The Development of Characterization of Silicon Carbide Reinforced Aluminium Alloy Lm 12 Metal Matrix Composite

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ABSTRACT - Aluminium and aluminium amalgam segments use has been expanded in car ventures because of its light weight and furthermore of their remarkable mechanical, physical and tri natural attributes over different materials. These properties are gotten by expansion of alloying components. Albeit a few throwing innovations are accessible to make such aluminium amalgams, High mach failure and usefulness of aluminium combinations are influenced by porosity development because of gas entanglement in the softening practices. Of the many throwing procedures that are accessible, crush throwing has higher bit of leeway to create the pore free part. Crush throwing (SC) is a nonexclusive term to indicate a manufacture system where cementing is advanced under high weight with a re-usable kick the bucket. Anyway in this procedure, present investigation centres around the creation of the LM6 aluminium compound and furthermore LM6 aluminium combination with fluctuating copper content by utilizing the crush throwing.

Keywords – Crush throwing, LM6, SC.

I. LM6 ALUMINIUM ALLOY

LM6 is a corrosion resistant aluminum casting alloy with average durability and strength, and with high impact strength and ductility. Applications: general, electrical, marine, intricate shaped castings, and building cladding panels.

1.1 LM6 Aluminum Casting Alloy (Al – Sil2)

LM6 alloy is essentially a hypoeutectic Al-Si alloy (typically consists of 11.5wt% Si, less than 12.6wt% Si of eutectic composition) with low copper content to impart it the excellent property of corrosion resistance under both ordinary atmospheric and marine conditions. The LM6 alloy possesses exceptional fluidity so that it is capable of producing intricate castings of thin sections. It is also resistant to hot tearing when cast in sand or chilled moulds throughout a wide range of temperatures. LM6 is especially suited to castings that need to be welded although special care is needed when machining. Carbide-tipped tools with large rake angles and relatively low cutting speeds give comparatively good machining results provided cutting lubricant and coolant are employed in the machining process. Some of the applications of LM6 alloy are marine on-deck castings, water-cooled and inlet manifolds, motor housings, doors, chemical equipment, dye and food equipment, and tools. The inferior mechanical properties of this type of structure make modification of Al-Si based casting alloys necessary. Modification is meant to change the shape of the silicon phase from flake to fibrous. Changing the morphology of eutectic Si from its original coarse acicular structure to a finer fibrous structure will enhance the mechanical properties of Al-Si castings significantly. In general, modification can be achieved by rapid solidification (quench solidification) or impurity modification (chemical modification). The ubiquitous modifier used in foundry industry is Al-Si master alloy that contains ~10wt% of strontium. Besides modification, grain refinement of Al-Si alloys is also a major treatment encountered in foundries. Grain refinement plays a vital role in cast and wrought aluminium alloys in terms of eliminating the associated defects caused by coarse columnar grain structure. Such defects are exemplified in reduced fabric ability, yield strength and tensile elongation to fracture; hot cracking is severe in the shell zone of a continuously cast ingot as well. Achieve the desired quality of LM6 sand casting through proper mould design, determination of appropriate casting modulus and process parameters.

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PROBLEM DEFINITION

Aluminum alloys are broadly used as a main matrix element in composite materials. Aluminum alloys for its light weight, has been in the net of researchers for enhancing the technology. The broad use of aluminum alloys is dictated by a very desirable combination of properties, combined with the ease with which they may be produced in a great variety of forms and shapes. Now a day the light weight composite material is Widely used in engineering field. The composite material has good characteristic of hardness, resisting wear resistance and tensile strength due to good strength and less weight the composite material play a vital role in engineering field. Discontinuously reinforced aluminum matrix composites are fast emerging as engineering material sand competing with common metals and alloys. They are gaining significant acceptance because of higher specific strength, specific modulus and good wear resistance as compared to ordinary unreinforced alloys.

METHODOLOGY

The methodology followed in our project begins from the identification of the problem followed by the surveying of various literature journals. After completing the survey the required LM6 Aluminum alloy material is selected for the squeeze sand casting process. Then the material testing is done for the LM6 Aluminum alloy with varying copper content in it. The Tensile test, Hardness test evaluation is done for the sand casted material and the result is analyzed.

OBJECTIVES

To produce Aluminum LM6 alloy by sand Casting Process.

