

STUDY OF STRUCTURAL, MECHANICAL AND ELECTRIC
PROPERTIES OF BINARY ALLOYS



THESIS

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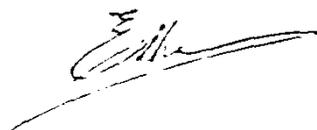
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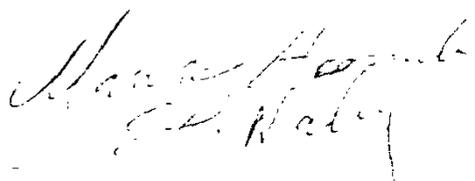
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ABSTRACT :

Isothermal creep curves of Al_{4.5} wt% Mg. alloy were studied using different applied stresses in the range from 91 Mpa to 117 Mpa ,at different temperatures ranging from 473 K to 553 K.

The transient creep characteristics showed two different temperature regions of deformations . a low temperature region (below 513 K) and a high temperature region (above 513 K).From the transient creep described by the equation :

$$\epsilon_{tr} = \beta t^n$$

where ϵ_{tr} and t are the transient strain and time respectively. The parameters n and B were calculated and found to change from 0.15 to 0.62 and from 0.6×10^{-5} to 5.5×10^{-5} , respectively. They exhibited peak values at 493 K. The parameter B was related to the steady state creep rate

by the equation $\beta = \beta_{st} (\dot{\epsilon}_{st})^m$
The exponent was found to be ranging from 0.85 to 0.5 as the strain rate varied from $0.2 \times 10^{-5} \text{ sec}^{-1}$ to $4.8 \times 10^{-5} \text{ sec}^{-1}$.

In the stage of steady state creep , the strain rate sensitivity parameter (m) was found to range from $0.2 + 0.01$ to $0.3 + 0.01$ in the temperature range from 473 K to 553 K. It exhibited a peak value at 493 K.

The activation energy of the steady state creep were found to be 147 KJ/mole and 227.6 KJ/mole in the low and high temperature ranges (below and above 513 K) respectively. These values characterized dislocation cross_slipping and dislocation climb. The grain diameter of the test samples decreased as the working temperature was increased. It reached to a minimum value at 513 K. it was 2.1×10^{-2} mm.

The lattice constant (a) of α phase (aluminium matrix), the half_line width and the integral X-ray diffraction intensity increased with increasing the working temperature . They also exhibited peak values at 493 K.

The effect of annealing and quenching of Al_4.5 wt% Mg. on the stress_strain characteristics was also investigated in the vicinity of the transformation temperature region. The stress_strain tests were carried out at different constant temperatures ranging from 473 K to 553 K. The obtained results exhibited two relaxation stages at different temperatures .

The first relaxation was attributed to the dissolution of β phase. The second one was referred to thermal effects .

The minimum value of the lattice parameter (a) of θ phase at 493 K is due to the relief of the internal strains or stresses during the dissolution of β phase. This observation was remarkable in case of the slow cooled samples as they have less concentration of vacancies than the quenched ones.

The electrical resistivity of Al-4.5 wt% Mg alloy was investigated in the temperature range from 473 K to 553 K. The relative change in electrical resistivity of the test samples was measured at different ageing times. The activation energy of the formation or dissolution processes of the precipitates was calculated. It was found to be in accordance with the binding energy between vacancy and magnesium solute atom. The microstructure variations of the samples used in electrical measurement were investigated by electron microscope.

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CHAPTER I
INTRODUCTION

CHAPTER 1

INTRODUCTION

1.1 CREEP AND CREEP THEORY:

1.1.1 CREEP CURVE AND VARIABLES AFFECTING CREEP:

All materials when subjected to a constant stress will exhibit an increase in strain with time. This phenomenon is called creep. The phenomenon of creep is defined as time dependent increase in strain at constant uniaxial load (1). The continuous deformation with time (creep) is very important in many designs. Excessive creep deformation may lead to premature buckling of structural members subjected to compressive loads. Permanent creep deformations under repetitive flight conditions, for example, are additive and may reach such large values as to make an aircraft aerodynamically unsatisfactory (2). Similar permanent creep deformations in other constructions might produce undeniable and unacceptable changes in shape. Furthermore for certain stress values, the creep deformations may become so large that fracture is produced during the lifetime of the part. Most of the available information on creep properties of materials has been obtained from observations on tensile specimens subjected to constant loads and temperatures (3,4,5).

The principle is that measurements are taken for a specimen of the material, under test, which is surrounded by an oven provided with an accurate temperature measuring device. The specimen is subjected to tensile force at frequent intervals of time until the specimen fractures, or rupture occurs. To some extent, creep testing has been standardized by the American Society of Testing Materials. In creep testing several units are used so that creep time variation can be obtained for a series of load or stress values.

From the measurements a family of creep time curves can be obtained for various stress values and constant temperature.

Typical curves of creep strain against time are plotted in fig.(1) for various nominal stress levels at constant temperature. After the initial strain due to the application of load, there is a gradually diminishing creep rate, which in the case of higher stresses is followed by a rapid increase in creep rate to fracture. At lower stresses the final stage is preceded by a region of constant creep rate, the length of which depends on the stress value. It appears that there might be a limiting

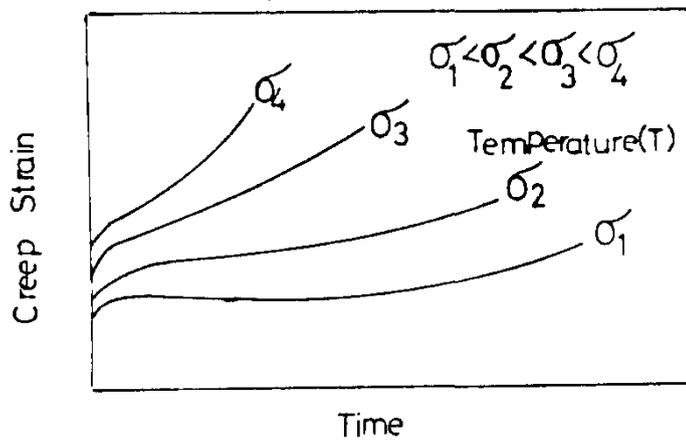


Fig.(1) Typical creep curves for various stresses at constant temperature.