Proceeding of

Aceh Development International Conference

ADIC 2010

Universiti Putra Malaysia

March 26th – 28th, 2010

http://www.adic2010.yolasite.com

ADIC 2010

Persatuan Pelajar Aceh
PPA-UPM

ISBN 978-967-5742-00-2

9 789675 742002

Jointly Organized by :

Persatuan Pelajar Aceh (PPA)-UPM

Ikatan Masyarakat Aceh Malaysia (IMAM)

Pemerintahan Aceh

Center for International Affairs (CIA)-UPM

PROCEEDING OF ADIC 2010

ACEH DEVELOPMENT INTERNATIONAL CONFERENCE 2010

26 – 28 March 2010

Auditorium Hall, Faculty of Engineering, Universiti Putra Malaysia

Jointly Organised by

CENTRE OF INTERNATIONAL AFFAIRS - UNIVERSITI PUTRA MALAYSIA
PERSATUAN PELAJAR ACEH – UNIVERSITI PUTRA MALAYSIA
IKATAN MASYARAKAT ACEH MALAYSIA (IMAM)

ORGANIZING COMMITTEE OF ADIC2010

PATRON
Vice Cancellor of UPM
President, The Aceh Club Malaysia

DIRECTED BY
Director, Centre for International Affairs of UPM
President, Persatuan Pelajar Aceh – UPM

Chairman
Muhammad Sayuti Fadhil

Co. Chairman
Azhari Muhammad Syam
Muhammad Sabri

Secretary
Rahmat Fadhil
Faisal Abnisa

Treasury
Annisa Soraya

Proceeding Affairs
Dandi Bachtiar
Azhari Muhammad Syam, Rahmat Fadhil, Muhammad Sayuti Fadhil

Venue Affairs
Muhammad Yasar
Zulhilmi, Asrilah, Syaiful Bahri, Khairul Fajri Muhamed, Rosnina, Asnawi, Ahmadallah, Azhar

Seminar & Documentation Affairs
Muhammad Yusuf
Armiyanti, Rahmawati, Syukriah, Sri Lianda, Lukman Hakim, Fuad, Samsul Bahri, Yusrini Marita, Ridwan Arifin, Riki, Hajrul, Afriani

Transportation & Accommodation Affairs
Safrilsyah Syarief
Muhammad, Rusla Razali, Husna, Darmawati, Agustinawati, Muhammad Dayyan, Khairi, Affan Ramli, Ratna Sari, Mukhlisien, Radhiah Zakaria

ADVISORY COMMITTEE OF ADIC2010

Prof. Dr. Ir. T.M. Indra Mahlia
Universiti Malaya (UM)
Malaysia

Prof. Ir. Dr. Mohd. Sapuan Salit
Universiti Putra Malaysia (UPM)
Malaysia

Prof. Dr. Hasanudin
Universitas Syiah Kuala (Unsyiah)
Indonesia

Prof. Dr. Ir. Hasanudin Z. Abidin
Institut Teknologi Bandung (ITB)
Indonesia

Prof. Dr. Syahrizal Abbas
Institut Agama Islam Negeri (IAIN) Ar-Raniry
Indonesia

Dr. Syafiie
Universiti Putra Malaysia (UPM)
Malaysia

Assoc. Prof. Dr. Sabri Abd. Majid
Universiti Islam Antarabangsa (UIA)
Malaysia

Assoc. Prof. Puan Sri Nila Inangda Manyam Keumala
Universiti Malaya (UM)
Malaysia

Message from the Chairman, ADIC2010 Organizing Committee

Assalaamu'alaikum Warahmatullaahi Wabarakaatuh

I greatly privilege to welcome all the authors, participant and delegates who are participating in the Aceh Development International Conference (ADIC) 2010. The ADIC hold from 26th to 28th March 2010.

The ADIC2010 appears to be one of the amount big international events to have been hosted by PPA-UPM (Acheh Students Association UPM). There is no doubt that such a big event will pay attention from many reputable academicians, researchers as well as practitioners and professionals from all over the world.

