Ain Shams University
Faculty of Engineering
Design and Production Engineering

Developing and Characterization of Al-Ceramic Particulate Reinforced and Hybrid MMCs

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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Master of Science in Mechanical Engineering

(Design and Production Engineering)

Faculty of Engineering, Ain Shams University, 2014

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Ain Shams University
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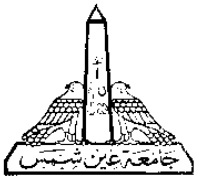

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Developing and Characterization of Al-Ceramic Particulate Reinforced and Hybrid MMCs

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Statement

This thesis is submitted as a partial fulfilment 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

Within the recent period of time, the world witnesses a technological and technical evolution. And -as always- this evolution requires an evolutionary update in usable materials in various industries to keep in pace with means of technical advancement.

Therefore, the traditional materials became non-sufficient to its purpose. Ergo, it became a necessity to create composite materials of two or more origins that have unique characteristics. Therefore, the main purpose of this thesis is to manufacture and develop composite materials of aluminum alloy 6063 (monolithic alloy) along with some enhancing materials such as; Silicon carbide, alumina, cement dust, and silica fumes.

This research is divided into two major parts:

First part:

The study of using (Silicon carbide, alumina, cement dust, and silica fumes) as enhancement materials to the aluminum alloy 6063.

By adding them during casting with various percentage of these materials in relation to the monolith alloy's weight (2.5, 5, 10 &15) during traditional casting whilst trying to cure the alloy before adding the materials so that, the alloy and the enhancing materials could dissolve and merge together.

By studying the result of the previously mentioned process under optical microscope; voids, cracks and unmerging of the fine materials with the alloy could be observed, which led to irregular distribution that affected the mechanical characteristics of the composite material.

To reduce and avoid the previously mentioned problematic results, accumulated hot rolling at 530 ℃ was applied to the composite material and by studying the results; regular distribution of fine materials in the alloy was observed therefore, proved a remarkable enhancement to the mechanical characteristics of the alloy, where the tensile strength had been enhanced by (168%) than the monolithic alloy at AA6063-15% silicon carbide composite sample and the hardness had been enhanced with (128%) than that of the monolithic alloy at AA6063-10% alumina composite sample.

Second part:

Adding a hybrid of enhancing materials to the monolith alloy provided taking a constant percentage of Silicon carbide (5%) and mixing in various percentages of; alumina, cement dust, and silica fumes.

The new hybrid consisting of; (5% silicon carbide + various percentages of alumina), (5% silicon carbide + various percentages of cement dust), and (5% silicon carbide + various percentages of silica fumes) were added to the monolith alloy.

And by studying the result under optical microscope and its mechanical characteristics; and improvement to its distribution towards regularity was observed which consequently led to an improvement to its mechanical characteristics but the problem with voids still remained as an issue.

And like the first part, hot rolling was applied to the composite alloy to reduce and diminish casting problems, and after studying the results in the same way a remarkable improvement in the mechanical properties, where the tensile strength enhanced with 232% at AA6063/5%SiC-10% Silica fumes hybrid composite sample and the hardness enhanced with 144% at AA6063/10% Alumina hybrid composite sample.

To summarize; using and adding the enhancing materials separately to the aluminum alloy 6063 led to an improvement to some of its characteristics, which got even better after applying hot rolling to the composite alloy, and got a greater result when using a hybrid of enhancing materials and applying hot rolling to the result.

This study is considered one of the few around the world based on recycling materials such as; cement dust, and silica fumes in enhancing alloys and it's an example of cost reduction and benefiting from recycled materials as well as raising its value.

Keywords: Composites, Aluminum Metal Matrix Composite, Hybrid Aluminum Metal Matrix Composite, Stir Casting.

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