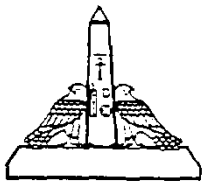

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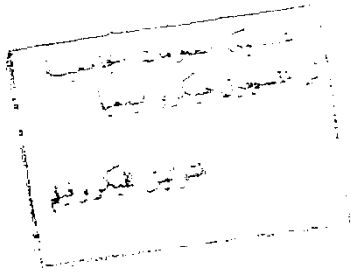

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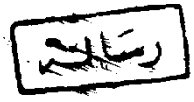

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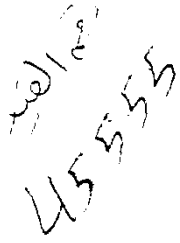

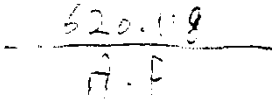

In

Mechanical Engineering

By

AHMED FARID ABDEL-GHAFFAR YOUSSEF

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1993

"FABRICATION AND PROPERTIES OF SOME METAL-MATRIX COMPOSITES"

M.Sc. Thesis

In

Mechanical Engineering

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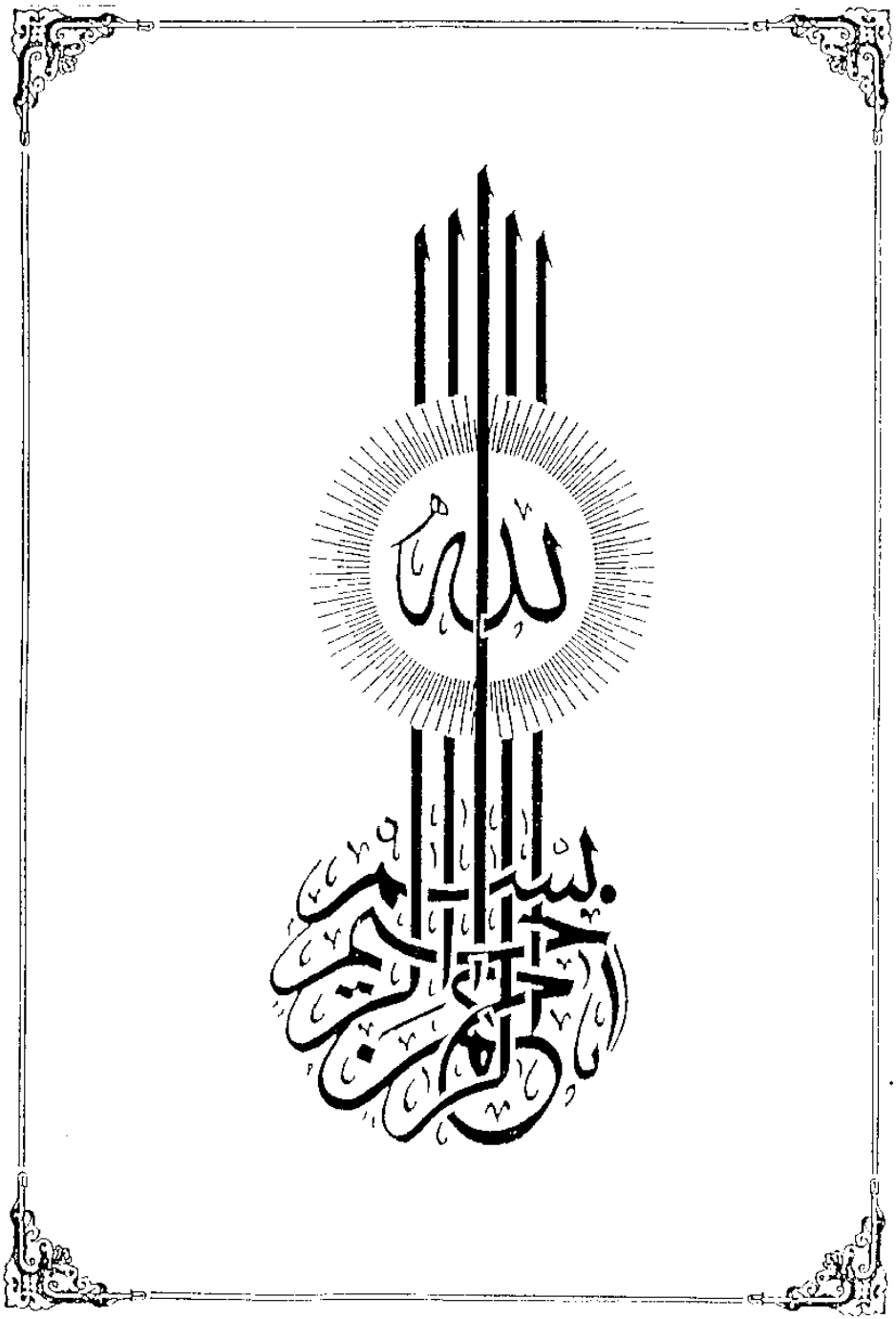

IN THE NAME OF ALLAH,
THE BENEFICIENT,
THE MERCIFUL.

