HANICAL, ELECTRICAL AND STRUCTURAL PROPERTIES OF AL-CU ALLOY

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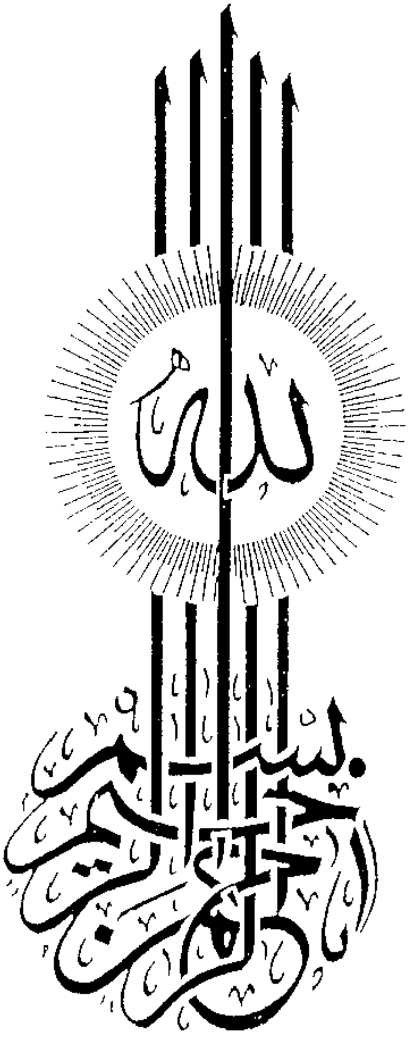
بسم الله الرحمن الرحيم

وقل اعملوا فسيرى الله عملكم ورسوله والمؤمنون

« صدق الله العظيم »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بسم الله الرحمن الرحيم

MECHANICAL, ELECTRICAL AND STRUCTURAL PROPERTIES OF AL-CU ALLOY

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ABSTRACT

The present work is mainly concerned with the effect of phase transformation of Al-2.5 wt.% Cu alloy on the plastic properties and also with studying kinetics of formation and subsequent dissolution of different precipitates. The changes of the microstructure were investigated by the measurements of electrical resistivity for the Al-2.5 wt.% Cu alloy.

Isothermal creep curves of Al-2.5 wt.% Cu alloy were determined under different tensile stresses 30, 33 and 36 MPa and at different temperatures up to 763 K.

From the transient creep, described by the equation $\epsilon_{tr} = \beta t^{n}$, the parameters β and n were calculated and found to change anomalously with the working temperature in the temperature range used.

The parameter β is related to the steady state creep $\dot{\epsilon}_{st}$, through the equation $\beta = \beta_o \ (\dot{\epsilon}_{st})^{\gamma}$. The exponent γ was found to be 0.75 to 0.95 for the Al-2.5 wt.% Cu alloy.

The energy activating transient creep at transformation temperature (733K) was found to be 126 K. Joule/mole, characterizing the cross - slipping of dislocations during the dissolution of θ-precipitates.

Steady state creep of Al-2.5 wt.% Cu alloy has been investigated near the phase transformation, the steady strain rate peaks of this alloy were obtained at the temperature range 673 K- 763 K. The steady strain rate sensitivity parameter m amounted to 0.3 ± 0.01 at these peaks characterizing disolocation climb along θ - grain boundaries and/or along its interface with the matrix.

The energy activating steady state creep as determined from the peak shift amounted to 210 K Joule/mole, characterizing dislocation climb mechanism during the dissolution of θ precipitates. The microstructure analysis of isothermally deformed samples, confirmed that the above mechanism took place during transformation steady state creep.

The effect of annealing and quenching on the stress-strain characteristics of Al-2.5 wt.% Cu alloy was investigated relevant to the dissolution and formation of θ-precipitate.

The stress-strain curves were determined at different temperatures up to 773 K. The curves exhibited two regions of tensile deformation, a linear hardening region and a cross-slip region.

The activation energy of fracture mechanism for slow cooled and quenched samples were found to be 79.8K. Joule/mole and 68.25 K. Joule/mole respectively in both temperature ranges from 693 K to 733 K and from 743 K to 773 K respectively. These values implied that the mechanism controlling the fracture process is disolcation intersection.

The minimum value of the lattice parameter a°A at 733 K of Al-matrix and or the maximum value of C/a of the tetragonal Θ- phase **are** due to the releif of the internal strains or stresses during the dissolution of Θ-phase . This was more remarkable in case of the slow cooled samples as they have less concentration of vacancies than the quenched samples.

The change in electrical resistivity of the polycrystalline Al-2.5 wt.% Cu alloy was studied in the temperature range 373-758 K. It depends upon the scattering of conduction electrons from precipitates.

The sequence of structure transformation were (G.P.1, zones, G.P.2 zones, semicoharent Θ'-phase and incoharent Θ-phase) at various aging temperatures.

The activation energy of the four aging stages ranges between 1.26 and 7.06 K. Joule/mole. It concords with the binding energy between vacancy and Cu solute atoms.

The correlation between lattice parameter and resistivity change caused by θ-phase has been investigated in the fourth aging stage of this alloy.

CHAPTER 1

INTRODUCTION

INTRODUCTION

1- Creep and creep theories

1.1 Creep curve

Creep of metals can be demonstrated directly by a creep curve representing creep strain as a function of time. An idealized creep curve is shown schematically in figure (1). As could be seen from this curve, three characteristic creep rates are defined:

(i) The primary creep, taking place at the begining between strains ϵ_o and ϵ_1. In this range the creep rate decreases continuously with time, where ϵ_o and ϵ_1 are the creep strain at $t = 0$, t_1 respectively.

(ii) Steady state"secondary creep" taking place during the period $t_1 \longrightarrow t_2$; for strains from $\epsilon_1 \longrightarrow \epsilon_2$, in which the creep rate ($\dot{\epsilon}_s$) remains almost constant. The value of the secondary creep rate

$$\dot{\epsilon}_S = \epsilon_2 - \epsilon_1 / t_2 - t_1 \qquad (1)$$

(iii) The tertiary creep for values of creep strain higher than ϵ_2 , in this region the creep rate increases continuously untill rupture takes place at a value ϵ_r of creep strain.