To fabricate Aluminum LM6 alloy with varying copper content by using sand casting process**.**

II. LITERATURE REVIEW

- **[1]Udhaya Chandran RM, [2]Umesh B, [3]Karthick A, [4]Shabarinathan K T. al [2016],** A Study on Mechanical Properties on Lm6 Aluminium Alloy by Varying Magnesium (Mg) Content Using Stir Casting, Aluminum and aluminum alloy components usage has been increased in automotive industries due to its light weight and also of their outstanding mechanical, physical and tri biological characteristics over the other materials. These properties are obtained by addition of alloying elements. Although several casting technologies are available to manufacture such aluminum alloys, High mach inability and workability of aluminum alloys are affected by porosity formation due to gas entrapment in the melting practices. Of the many casting techniques that are available, squeeze casting has higher advantage to produce the pore free component. Squeeze casting (SC) is a generic term to specify a fabrication technique where solidification is promoted under high pressure with a re-usable die. However in this technique, present study focuses on the fabrication of the LM6 aluminum alloy and also LM6 aluminum alloy with varying magnesium content by using the squeeze casting.

- **AnjumAnwarShaik, Shamanth.T, Syed Mohsin, Zamran Lateef Baig. Al [2017],** The Study of Mechanical properties of LM6 Reinforced with Albite Particulate Composites and fabricated by Chill Casting Method. The study is intended to investigate mechanical properties of LM6 based metal matrix composite, where Albite particulates are character enhancing reinforcement. Composites were fabricated by chill casting process utilizing copper as a chill. Specimens were prepared as per ASTM standards at different weight percentages of Albite varied from 0 to 12 with increment of 3. The microstructure study clearly indicates uniform distribution of Albite particulate in matrix alloy. These results revealed that increase in weight percentage of Albite as reinforcement in LM6 matrix alloy increases the tensile strength, compressive strength and hardness giving rise to improved microstructure of composite.

- **Akhil. RȦ, J. David RathnarajȦ and S. SathishȦ** al. [2014], Study on Mechanical and Microstructure Properties of LM6 Metal Matrix Composite with PbO Glass Reinforcement, In this study, the metal–matrix composites of an aluminum–silicon based alloy (LM6) with Lead oxide glass particles with % addition of 2.5%, 5%, 7.5%, and 10% were produced using a sand casting technique. The variation in composition, hardness, tensile strength and microstructure properties were examined. The change in volume of Silicon and lead content was examined in the spectroscopic analysis. The tensile strength and hardness of the composite increased with increasing the % reinforcement. The microstructure shows the formation silicon dendrites and the dispersion of the glass particle.
- **Santosh V. Janamatti, Ganesh Rao I.N., Rakesh H. Manasa T. Arul Mary A. [2017], al,** Experimental Study on Mechanical Properties of LM6 Metal Matrix Composite with Ti-Boron Reinforcement. LM6 metal matrix composite have been increasingly used in advanced applications like Aerospace, Automobiles and Marine. These composites are subjected to different environmental conditions, hence this work deals with\ producing Aluminium based metal matrix composite and then studying its mechanical properties such as Tensile strength, Impact strength, Shear strength, Torsional strength and Hardness with produced test specimen. In this present study a modest attempt has been made to develop all properties with low cost method of casting technique. Aluminium alloy and titanium-

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boron has been chosen as a matrix and reinforcing material respectively, experiment has been conducted by varying weight fraction of 18% & 20% of titanium-boron.

- **Mr.Prashant Kumar Suragimath, Dr. G. K. Purohit, al [2018], A Study on Mechanical Properties of Aluminum Alloy (LM6) Reinforced with SiC and Fly Ash,** This work deals with fabricating or producing aluminum based metal matrix composite and then studying its microstructure and mechanical properties such as tensile strength, impact strength and wear behavior of produced test specimen. In the present study a modest attempt has been made to develop aluminum based MMCs with reinforcing material, with an objective to develop a conventional low cast method of producing MMCs and to obtain homogeneous dispersion of reinforced material. To achieve this objective stir casting technique has been adopted. Aluminum Alloy (LM6) and SiC, Fly Ash has been chosen as matrix and reinforcing material respectively. Experiment has been conducted by varying weight fraction of Fly Ash (5% and 15%) while keeping SiC constant(5%).
- **Mr.Vijay Kumar S Maga, B S Motag**, al[2014], A Study on Mechanical Properties of Aluminium Alloy (Lm6) Reinforced With Fly Ash, Redmud and Silicon Carbide. This work deals with fabricating or producing aluminium based metal matrix composite and thenstudying its microstructure and mechanical properties such as tensile strength, impact strength and wear behavior of produced test specimen. In this present study a modest attempt has been made to develop aluminium based MMCs with reinforcing material with an objective to develop a conventional low cast method of producing MMCs and to obtain homogeneous dispersion of reinforced material. To achieve this objective stir casting technique has been adopted. Aluminium Alloy (LM6) and Sic, Fly Ash, Red mud has been chosen as matrix and reinforcing material respectively.