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SUMMARY

This thesis aims to study the ability of fabrication of metal matrix composites using the **centrifuged casting technique.**
In this work the centrifugal force applied on the molten metal due to its rotation was used to infiltrate it between the ceramic free powder.

[Al-Al_2O_3] Composite system was chosen to be used in this study, where both materials are mutually nonreactive. Near eutectic **[Al-12wt%Si-2wt%Mg]** alloy was selected because of its good fluidity and low melting point. The magnesium was added to enhance the wettability by limited chemical reaction with the alumina.

In this work a special apparatus was designed and constructed in order to rotate the specimens, and to allow the molten metal to infiltrate through the alumina powder along the axis of the cylindrical specimen.

The processing variables used were as follow:
Rotational speed (N) from 700 to 2000 RPM, Centrifugal pressure (P) from 0.34 to 6.92 bar, Alumina powder length inside mould (Lp) from 20 to 60 mm , Powder grain size from 30.8 to 89.8 microns, and Alloy superheat from 20 to 150 K.

It is found that the acting centrifugal pressure (P*) plays the major role in determining the resulting composite length and soundness.

An entirely uniform distribution of the alumina particles in the aluminium matrix was obtained. It was observed that the alumina particles volume fraction in the resulting composite is always about 57%. The porosity examinations reveals that the microporosity increases gradually along the composite length from

the specimen end toward the the axis of rotation from 0.285% to 3.28% by volume and reaches about 5.84% at the metal/composite interface for the conditions (2000 RPM rotational speed, and 100 K alloy superheat).

The metal/ceramic interface was examined using the scanning electron microscope , and a line-scann examination across the interface was made. The effect of both Mg & Si as alloying elements on the interface quality was also investigated.

Comparing with matrix average hardness (75 VHN), the hardness measurements indicate an improvement in the composite hardness by an average value 20%. The maximum measured hardness of the resulting composite is (93.4 VHN) was obtained for the operating conditions (2000 RPM rotational speed, and 100 K alloy superheat) in the as cast conditions.

CONTENTS

INTRODUCTION

INTRODUCTION

Because of their superior mechanical properties, and the continuous development of their fabrication techniques, the use and the importance of the metal matrix composites increased during the last few years.

The MMCs have a wide field of application specially in the automobile industry and the space technology applications, where a perfect performance is needed at high temperatures.

The most common problems encountered during the fabrication of MMCs using the casting techniques is the mixing problems such as (floatation, settling, and agglomeration). The dewetting between the molten metal and the ceramic reinforcement fibers or particles is another important problem. Good interfacial bond is also necessary to permit the transfer and the distribution of the mechanical loads from the matrix to the reinforcement elements under the operating conditions.

Many work have been published, discussing the interfaces in MMCs and their stability, some of them have suggested or have improved new casting techniques. The goal was always to produce a sound cast-composite having an uniform distribution of the reinforcement elements, and having a void free metal/ceramic interface, stable under the operating conditions.

In this work, an experimental technique has been developed for the production of MMC using the centrifuged casting process. This technique was applied on AL/AL_2O_3 system.

The infiltration process (mechanism), structure and particulate distribution, soundness, interface quality, and composite hardness were studied.

LITERATURE SURVEY

CHAPTER (1)
LITERATURE SURVEY

1.1 INTRODUCTION & DEFINITIONS

1.1.1 Composite Materials

The composite material is the material which consists of two or more identifiable constituents. The concept of using two or more elemental materials combined to form the constituent phases of a composite solid has been employed ever since materials have first been used.

From the earliest uses, the goals for composite development have been to achieve a combination of properties not achievable by any of elementals acting alone, and could not satisfy a particular design requirements [1].

There are different types of composites, fiber and whisker - reinforced composites, directionally solidified eutectic alloys, filled, flake, particulate, and laminar composites. Some of these types are illustrated in **figure 1.1** . The most typical types are composed of an additive constituent such as fibers or particles embedded in a matrix, and some composites have no matrix and are composed of one or more constituent form consisting of two or more different materials. Sandwiches and laminates , for example are composed entirely of layers which, taken together, giving the composite its form. The composite types are sometimes difficult o distinguish from one another. The difference between one omposite type and another may seem fairly clear, but in practice .t is not always easy to draw the line [2].