



UNIVERSITI PUTRA MALAYSIA

***SIMULATION AND CHARACTERIZATION OF ALUMINIUM-BASED
METAL MATRIX COMPOSITE***

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**SIMULATION AND CHARACTERIZATION OF
ALUMINIUM-BASED METAL MATRIX
COMPOSITE**

The logo of Universiti Putra Malaysia (UPM) is a shield-shaped emblem. It features a red and white color scheme. At the top left, the letters 'UPM' are displayed in white on a red rectangular background. The central part of the shield contains a stylized white and red design, possibly representing a book or a traditional symbol. The shield is set against a light grey background.

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**MASTER OF SCIENCE
UNIVERSITI PUTRA MALAYSIA**

2011

**SIMULATION AND CHARACTERIZATION OF ALUMINIUM-BASED
METAL MATRIX COMPOSITE**



By

SURAYA BINTI SULAIMAN

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfilment of the Requirement for the Degree of Master of Science**

April 2011

DEDICATION

Thank you to Allah SWT, for giving me strength and spirit.

I would like to dedicate this research work to my beloved family. There is no doubt in my mind that without their support and counsel I could not have completed this process.

Thank you to Prof. Dr. Shamsuddin Sulaiman and Associate Professor Dr. Mohd Khairol Anuar Mohd Ariffin. Both of these men have given me a deep appreciation, inspirational instruction and guidance.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

SIMULATION AND CHARACTERIZATION OF ALUMINIUM-BASED METAL MATRIX COMPOSITE

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April 2011

Chairman : Professor Shamsuddin Sulaiman, PhD

Faculty : Engineering

This research work is concerned with the areas of computer simulation of casting process to investigate the mould filling and solidification characteristics of aluminium-11.8% silicon alloy matrix (LM6 alloy matrix) reinforced at five different weight percentages; 0%, 5%, 10%, 15%, and 20% of titanium carbide (TiC) as particulates. The experimental works focused on the cooling curve, microstructural and mechanical properties of composite material. Effects on different weight percentages (wt%) addition of the TiC particulates distribution in LM6 alloy matrix are studied. The simulation software used is AnyCasting. The temperature and time during solidification process for experimental work and simulation are compared. The cylinder composite casting has been made by pouring the composite mixture in sand and copper permanent metallic moulds. The tensile specimens were then prepared in accordance to ASTM B557 M-94 specifications, hardness specimens were tested using MITUTOYO ATK-600 MODEL machine and microstructure of

the fracture surface have done by using Scanning Electron Microscopy (SEM). The outcome of the investigations reveals that the tensile strength and hardness are enhanced from 0wt% to 10wt% of TiC and start to decrease after addition of 10wt% of TiC. Good bonding and wettability between the composites ranging from 0% wt. to 10% wt. of TiC influence the close distribution of TiC particles in the LM6 alloy matrix. The addition of 10% wt. to 20% wt. of TiC in LM6 alloy matrix cause the lower resistance and load-bearing capacity and the particle are no longer isolated with the LM6 alloy matrix causing the worse value of tensile strength and hardness.

Abstrak tesis dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

SIMULASI DAN PENCIRIAN ALUMINIUM BERASASKAN LOGAM Matrik Komposit

Oleh

SURAYA BINTI SULAIMAN

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Pengerusi : Profesor Shamsuddin Sulaiman, PhD

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Keja penyelidikan adalah berkaitan dengan bidang simulasi komputer untuk menyiasat ciri-ciri tuangan dan pembekuan aluminium-11.8% silikon aloi matrik (LM6 aloi matrik) yang diperkuat dengan lima peratusan berat titanium karbida (TiC) yang berbeza; 0%, 5%, 10%, 15%, and 20% sebagai zarah dan kerja eksperimental yang difokuskan pada lengkungan penyejukan, struktur mikro dan sifat mekanik bahan komposit. Kesan pengagihan daripada perbezaan penambahan peratusan berat (wt%) zarah TiC pendedaran di LM6 aloi matrik dipelajari. Perisian simulasi yang digunakan adalah AnyCasting. Perbandingan mengenai masa suhu semasa proses pembekuan untuk eksperimen dan simulasi dilakukan. Tuangan silinder komposit dibuat melalui proses tuangan antara campuran komposit di dalam acuan pasir dan acuan logam kekal tembaga. Spesimen tegangan dibuat mengikut spesifikasi ASTM B557-94 M94, spesimen kekerasan diuji menggunakan mesin Mitutoyo ATK-600 MODEL dan keretakan mekanik dikaji menggunakan Scanning

Electron Microscopy (SEM). Hasil keputusan menunjukkan peningkatan dari 0wt% sehingga 10wt% dalam kekuatan tegangan dan kekerasan dan keputusan mula menurun selepas 10wt% TiC. Ikatan yang baik dan keterbasahan antara julat 0wt% sehingga 10wt% dipengaruhi oleh pengagihan yang rapat antara zarah-zarah TiC dengan LM6 aloi matrik. Penambahan 10wt% sehingga 20wt% TiC di dalam LM6 aloi matrik menyebabkan rintangan dan kapasiti dukung beban rendah dan zarah-zarah tidak lagi terpen cil dengan LM6 aloi matrik yang menyebabkan kemerosotan nilai kekuatan tegangan dan kekerasan.

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I certify that an Examination Committee has met on date of viva voce to conduct the final examination of Suraya Sulaiman on his thesis entitled “Simulation and Characterization of Aluminium-based Metal Matrix Composite” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the Master of Science.

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DECLARATION

I declare that the thesis is my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or other institutions.



SURAYA BINTI SULAIMAN

Date: 15 April 2011

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