The technical committee has received more than 121 abstracts and after initial reviewing process, it has accepted to be presented 90 full papers in the conference from more than 5 countries. The conference presentations are divided into 4 parallel sessions delivering during the 2-days conference whereas there are three important keynote speakers who deliver their speeches during the first day of conference.

The related and update topics which connect to the scientific and social research and development in this conference are divided into 15 topics, namely, concept of development based on Islamic studies, rural and urban planning, development of education, culture and custom, Design on Public Facilities and transportation system, planning on housing, offices and community services, development of management system and international relationship, development of infrastructure, telecommunication and advance technology, agriculture and food technology, poultries and veterinaries, fishery, offshore and onshore, tourism and promotion, computerize and IT, environmental, industries and automotive engineering, economic, banking and related, women, family and kids, healthy and other related topics in the area of new issue for Acheh development in future.

Finally, let me convey my sincere gratitude to the members of the all committee for the hard work to make ADIC 2010 possible as such an international level event. Hopefully, this conference will be a great success and fruitful event for sharing and exchange of knowledge for Acheh in future.

Thank you.

Muhammad Sayuti Fadhil
Chairman,
ADIC2010 Organizing Committee

PREFACE

The Aceh Development International Conference 2010 provides a good opportunity for sharing the information, knowledge and experiences amongst the scientist, practitioners, researchers and other professional in related fields in rebuilding Aceh issues. The conference also being an indicator to measure the progress of development activities in whole of Aceh and in all of affected sectors primarily public sectors which collapsed by the Tsunami.

Hopefully, through this International conference, the beneficial outcomes will be attained for the sustainability development of Aceh province in the future. Last but not least, the editors team congratulate for all of participants, especially the authors who spent their time for joining this International event.

Thank you.

Editor Team

Dandi Bachtiar
Azhari Muhammad Syam
Muhammad Sayuti
Rahmat Fadhil

LIST OF CONTENT

Politics

Laws and Qanun

Economics

Religion

Psychology and Health

Public Service and Infrastructure

Good Government Management

Engineering Science and Technology

ISBN 978-967-5742-00-2

PROCESSING AND CHARACTERISATION OF PARTICULATE REINFORCED ALUMINIUM -11.8 % SILICON MATRIX COMPOSITE

Sayuti*, M, Suraya, S, Sulaiman, S, B.T.H.T. Baharudin, and Arifin, M.K.A

Department of Mechanical and Manufacturing Engineering, Faculty of Engineering, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

*Email: tgk_sayuti@yahoo.co.uk

Abstract

This paper describes and discusses the processing and characterization of titanium carbide particulate reinforced aluminium-silicon alloy matrix composite. In this regard, titanium carbide particulate reinforced LM6 alloy matrix composites were fabricated by carbon dioxide sand molding process with different particulate weight fraction. Tensile tests and scanning electron microscopic studies were conducted to determine the maximum load, tensile strength, modulus of elasticity and fracture surface analysis have been performed to characterize the morphological aspects of the test samples after tensile testing. Hardness values are measured for the quartz particulate reinforced LM6 alloy composites and it has been found that it gradually increases with increased addition of the reinforcement phase. The tensile strength of the composites increases with the increase in addition of quartz particulate.

Keywords: characterisation; tensile; Hardness.

Introduction

Industrial technology is growing at a very rapid rate and consequently there is an increasing demand and need for new materials. Particulate reinforced composites constitute a large portion of these new advanced materials. The world of tomorrow will probably involve a synergistic mix of materials rather than the replacement of one material by other. In pursuit of this, the last few decades have witnessed unprecedented developments of harder metals and alloys. Among these are the categories of composite materials, the metal matrix composites (MMCs) which are increasingly being used in the automobile, aircraft, and space industries. As a result, worldwide attention has been focused on the processing and fabrication of these materials because of both manufacturing costs and performance. These composite materials also offer outstanding properties such as high strength-to-weight ratio, high torsional stiffness, good corrosion resistance and good tolerance characteristics and versatility to the designer [1] .

