STUDY OF THE MECHANICAL PROPERTIES OF SOME ALLOYS

THESIS

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By
ENSHERAH ABD EL WAHAB HASSAN
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بسم الله الرحمن الرحيم

وقل اعملوا فسيرى الله عملكم ورسوله والمؤمنون

« صدق الله العظيم »

بسم الله الرحمن الرحيم

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The present work is an attempt to add some experimental information by studying the kinetics of impurity distribution within pure deformed matrix and the associated structural and mechanical variations throught measurements of microhardness, electron microscopy, X-rays and internal friction.

The materials used in the present study were obtained in the form of rods of both pure Al and Al-Fe alloy of about 0.8 cm diameter. The rods were homogenized for 20 hours at 500^{o}C then slowly cooled to room temperature. The rods were either cold drown to get wires of 0.5 mm.diameter or cold rolled to get sheets of 0.8 mm thick. The investigated samples were heated for 1 hour at 550^{o}C. then quenched to room temperature to bring the samples of each type to initially identical state.

Heat treatment of the samples was carried out under vacuum (10^{-4} torr) by using resistance coil-voltage stabilized furnace in the temperature range 250--400^{o}C with accuracy of $\pm$ 2^{o}C. Experimental observations aimed in one direction at clarifying the role of impurity atoms

on the annealing kinetics of pure Al, and on the other direction to trace the effect of predeformation on the parameters characterizing the heat treatment procedure of the investigated materials.

Room temperature microhardness and grain diameter measurements were traced for samples under two conditions:

1. Samples preheated at different temperatures for measured times (isothermal annealing).
2. Samples heated for the same time at different preannealing tempeartures.

The behaviour of impurity atoms in the matrix as revealed by electron microscope measurements and the X-rays data were coincident with the results obtained from microhardness and grain diameter measurements. While a single mechanism with activation energy of 1.1 eV, attributed to polygonization, was suggested for pure Al, two stages of complicated behaviour were observed for the alloy structure. The first stage was activated by 0.59 eV, a value characterizing a recovery process depending on vacancy impurity pairs migration associated with softening.

The second stage showed hardness increase to a peak value followed by resoftening. These processes were activated by 1.1 eV and 0.2 eV respectively and were attributed to pair dissociation and the state of final annealing stage of softened matrix including 1 largely wide spaced precipitates.

The kinetics of the precipitation reaction were analysed by applying Avrami's equation to the microhardness measurements obtained. The time exponent obtained supported the suggested mechanisms introduced to explain the different observed annealing stages.

The effect of predeformation as measured by the quantity ND/L on the behaviour of the investigated samples was traced through room temperature internal friction measurements.

The results in general showed the same sequence of softening obtained before in microhardness measurements and showed irregular change in internal friction by increasing predeformation.

The role of impurity atoms was clear in lowering both the level of internal friction values and the range of variation of these values for the alloy samples than in pure Al.

It was found that the peak values increased and were shifted towards lower predeformation values by raising temperature for pure Al. On the contrary in the tested alloy although the internal friction peak values were lower than those of pure Al for the same temperatures, yet, these peaks were shifted to highier ND/L values

The activation energies obtained from internal friction measurements were the same as those obtained from microhardness measurements. so they were explained on the basis of the same proposed mechanisms.

As expected the highier values of internal friction were those obtained for larger grain size samples.

All the obtained results support the explanations based on the role played by lattice defects existing in the matrix and their interactions with impurity atoms which leads to effective variation on the density of mobile dislocations within the matrix.

CHAPTER I

INTRODUCTION

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I.1. Lattice Imperfection In Crystalline Solids:

The study of lattice imperfections in metals has presently achieved very great importance in the field of physical metallurgy. Theories of work hardening, multiplication of dislocations, and interaction of point defects with dislocations during deformation are now quite basic in order that annealing mechanisms and plastic deformation might be understood.

The lattice, imperfections which are known to be present in crystalline solids, and affect their structure sensitive physical and mechanical properties are point defects including vacant sites interstitial atoms and impurities or foreign atoms, line defects or dislocations, and surface defects as stacing Faults or any two dimensional network of dislocations.

a. Point Defects:

A point defect is an irrigularity in the crystal structure localized in the lattice. In a perfect crystal, when an atom leaves its usual site and goes into the spaces between the normal atom positions, a Frenkel type of point defects is formed. The lattice site vacated by the atom is called a vacancy.

A defect which is more or less the counter part of the vacancy is the interstitial atom. Schottky[2] pointed that atoms might be found in places other than lattice sites and these are called interstitials, impurity atoms may also occupy interstitial sites, i.e. they may be squeezed into positions between the solvent atoms, although the energy of formation of the interstitial defect is higher than that of a vacancy yet its migration energy is much lower and therefore it is scarcely found at high temperature.

b. Line Defects

A line defect which is usually called dislocation, is a linear array of misplaced atoms extending over a considerable distance inside a lattice. The dislocation is the defect responsible for phenomenon of slip by which most metals deform plastically.

There are basically two different types of dislocations, edge dislocation was first presented by Taylor and Orowon[3] and the screw dislocation presented by Burger [4]. The strength of a dislocation is measured