EFFECT OF MACHINING PARAMETERS AND BISMUTH ADDITION ON AL-20%MG_2SI MACHINABILITY DURING DRY TURNING

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To my beloved family and specially my dear father, mother, brother and sisters

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ABSTRACT

The metal matrix composite has become an important material in aerospace and automotive industry due to their mechanical properties such as light weight, wear resistance and high strength. although metal matrix composite, are produced in net shape, there is some need for secondary operation such as machining. The main problem in MMC machining is high tool wear which result in extra cost. This observation has resulted in an investigation to evaluate the effect of machining parameters and Bismuth as modifier on machinability of Al-20%Mg_2Si. The classical experimental design was also applied to develop empirical model, (regression model), to represent the relationship between machining parameters and cutting forces, surface roughness and the Bi modifier.

ABSTRAK

Komposit logam matrik merupakan bahan yang penting terutamanya dalam industri aero-angkasa dan automotif. Ini kerana bahan tersebut mempunyai sifat-sifat mekanikal seperti ringan, rintangan terhadap kehausan dan mempunyai kekuatan yang tinggi. Walaupun komposit logam matrik dihasilkan dalam bentuk yang tepat dan jelas, ianya masih memerlukan operasi sekunder seperti pemesinan. Namun, masalah utama dengan komposit logam matrik ini adalah kehausan pada mata alat yang tinggi dan secara tidak langsungnya, kos yang tinggi juga diperlukan. Pemerhatian ini telah menderong satu pengiastan untuk menilai kesan parameter pemesinan dan penambahan Bismuth sebagai pengubahsuai lupada kebolehmesihan Al-20%Mg_2Si. Rekabentuk ujikaji klasik juga digunakan untuk menghasilkan model emprikal (model regresi) untuk menjelaskan hubungan antara parameter pemesinan dengan daya pemotongan, kekasaran permukaan dan juga pengubahsuai Bi.

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CHAPTER 1

INTRODUCTION

1.1 Background

MMCs are compounded of a moderately soft and ductile metal base material, or ‘‘matrix’’ reinforced with a hard and brittle reinforcement material. The reinforcement are divided to three groups, particles, whiskers, or fibers. The first advantages provided by these materials are their enhanced mechanical properties, especially in the aspects of wear, strength and stiffness. These matrix materials contributes to the properties of high specific stiffness and strength. In the form of particle is most typically shape for reinforcement. Fiber reinforcement is not so common and is barred to situations where performance is the important factor rather than cost. The amount of reinforcement in MMCs is often less than 40%.

The perfect properties are experienced with Mg2Si, and as result have high potential as structural material. It attracts engineers attention in the automotive industry to produce items such as cylinder blocks and cylinder heads. The low density of Mg2Si brings about weight reduction and reduce cost as result of Al, Mg and Si as starting materials, provide excellent advantages. Attributed to the intermetallic compound Mg2Si offers some advantages such as high melting temperature, low density, high hardness, low thermal expansion coefficient and high elastic modulus.

The cast composites which are produced by conventional casting tends to form undesirable coarse primary Mg2Si particulates, which have considerable effect on the mechanical properties because of the large and brittle nature of Mg2Si particles and enhancement in the mechanical properties may be obtained by fast solidification during casting and mechanical alloying which result in the production of composite with very fine matrix structure and in situ Mg2Si particles(Nordin, Farahany et al. 2013).

Although the MMCs are produced to net shape by using appropriate techniques, there is still the need for some operation such as secondary machining. The high tool wear due to the abrasive action of reinforcement particles is the most important consideration during MMCs machining(El-Gallab and Sklad 1998).

1.2 problem Statement

There are many factors including cutting speed and feed rate which influenced the machining of AL-Mg_2Si. However the following reasons provide the motivation for performing this work.

- Unavailability of information of machining and machinability of Al-Mg_2Si.
- To make available empirical models to predict the final surface roughness and cutting force when turning Al-Mg_2Si (Non-modified) and Bismuth modified Al-Mg_2Si in specific cutting speed and feed rate.

1.3 Objective

The objective of this study are as follow:

- To evaluate the effect of machining parameters (Cutting speed and Feed rate) on surface roughness and cutting forces when turning non-modified and modified Al-20%Mg_2Si.
- To develop empirical model, to represent the relationship between machining parameters and surface roughness and cutting forces.

1.4 Scope

The scope of this work are as follow:

- Work-piece materials which will be used in this investigation are, Al-20% Mg_2Si (non-modified) and Al-20% Mg_2SiBi modified (0.6wt.%Bi).
- The experiments will be conducted on an ALPHA 1350S 2-Axis CNC Lathe turning machine and PVD coated ceramic cutting tool will be used.
- The surface roughness and cutting force (Fc) during the dry turning are the machinability parameters that will be evaluated in terms of determine machinability.
- Statistical Design of Experiment will be implemented in this study.
- The surface morphology and integrity will be analyzed by using Scanning Electron Microscope (SEM).

1.5 Thesis Organization

Chapter one, covers an introduction and overview of metal matrix composites and their properties. This chapter also discusses background of the study, statement of problem, determining the objective and scope of the study.

Chapter two includes the review of literature consisting of basic definitions regarding composites, machining and related concepts. And finally all information about machinability, cutting tools, cutting forces and related equipment.

chapter three puts forward research framework and methodology, which provides guidelines on how this research will be conducted in order to reach its objective.

In chapter four, the appropriate model and experiment variables based on objective and study condition are selected. And all data are compared to evaluate the concerned material and its machinability.

In chapter five, the result of the study is provided and findings are discussed. In order to investigate the effect of machining parameters on Al-20%Mg_2Si machinability and develop empirical model to represent the relationship between cutting speed, feed rate, cutting force and surface roughness.

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