The choice of the processing method depends on the property requirements, cost factor consideration and future applications prospects. The choice of the processing method depends on the property requirements, cost consideration and future applications prospects. The advantage of processing composites by casting technology leads to near-net shape manufacturing which is a simple and cost-effective process [2]. Incorporation of hard second phase particles in the alloy matrices to produce MMCs has also been reported to be more beneficial and economical [2,3,7] due to its high specific strength and corrosion resistance properties. In the past, various studies have been carried out on metal matrix composites. SiC, TiC, TaC, WC, B4C are the most commonly used particulates to reinforce in the metal or in the alloy matrix or in the matrices like aluminium or iron, while the study of silicon dioxide reinforcement in LM6 alloy is still rare and scarce.

ISBN 978-967-5742-00-2

However, very limited studies have been reported and so the information and the data available on the mechanical properties and fracture surface analysis are scarce and hence make this study a significant one. In this investigation quartz particulate reinforced LM6 alloy matrix composites test samples fabricated and processed by casting method are chosen [4,5]. So in this research work the parameter of different percentage of SiO2 particulate addition in the LM6 alloy matrix is examined to study the mechanical behavior and fracture surface characteristic used tensile testing of the processed specimens. In this study, tensile testing and Scanning Electron Microscopy are employed to evaluate the maximum load, Young's modulus, tensile strength and to characteristic the morphological features of the fracture surfaces in titanium carbide (TiC) - particulate reinforced LM6 alloy composites after the tensile testing.

Methodology

Materials preparation

The materials used in this work were Aluminium LM6 alloy as the matrix and TiC as reinforcement particulates with different percentages. The tensile test specimens were prepared according to ASTM standards B 557 M-94 [6]. The main materials used in this project were Aluminium LM6 alloy as a matrix material and TiC (titanium carbide) as a particulate reinforced added in different percentages based on weight. Sodium silicate and CO_2 gas is used to produce CO_2 sand mould for processing composite casting. The aluminium alloy, LM6, was based on British standards that conform to BS 1490-1988 LM6.

The mechanical, thermal and electrical properties of LM6 are shown in the Table-1. Alloy of LM6 is actually a eutectic alloy having the lowest melting point that can be seen from the Al-Si phase diagram. The main composition of LM6 is about 85.95% of aluminium and 11% to 13% of silicon. The details of the LM6 alloy composition is shown in Table-2. Titanium carbide (TiC) materials are compounds of a titanium metal and carbon. Metal carbides are also known as hard metals. Metal carbides have high hardness and high hot hardness which makes them useful for cutting tools, forming dies and other wear applications. Metal carbides often used a cobalt, nickel or intermetallic metal bond between grains (cemented carbides) which results in increased toughness compared to pure carbides or ceramics. Titanium carbide is often used as an addition to tungsten carbide cutting tools [8]. The mesh size of titanium carbide particulate is -325mesh 98% and the average particle size equal to 44 microns (µm).

Table 1. The Mechanical, Properties Of LM6

PROPERTIES	VALUES
Density (g/cc)	2.66
Tensile strength, Ultimate (MPa)	290
Tensile strength, Yield (MPa)	131
Elongation %; break (%)	3.5
Poissons ratio	0.33
Fatigue strength (MPa)	130
Machinability	30
Shear strength (MPa)	170
Hardness (BHN)	50
Modulus of elasticity (N/sq.mm)	71000

ISBN 978-967-5742-00-2

Table 2. COMPOSITION OF LM6 (%)

Chemical constituents	wt.%
Al	85.95-87.95
Cu	0.1
Fe	0.6
Mg	0.1
Mn	0.5
Ni	0.1
Pb	0.1
Si	10-13
Sn	0.05
Ti	0.2
Zn	0.1

Fabrication of composites

Only one type of pattern was used in this project and the procedure for making the pattern involves the preparation of drawing, selection of pattern material and surface finishing. Carbon dioxide moulding process was used to prepare the specimens as per the standard moulding procedure. Quartz-particulate reinforced MMCs were fabricated by casting technique. Four different weight fractions of TiC particle in the range from 0.2, 0.6, 1 and 2 %wt are used. An induction furnace was used to melt the aluminium alloy and TiC was mixed in it after the alloys attains the liquid state. The main concern was to maintain the temperature while transferring the molten metal to the mould and hence to ensure the quality of the cast product. The metal handling equipment used to transfer the molten metal also depends on the mould size and quality of cast being cast. Figure 1 and 2 shows the LM6 ingots and processing and LM6 ingot.


