



AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Design and Production Engineering

Assessment of Some Al Alloy Casting Produced by Special Casting Technique

A Thesis submitted in partial fulfillment of the requirements of the degree of
Master of Science in Mechanical Engineering
(Design and Production Engineering)

by

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Cairo - (2018)



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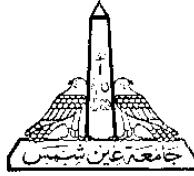
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Statement

This thesis is submitted as a partial fulfillment of Master of Science in Mechanical Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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ABSTRACT

The main objective of this work is to study the enhancement of microstructure & mechanical properties of A356/ZrO₂ Metal Matrix nano composites. For completing such study different treatments were executed for the additives at different volume fraction using stir casting technique. Also heat treatment affected the fabricated composites was studied.

Recent investigation has-been divided into three parts:

Part I: This section describes the effect of using different nanoparticles feeding routes (direct, capsule & regular) treatments of nanoparticles (as additives) on the microstructure and mechanical properties of A356 alloy.

A number of cast samples of A356 alloy were prepared by rheo-casting in a specially designed and built resistance furnace unit allowing feeding ZrO₂ nano- particles (30nm) in to the slurry in the semi-solid state with mechanical stirring at constant parameter (temp stirring 595-610°C, stirring speed 670 r.p.m at stirring time 2 minute).

Part II: This section presents the effect of different weight% of nano particles addition (1%, 2%, 3%, 4% & 5%) on the microstructure and the mechanical properties of the nano ZrO₂ reinforced A356 cast alloy.

Part III: This section presents the results obtained in this work for the microstructure and mechanical properties of capsule feeding 3% ZrO₂ nanoreinforced A356 alloy with compare to monolithic cast A356 alloy in T6 heat treated condition. The samples were solution treated at temperature of 550°C for 2 hours, followed by aging at different temperatures (170°C&180°C), for different aging times (2, 4 & 6 hours).

The results showed that microstructure of the nano composite samples revealed grain refinement in aluminum matrix support dendrite and inter lamellar spacing in the eutectic silicon phase for the nano composite ZrO_2 . The capsule treated feeding at 3% ZrO_2 alloy has the best mechanical properties (Strength 165MPa, %Elongation 4.7 & Hardness 60 HRB), compared to monolithic cast alloy (Strength 119MPa, %Elongation 4.5 & Hardness 23 HRB). The heat treatment T6 produced for capsule feeding 3% ZrO_2 Alloy result has better than monolithic casted alloy (Strength from 119MPa to 198MPa, %Elongation from 4.5 to 6.4, Hardness from 23 to 70 HRB), an effective change on morphology of the eutectic silicon lamellae. More details discussed using SEM and EDX analysis.

The nano-composites exhibited better mechanical properties when compared with the A356 monolithic alloy, also the addition of 3% ZrO_2 nanoparticles, and heat treated T6 process has the best result in mechanical properties.

Key words:

Aluminum alloy, stirring casting, ZrO_2 nanoparticles, strength, hardness, heat treatment.

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