III. EXPERIMENTAL PROCEDURE

Aluminum alloy LM6 Ingots were taken and are cut into 500gms approximately. The idea of this work is to improve the tensile strength of LM6 alloy with addition of Cu and Grain refinement and scrap. The L9 series orthogonally array table is chosen. Accordingly all the calculations are done for the addition of Copper Grain refinement and scrap. A total of 9 experiments are done each of different compositions. The copper is added in the form of powder, and then 2%-4% copper powder is calculated and packed separately for each experiment. In the same way 0.4%-0.8% of Grain refinement is calculated and packed separately for nine different experiments. 20%-40% of scrap is taken from the same LM6 alloy and then required amount of scrap is calculated and packed separately for nine different experiments. A spiral pattern is made with the wood. This pattern is used to check the fluidity property. Sand casting process is chosen. The spiral pattern is made in the sand casting and a shaft of 20mm diameter and 200mm length. Now the LM6 alloy was placed in the furnaces. The furnaces we choose are core furnace.

The LM6 alloy is made to melt in the core furnace and then calculated amount of scrap, copper and Grain refinement are added in equal intervals and are stirred well. The temperature of the alloy is measured by using a k-type thermocouple. At 720^0C the melted LM6 alloy with composition is made to mould in the design patterns. The same procedure is done at three different temperatures 720, 750 and 780. At these temperature spiral mould and a shaft mould are prepared. The amount of passage of the melted material in the spiral mould says the amount of fluidity the material process. The shaft mould is used to know the tensile properties and the hardness of the material.

Parameter Destination	Process Parameters	Range	Level 1	Level 2	Level 3
A	Pouring temperature	720ºC-780ºC	720ºC	750ºC	780ºC
B	Addition of scrap	0-40%	0	20%	40%
C	Grain refinement	0-0.8%	0	0.4%	0.8%
D	Addition of Copper	2-4%	0	2%	4%

IV. RESULTS AND DISCUSSION

Following are the tests carried out to check the mechanical properties of LM6 –Titanium boron (LM6-Ti-B) metal matrix composites.

4.1 TENSILE TEST

Tensile strength is a measurement of the force required to pull something to the point before it breaks .Tensile test was done using Universal Testing Machine (UTM) fig 2. The Specimen used as per ASTM E8 standard. The specimen made of LM6 –Titanium boron (LM6-Ti-B) metal matrix composites having 20% titanium boron (LM6-20% Ti-B) is used for tensile test . Fig 3 (a) and (b) shows the specimens before and after tensile testing.

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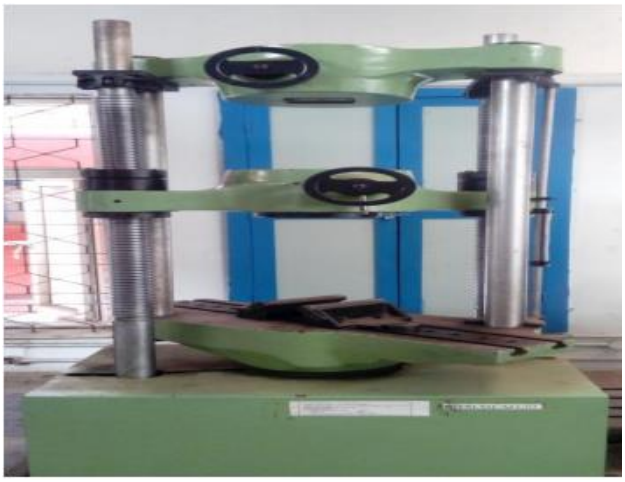

Fig:2 Universal Testing Machine

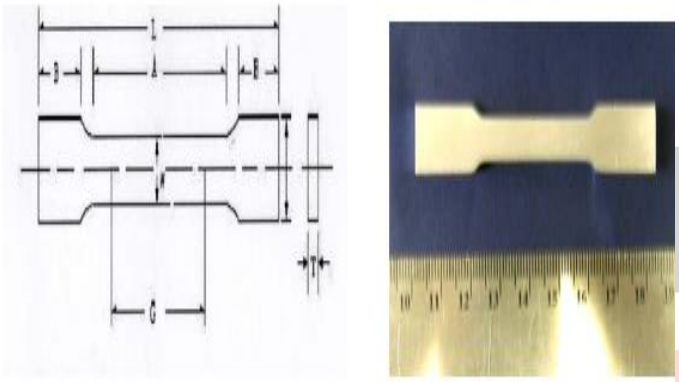

Figure 2Tensile test

G-Gage length: 25±0.1mm W-Width: 6±0.1mm

T-Thickness 6±0.1mm R-Radius of fillet, min: 6mm

L-Overall length, min: 100 mm: A-Length of reduced section: 32mm

B-Length of grip section, min: 30 mm C-Width of grip section: 10mm

Figure 3-5 Schematic illustration of Tensile Test Specimen & machine.