Figure 1. LM6 ingots


Figure 2. Casting process

Tensile testing

Tensile test was conducted to determine the mechanical properties of the processed TiC particulate reinforced LM6 alloy composites. Test specimens were made according to ASTM standard B557 M-94. Figure 3 tensile Specimen as ASTM standard. A 100 KN servo hydraulic INSTRON 8500 UTM was used to conduct the tensile tests. The test samples were subjected to a tensile load and the mechanical properties were determined. Hence, the tensile strength, and Young’s modulus values

ISBN 978-967-5742-00-2

were calculated. A thin flat material with a constant rectangular cross-section was mounted and gripped in the INSTRON 8500 UTM testing machine and it was monotonically loaded in tension while recording the load. The test coupon strain was monitored for accuracy with displacement transducers where the stress-strain response of the material can be determined and hence the modulus of elasticity can be calculated. Figure 4 and 5 shows the specimens before and after testing.

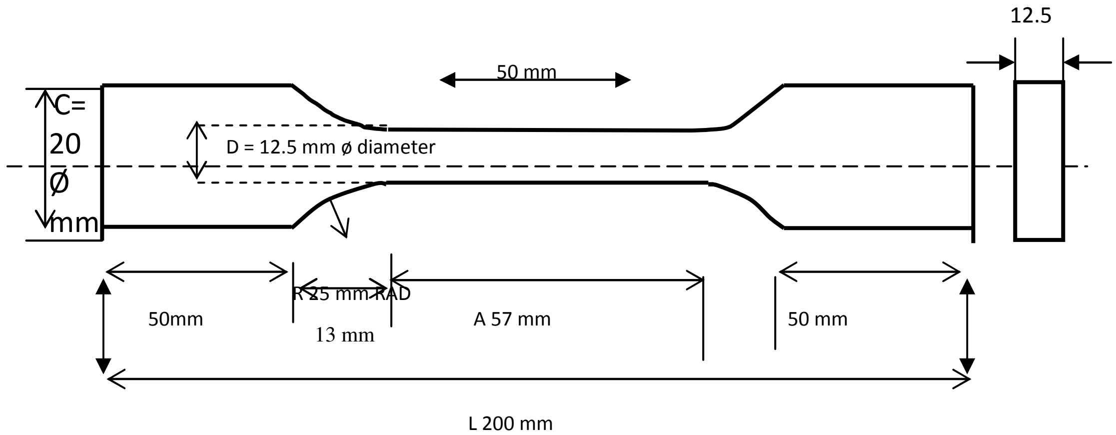

Fig.3. Tensile test specimen

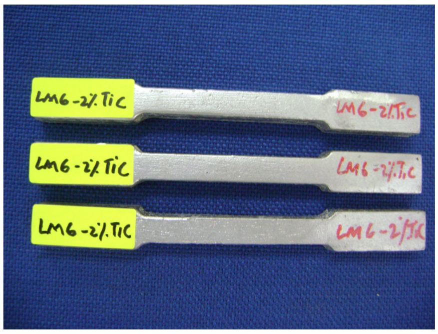

Figure 4. Specimen before testing

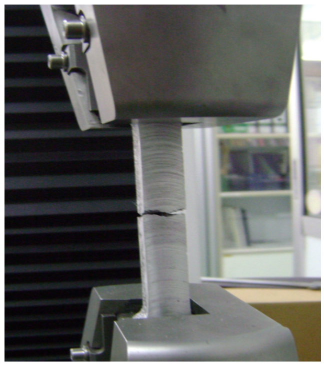

Figure 5. Spesimen after testing

Scanning electron microscopy

Scanning Electron Microscope (SEM) using Hitachi S-3400N variable pressure microscope with Inca 300 Energy Dispersive X-ray (EDX) and model 8500 INSTRON UTM testing machines are used to test the tensile specimens of TiC particulate reinforced LM6 alloy matrix composites and its fracture surfaces are analyzed after tensile testing. Results and data obtained from the tensile tested samples are correlated with the reported mechanical properties for each weight fraction of TiC percentage addition to the LM6 alloy matrix.

