

Creep Studies in Aluminium-2.25WT.% Magnesium.

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Abstract:

In this project, a study of creep mechanism in an Al-2.25wt% Mg alloy is conducted at temperatures between 573K and 623K and stresses (σ) ranging from 7.70 to 48.10 Mpa. Using the dislocation network model, the characteristics features of recovery-controlled and glide-controlled creep mechanisms are delineated. One of the manifestations of the fundamental differences between these two mechanisms, it is demonstrated, is the disparity which should be observed between the experimentally observed obstacle strength parameter α_{exp} in the equation

$$\sigma = \alpha_{exp} Gb/p$$

where G, b and p are the shear modulus, the Burgers vector of dislocations and the dislocation density respectively and the theoretically calculated value, α_0 . Specifically, the theoretical model predicts that α_{exp} for glide creep should be greater than α_{exp} for recovery creep.

The conditions under which a transition from one creep mechanism to the other could occur in a given material are investigated (theoretically). It is demonstrated that for creep to be glide-controlled, the dislocation glide velocity V_g must be related to the annihilation rate p_a according to the expression $V_g \ll \beta p_a / (\alpha_1 p^{3/2})$,

where α_1 and β are constants. Otherwise, creep should be recovery-controlled. The implications of the theoretical model on the shape of creep curves for both mechanisms are discussed and are shown to be generally consistent with literature data.

The creep tests performed on the Al-Mg alloy show that inverse transient creep curves are observed at low stresses and normal transients at high stresses. Also a change in transient creep curve shapes are observed when the annealed samples are restrained prior to creep. Stress increase and stress removal tests performed (in the high stress range) during creep reveal certain creep characteristics which are trademarks of recovery-controlled creep at high stresses. Recovery tests performed on restrained samples show that the flow stress decreases with recovery time, even though it never quite approaches the value characteristics of annealed samples.

Keywords: Creep mechanism

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