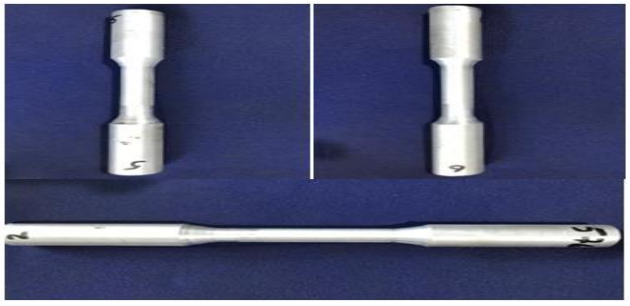

Figure 3 Tensile test specimen

Figure 4 Tensile test break specimen

4.2 Hardness testing

Macrohardness measurements were conducted on the polished AM60 matrix alloy and composites. The Rockwell F scale was used for macrohardness measurement in accordance with ASTM E18-94 standard for both the matrix alloy and composites. Figure 3-6 the macrohardness testing equipment which is Wilson M1CI mode of Rockwell hardness tester.

Figure 5 Hardness test

Figure 6 Hardness test specimens

V. CONCLUSION

Composite of aluminum alloy LM12 and silicon carbide was successfully fabricated by using a stir casting technique and tested. The microstructure of the composite revealed a fairly uniform distribution of silicon carbide in LM12 matrix. Silicon carbide reinforcement enhanced the hardness of the composite. With increasing reinforcement content an increase in hardness was observed. Increase in hardness could be attributed to dispersion hardening resulting from the reinforcement particle aggregate. Following an increase in hardness, an improvement in strength and reduction in percent elongation and reduction of area was noticed. Visual and fact graphic observations on the base metal and the composite revealed dimpled as well as cleavage areas on the fractured surface indicating ductile as well as the brittle mode of failure. Brittle fracture was dominant due to as cast nature of the material. With increasing silicon carbide content brittle fracture became

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still more dominant. The phenomenon could be attributed to increased brittleness of the matrix with the ceramic particle dispersion.

REFERENCES

[1] Udhaya Chandran RM, 2Umesh B, 3Karthick A, 4Shabarinathan K T. al [2016],“ Mechanics of Composite Materials” Taylor and Francis Group, Press 2016) LLC(CRC

[2] 2. AnjumAnwarShaik, Shamanth.T, Syed Mohsin, Zamran Lateef Baig. Al [2017],”Metal matrix composites production by the stir casting method”, Journal of Materials Technology (Elsevier 1999) Vol.92-93, pp 1-7.

[3] Akhil. RȦ, J. David RathnarajȦ and S. SathishȦ al. [2014], Study on Mechanical and Microstructure Properties of LM6 Metal Matrix Composite with PbO Glass Reinforcement

[4] Santosh V. Janamatti, Ganesh Rao I.N., Rakesh H. Manasa T. Arul Mary A. [2017], al, Experimental Study on Mechanical Properties of LM6 Metal Matrix Composite with Ti-Boron Reinforcement. Materials and Design 24 (Elsevier 2003),671-679.

[5] Mr.Prashant Kumar Suragimath, Dr. G. K. Purohit, al [2018], A Study on Mechanical Properties of Aluminum Alloy (LM6) Reinforced with SiC and Fly Ash, Metals Handbook Vol 2 (ASM International1990),592–633.

[6] Mr.Vijay Kumar S Maga, B S Motag, al[2014], A Study on Mechanical Properties of Aluminium Alloy (Lm6) Reinforced With Fly Ash, Redmud and Silicon Carbide Journal of Materials Processing Technology 63 (Elsevier 1997)358-363

[7] B Agarwal and D. Dixit “Fabrication of aluminium based composites by foundry techniques”, Transaction of Japan Institute of Metals Vol 22 (8) (1981)93.

[8] Mr.Vijay Kumar S Maga, B S Motag, al[2014], A Study on Mechanical Properties of Aluminium Alloy (Lm6) Reinforced With Fly Ash, Redmud and Silicon Carbide., Vol. 3(1) (2001),119– 124.

 DOI : 10.35291/2454-9150.2021.0070