RESULT AND DISCUSSION

The tensile testing of the samples was performed based on the following specifications and procedures according to the ASTM standards.

ISBN 978-967-5742-00-2

Type of testing : Tensile test
Crosshead speed : 2.00 mm/minute
Grip distance : 50.000 mm
Specimen distance : 50.000 mm
Temperature : 24^0 C

The Table 3, shows the effect of TiC on tensile strength and young modulus of the composite. The tensile properties of the LM6/TiC MMC for four different weight fractions at ambient temperature reveals an increases in tensile strength and modulus with increase in reinforcement content in the LM6 alloy matrix. The graph plotted between the average tensile strength and modulus or elasticity values variation in percentage weight of TiC particulate addition to LM6 alloy indicated that both the properties increases with increase of TiC particulate. The increases of tensile strength and young modulus of the TiC particulate reinforced LM6 alloy composite with increased addition in weight fraction of TiC particulate is explained as follow with reference to the Figure 6 and 7. The increase in tensile strength may be due to the TiC particles acting as barriers to dislocations in the microstructure. This dislocation increases the dislocation density, which provides a positive contribution to strength of the composite. This result was well supported and evidenced from the literature citation [9,10].

Table 3. Tensile properties of MMC containing various amounts reiforcement content.

wt% of TiC	Tensile Strength (MPa)	Young modulus (MPa)
0	116.0743	1881.246
0.2	123.9025	7011.749
0.6	130.9343	1935.583
1	133.9486	1876.223
2	135.8325	5853.59

The examine fracture surface of an LM6 matrix composite surfaces exhibit a brittle cleavage fracture mechanism. The fracture surface of the grain refined composite showed broken Aluminium and TiC particles (Figure 8 - 12) and well-attached particles within the dimples, indicating rather good interface cohesion between matrix and reinforcing particles.

