Ain Shams University
Faculty of Education
Physics Department

Study of the Effect of Heat Treatment on the Structural and Mechanical Properties of an Aluminum Based Solder Alloy

THESIS

Submitted for the Degree of Doctor of Philosophy for the Teacher's Preparation in Science (Physics)

By

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To

Physics Department
Faculty of Education
Ain Shams University

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بسم الله الرحمن الرحيم

{و قل رب زدني علما}

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Submitted to:

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جامعة عين شمس
كلية التربية
قسم الفيزياء

دراسة تأثير المعالجات الحرارية على الخصائص التركيبية والميكانيكية لسبيكة لحام قاعدتها الألومنيوم

رسالة مقدمة
للحصول علىدرجة دكتوراه الفلسفة لإعداد المعلم
فى العلوم (فيزياء)

مقدمة من

غادة محمد إبراهيم بدر

إلى

قسم الفيزياء- كلية التربية- جامعة عين شمس

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فبتوفيق من الله سبحانه وتعالى ثم بفضل معاونتهم لى صار هذا العمل ممكنا.

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Conclusions

From what have been discussed, one can deduce the following conclusions:

1. Tensile properties of Al-4043 alloy mainly depend on the size of Si-particles.
2. Traditional heat treatment regimes for Al-Si-Fe-Cu alloys resulted in increasing the size and/or coalescence of Si-particles with increasing temperature of annealing T_a and/or time of annealing t_a while size of α- and β-particles was slightly decreased.
3. The work-hardening parameters $\sigma_{y0.2}$ and σ_f were found to be decreased with increasing T_a and/or t_a while ε_T increased leading to softening the material.
4. The higher rate of decrease of the WHP in the early stage of annealing may be due to the increase of the precipitation (coalescence) rate Si-phase particles.
5. The detrimental effect of α- and β-particles in Al-Si alloys may be kept low as possible by suitable heat treatment.
6. The work-hardening parameters $\sigma_{y0.2}$ and σ_f were found to satisfy the well known Norton power law, $\sigma = C\,\dot{\varepsilon}^{\,m}$.
7. The work-hardening parameters $\sigma_{y0.2}$, σ_f and χ_p increased with increasing $\dot{\varepsilon}$ and /or decreasing the testing temperature T.
8. Both the total strain ε_T and strain rate sensitivity index **m** increased with increasing T and/or decreasing $\dot{\varepsilon}$.

9. Activation energy was estimated as 21 k J mol^{-1} corresponding to that of dislocation movement and ordering to be the operating mechanisms during the tensile tests.
10. Refinement of the internal microstructure in Al-4043 alloy is probably due to the presence of Fe-, Cu- and Ti-rich phases that produced fine and homogenously distributed Si-particles.
11. The normalized relaxed stress decreased with increasing the relaxation time at different strain rates, testing temperatures, annealing temperatures and time of annealing.
12. The energies activating the relaxation process in the two stages (I and II) were found to be10.6 and13.4 kJ/mol, respectively which are close to that required for movement of the released dislocation loops from the pinning points acting upon it.

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Contents

Contents

CHAPTER II

Experimental Techniques and Devices