Ain Shams University
Faculty of Education
Department of Physics

Phase Characteristics of Aluminum - Base Alloys

Thesis

Submitted for the Ph.D. Degree of Teacher's Preparation in Science (Physics).

By

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To

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2010

Abstract

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Title : Phase Characteristics of Aluminum - Base Alloys.

Submitted to: Physics Department, Faculty of Education, Ain Shams University.

The structural variations and mechanical properties of Al-Si based ternary alloys containing either Ag or Sn were studied for samples prepared form elements of purity 99.99%, homogenized at 823K for 53h and aged at 673K for 2h then quenched into iced water.

The structural variations of all the tested alloys were studied by using (TEM) transmission electron microscope.

The changes in the mechanical properties of the tested alloys were studied through :

1- tensile tests in the temperature range (413 – 493K).

2- applying the different values of :

a) cyclic stress reduction σ_{cy} (0.87, 1.74, 2.6 and 3.48 MPa) at constant frequency υ = 0.38 Hz.

b) frequency υ (0.18, 0.25, 0.33 and 0.38 Hz) at constant cyclic stress reduction σ_{cy} = 3.48 MPa.

Softening behaviour was observed with increasing the working temperature, σ_{cy} and/or υ. The mechanical results were discussed according to the structure analysis of TEM micrographs. Sn addition improved the mechanical properties of the samples but this was not achieved with Ag addition which improved softening and ductility under the same testing conditions.

Approval Sheet

Title : Phase Characteristics of Aluminum -Base Alloys.

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Degree : Ph.D. Degree of Teacher's Preparation in Science (Physics).

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Date of presentation / /2010

Post graduate studies :

Stamp : / / Date of approval : / /

Approval of Faculty Council : / / 2010

Approval of University Council : / / 2010

ACKNOWLEDGMENT

Before all and above all, many thanks to Allah, the most gracious, the most merciful.

The author wishes indebted with her utmost thanks to ***Prof. Dr. Fakhry Abd El-Salam Ibraheim*** for continuous supervision, valuable suggestions, encouragement and fruitful advice through this work.

Deepest gratitude to ***Prof. Dr. Lobna Ali Abd El-Wahab*** for her advice, valuable help and encouragement during this study.

The author wishes to thank ***Asist. Prof. Asaad Mohammed Abd El-Khalek*** for his valuable help, encouragement and fruitful advice throughout this work.

The author wishes to thank ***Asist. Prof. Radwan Hamouda Nada*** for his valuable help, encouragement and fruitful advice throughout this work.

Thanks are also due to ***Prof. Dr. Madeha Fadel***, Head of Physics Department, and the staff members and colleagues of our Laboratory, at the Faculty of Education, Ain Shams University.

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1. Arrangement of atoms

The distribution of molecules or atoms, when a liquid or a gas cools to the solid state, determines the type of solid. Depending on how the solid is formed, a compound can exist in one of the three following forms.

1.1. Single crystal

The ordered crystalline phase is the stable state with the lowest internal energy (absolute thermal equilibrium). The solid in this state is called the single crystal form. It has an exact periodic arrangement of its building blocks (atoms or molecules).

1.2. Polycrystalline materials

Sometimes the external conditions existing during solidification (temperature, pressure, cooling rate) are such that the resulting materials have a periodic arrangement of atoms which is interrupted randomly along two-dimensional sections that can intersect, thus dividing a given volume of a solid into a number of smaller single-crystalline regions or grains. The size of these grains can be as small as several atomic spacings. Materials in this state do not have the lowest possible internal energy but are stable, being in so-named (local thermal equilibrium).

1.3. Amorphous materials

These are polycrystalline materials. There exist, however, solid materials which never reach their equilibrium condition, e.g. glasses or amorphous materials. Molten glass is very viscous and its constituent atoms cannot come into a periodic order (i.e. reach equilibrium condition) rapidly enough as the mass cools. Glasses have a higher energy content than the corresponding crystals and can be considered as a frozen, viscous liquid. There is no periodicity in the arrangement of atoms (the periodicity is of the