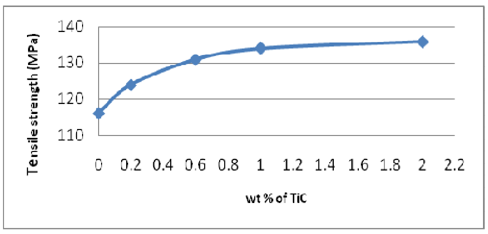

Fig. 6 Average tensile strength versus weight fraction of TiC

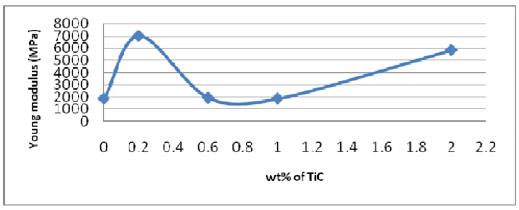

Fig. 7 Average young modulus versus weight fraction of TiC

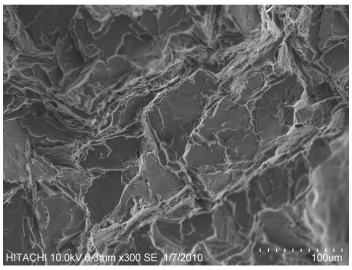

Fig. 8 Fractograph of LM6 at Fractograph of LM6 at 300X magnification

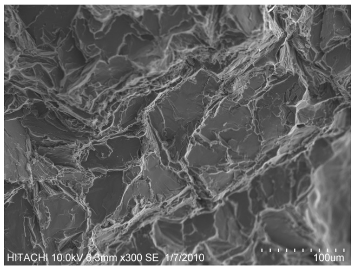

Fig. 9 Fractograph of 0.2% TiC in matrix composite at 300X magnification

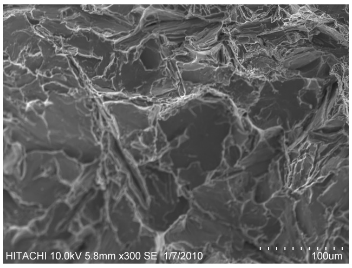

Fig. 10 Fractograph of 0.6% TiC in matrix composite at 300X magnification

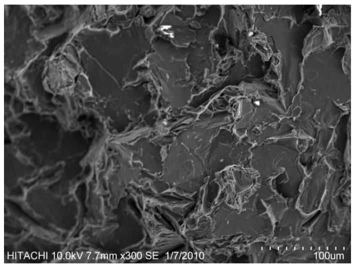

Fig. 11 Fractograph of 1% TiC in matrix composite at 300X magnification

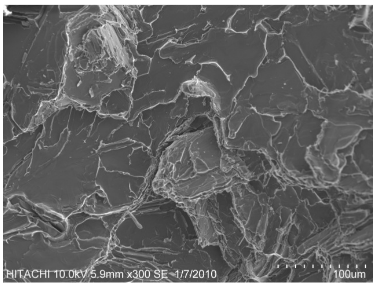

Fig. 12 Fractograph of 2% TiC in matrix composite at 300X magnification

Conclusion

In this experimental study, quantification of strength, Hardness and fracture surface morphological aspects of quartz-silicon dioxide particulate reinforced LM6 alloy matrix composites test specimens after tensile testing are described. Based on the experimental evidence from this research work the following conclusions are drawn:

1. The split tensile strength and young's modulus values increased gradually as the titaniumcarbide content in the composite increased by weight fraction. The reason for this mechanical behavior is due to the dominating nature of the compressive strength of the Titanium carbide particulate reinforced in the LM6 alloy matrix.

2. The hardness value of the silicon dioxide reinforced LM6 alloy matrix composites is increased with the increased addition of titanium carbide particulate in the matrix and it is well supported.
3. The mechanical behavior of the processed composite had a strong dependence on the weight fraction addition of the second phase reinforcement particulate on the alloy matrix

Acknowledgment

The authors would like to express their deep gratitude and sincere thanks to the staff and laboratory technicians of the Department of Mechanical and Manufacturing, Universiti Putra Malaysia for their help with the experiments.

References

1. K. C. Ramesh and R. Sagar, Fabrication of Metal Matrix Composite Automotive Parts, Int J Adv Manuf Technol (1999) 15:114–118
2. A.Burr, J.Y. Yang, C.G. Levi and F.A. Leckie, The strength of metal matrix composite joints, Acta metallurgica et materialia Pergamon Press, 43/9 (1995) 3361-3373.
3. A.J. Clegg, Precision casting processes, pergamon press 1991.
4. A.K. Kau, Mechanics of composite materials, CRC Press Boca Raton, New York, USA, 1997.
5. A.L. Kheng Hooi, Thermal analysis of two and three-gate sand casting mould, Thesis Master UPM 2001.
6. American Society for Testing and Material, Annual Book of ASTM Standards, USA, 1999.
7. Chadwick, G. Production, properties and applications of metal matrix composites, Developments in the science and technology of composite materials, ECCM4, Fourth European Conference on Composite Materials, 1990.
8. Global spec, http://www.globalspec.com/reference/3769/Titanium-Carbide-TiC, march 10, 2010.
9. D.D.Himbeault, R.A.Varin and K.Piekarski, "Tensile properties of titanium carbide coated carbon fibre-aluminium alloy composite' butterworth & co Publisher LTD, Volume 20, number 5, september 1989.
10. Woei-Shyan Lee and Wu-Chung Sue, "Dynamic Impact and Fracture Behaviour of Carbon Fiber Reinforced 7075 Aluminum Metal Matrix Composite" Journal of Composite Materials 2000 34: 1821-184

M. Sayuti was born on August 30, 1972 in Luengdaneun, Matang Glumpang Dua, Bireuen, Acheh- Indonesia. He obtained his Bachelor's degree in Industriall Engineering, Universitas Malikussaleh Lhokseumawe Aceh - Indonesia and Master in Mechanical Engineering, Universiti Putra Malaysia. And now is a PhD student of Mechanical Engineering, Universiti Malaysia Putra. His current specialization is in the field of Metal Matrix Composite (MMC).