

DEVELOPMENT OF Al-Cu-SiC<sub>p</sub> METAL MATRIX COMPOSITE  
FOR AUTOMOTIVE APPLICATIONS

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DISSERTATION SUBMITTED TO THE FACULTY OF ENGINEERING,  
UNIVERSITY OF MALAYA IN PARTIAL FULFILMENT OF THE REQUIREMENTS  
FOR THE DEGREE OF MASTER OF ENGINEERING (MANUFACTURING)

FACULTY OF ENGINEERING  
UNIVERSITY OF MALAYA  
KUALA LUMPUR

APRIL 2005

Perpustakaan Universiti Malaya



A511898834

## ABSTRACT

In recent years, the demand for reduced weight and high performance materials for automotive applications such as brake disc have increased. The newly developed, aluminium metal matrix composite (Al-MMC) reinforced with silicon carbide (SiC) particulate seem suitable to be an alternative material for this application. In this experimental study, Al-Cu-SiC<sub>p</sub> MMC was developed through stir casting method with sand mould. A constant 4.5% of weight percentage of 5 µm pure copper powder was added to the mixtures to enhance the properties of Al-MMC. The effects of particle sizes of SiC as well as the weight percentage of SiC, pouring temperature and stirring time on the hardness, wear, compressive properties, flexure behavior and density of Al-Cu-SiC<sub>p</sub> MMC were investigated. Taguchi's Robust Parametric Design was used with inner array L<sub>9</sub> 3<sup>4</sup> and outer array with 2 replications to plan the experimental runs. A statistical Pareto Analysis of Variance (Pareto ANOVA) was employed to determine the significant factors of these properties and optimum combinations of process variables for targeted functions. From the analysis, it was found that particle sizes of SiC is the most significant factor for density characteristic and compressive properties while weight percentage of SiC is the most significant factor for hardness and wear resistance characteristics. Optimum combinations were determined and conformity test were conducted to verify the optimum properties of newly developed material, Al-Cu-SiC<sub>p</sub> MMC. Optimum combination of hardness was A<sub>1</sub>B<sub>2</sub>C<sub>0</sub>D<sub>0</sub> ( 59 µm particle size of SiC, 15% of weight percentage of SiC, 675 °C pouring temperature and 5 minutes stirring time) with 82.5 HV; wear rate A<sub>2</sub>B<sub>2</sub>C<sub>2</sub>D<sub>0</sub> ( 106 µm particle size of SiC, 15% of weight percentage of SiC, 725 °C pouring temperature and 5 minutes stirring time) with 1.585 x 10<sup>-5</sup> g/sec; compressive strength A<sub>1</sub>B<sub>2</sub>C<sub>2</sub>D<sub>1</sub> ( 59 µm particle size of SiC, 15% of weight percentage of SiC, 725 °C pouring temperature and 10 minutes stirring time) with 9410.06 MPa and density A<sub>0</sub>B<sub>1</sub>C<sub>1</sub>D<sub>1</sub> ( 40 µm particle size of SiC, 10% of weight percentage of SiC, 700 °C pouring temperature and 10 minutes stirring time) with 2.6592 g/cm<sup>3</sup>.

## **ACKNOWLEDGEMENT**

I would like to express my sincere gratitude to my supervisor, Prof. Dr. Mohammed Hameedullah for guiding and encouraging me, and for being a mentor throughout this course. I could count on his support and knowledge when in need, and I am very grateful for this. I would also like to thank to my co-supervisor on-site, Mr. Mohd Amri Lajis for his help, understanding and full support on my work.

A special thank is extended to the following for their assistance and technical expertise: Mr. Leong Kin Yuen, Mr. Azmi Ruhani, Mr. Hafizzudin Hehsan, Mr. Tarmizi, Mr. Mohd Amin and Mr Fazlannudin. I also would like to convey my appreciation to the management of Kolej Universiti Teknologi Tun Hussein Onn (KUiTTTHO) for their support given such as equipments, laboratory and technical advice. Last but not least, I would like to thank to those who have contributed directly or indirectly towards the success of this project.

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## LIST OF SYMBOLS

Al-Cu-Mg	-	Aluminium-Copper-Magnesium
Al-Cu-SiC <sub>p</sub> MMC	-	Aluminium-Copper-Silicon Carbide particulate metal matrix composite
Al-Li	-	Aluminium-Lithium
Al-MMCs	-	Aluminium metal matrix composites
Al <sub>2</sub> O <sub>3</sub>	-	Alumina
Al-Zn-Mg-Cu	-	Aluminium-Zinc-Magnesium-Copper
ASTM	-	American Society for Testing and Materials
BS	-	British Standard
DPS	-	Dual particle sizes
SiC	-	Silicon Carbide
SPS	-	Single particle sizes
Wt%	-	Weight percentage
B	-	Constant (Dimensionless wear coefficient)
F	-	Exerted force (N)
H	-	Hardness of the body
k	-	Spring stiffness (3.27kN/m)
n	-	Quantity of data taken
N	-	Rotational per minutes of rotating disc
Q	-	Volume removed per unit sliding
S	-	Sum of squares of differences
SN	-	Signal to noise ratio
V	-	Linear velocity of the disc (m/s)
W	-	Applied load (N)
W <sub>a</sub>	-	Weight of specimen after experiment
W <sub>b</sub>	-	Weight of specimen before experiment
W <sub>l</sub>	-	Weight loss
x	-	Displacement of spring
y	-	Value of data from experiment ( for instance, value of hardness

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