



*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).*

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The structural variations and mechanical properties of Al-Si based ternary alloys containing either Ag or Sn were studied for samples prepared from 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  $\sigma_{cy}$  (0.87, 1.74, 2.6 and 3.48 MPa) at constant frequency  $\nu = 0.38$  Hz.

b) frequency  $\nu$  (0.18, 0.25, 0.33 and 0.38 Hz) at constant cyclic stress reduction  $\sigma_{cy} = 3.48$  MPa.

Softening behaviour was observed with increasing the working temperature,  $\sigma_{cy}$  and/or  $\nu$ . 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**

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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