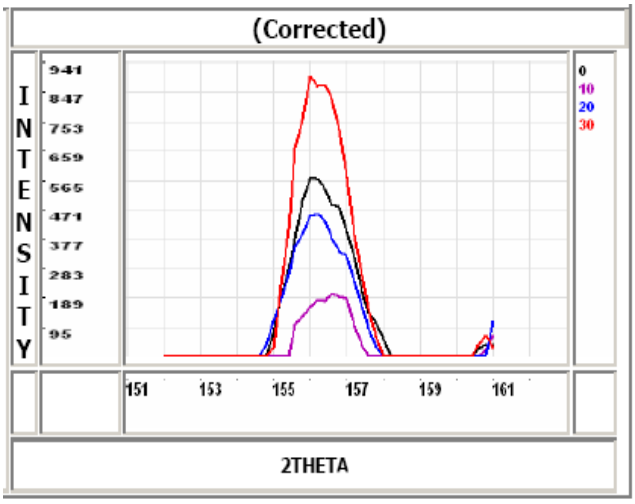

Figure :1 Stress intensity Vs 2 θ for as received material

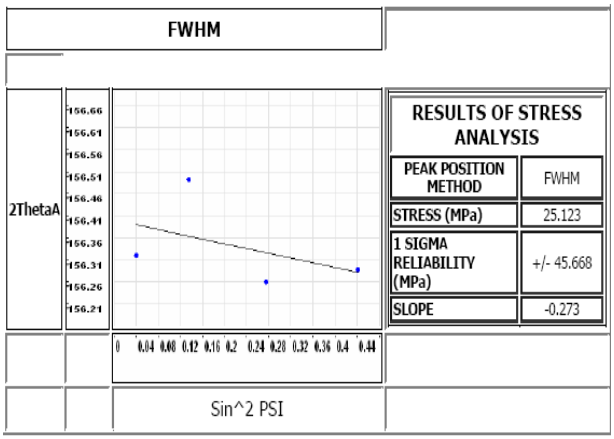

Figure :2 2θ Vs $Sin^2\Psi$ for as received material

Further the samples were aged at120^oC for 24 hours (T6 condition). Retrogression and Reaging heat treatment was performed at 160^oC, 180^oC & 200^oC for various time interval followed by water quenching. Later the samples were reaged at 120^0C for 24 hours.

Residual stress analysis for retrogression (at 200^0C for 40min) and re-aging (at120^0C for 24 hrs) treated material clearly shows that there exist compressive stresses in magnitude 112.155 Mpa Figure 3 shows the intensity vs. 2θ and Figure 4 shows the 2θ Vs $Sin^2\Psi$ using peak position method. Residual stress analysis of RRA specimens indicated the compressive stresses at higher retrogression time and peak compressive stresses were obtained at 10 min retrogression time. This refers to same retrogression time at which the material exhibits maximum strength and hardness. Further presence of compressive stresses reduces the Stress corrosion cracking tendency in the material [4]

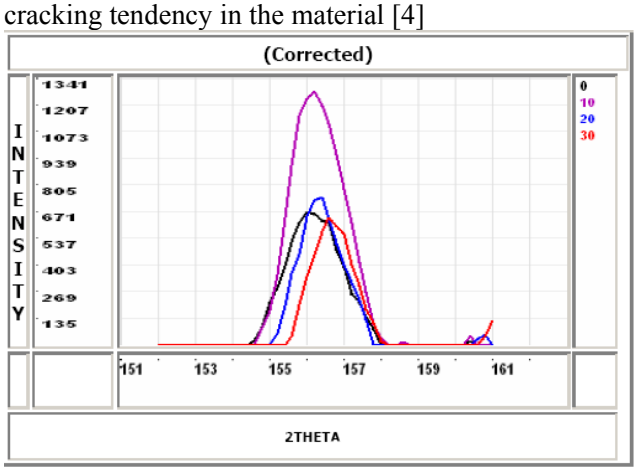

Figure: 3 Stress intensity Vs 2 θ for RRA-40 Min treated material

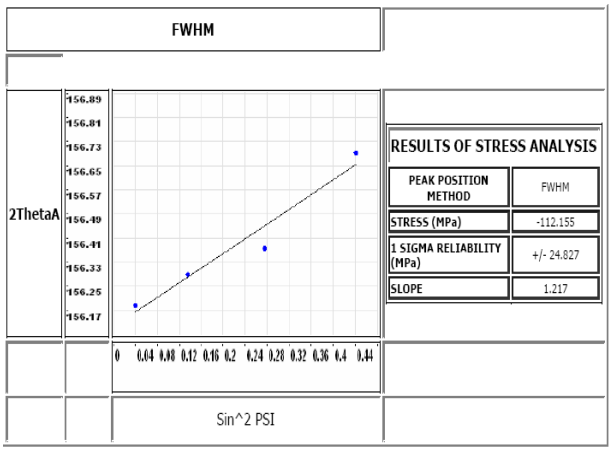

Figure:4 2θ Vs $Sin^2\Psi$ for RRA-40Min treated material.

Conclusions

From residual stress analysis results, with increase of retrogression time, the beneficial compressive stresses present. The peak was observed at Retrogression and reaging at 200 ^0C for 10 min sample. At this point the tensile strength was observed was maximum. So compressive stresses is desirable for improving fatigue and stress corrosion strength.

References

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