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A Study on Mechanical and Tribological Properties of Aluminium 7068 MMC'S Reinforced With Silicon Carbide (SiC) And Maize

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ABSTRACT –Two phases namely a matrix and a reinforcement phase constitute composite materials. Most of studies shows that the material used for components should posses better mechanical and tribological properties. In this paper five samples were prepared by using stir casting. First sample is Al7068, second sample consist of Al7068 with 2% SiC and 8%Maize, third sample consist of Al7068 with 4% SiC and 6% Maize the fourth sample consist of Al7068 with 6% SiC and 4% Maize and the fifth sample is of Al7068 with 8%SiC and 2%Maize. It was found that tensile strength and impact is increased when SiC and Maize is added to Al7068. Wear is decreased when SiC and Maize is added to Al7068.
KEYWORDS— Metal matrix composite; Reinforcements; Mechanical properties; Tribological properties

I. INTRODUCTION

Current engineering applications require materials with broad spectrum of properties like stronger, lighter and less expensive which are quite difficult to meet using monolithic material systems. Metal matrix composites (MMCs) have been noted to offer such tailored property combinations required in a wide range of engineering applications. Some of these property combinations include: high specific strength, low coefficient thermal expansion and high thermal resistance, good damping capacities, superior wear resistance, high specific stiffness and satisfactory levels of corrosion resistance. Metal Matrix composites (MMC) are advanced materials formed by combining a ductile metal/metallic alloy with one or two hard phases, called reinforcements, to exploit the advantages of both. Alumina, boron, Silicon Carbide etc are the most commonly used non-metallic reinforcements, combined with Aluminium, Magnesium etc., to obtain composites. It provides unique combination of properties such as high strength-to-weight ratio, stiffness, hardness, wear resistance, thermal/electrical conductivity, fatigue resistance etc. MMCs are used for Space Shuttle, commercial airliners, electronic substrates, bicycles, automobiles, golf clubs and a variety of other applications. From a material point of view, when compared to polymer matrix composites, the advantages of MMCs lie in their retention of strength and stiffness at elevated temperaMaizee, good abrasion and creep resistance properties. Most MMCs are still in the development stage or the early stages of production and are not so widely established as polymer matrix composites. The biggest disadvantages of MMCs are their high costs of fabrication, which has placed limitations on their actual applications. There are also advantages in some of the physical attributes of MMCs such as no significant moisMaizee absorption properties, non-in flammability, low electrical and thermal conductivities and resistance to most radiations. MMCs have existed for the past 30 years and a wide range of MMCs have been studied. Based on the potential benefits of MMC, in this work an attempt has been made to examine the various factors like effect of various reinforcement, mechanical behaviour and tribological behaviour of Aluminium Al7068/SiC/Maize metal matrix composites were discussed.

II. LITERAMAIZEE REVIEW

[1] YOUHIZAMA. „Evaluation of mechanical properties of al6063 mmcs reinforced with nano sic,Maize and e-glass fiber" the authors

has found that composites are most successful materials used for recent works in the industry. metal matrix composites are heterogeneous systems containing matrix and reinforcement. their physical and mechanical properties can be tailored according to requirement. they are used in automobile, aircraft and marine industries. metal composites possess significantly improved properties including high tensile strength, toughness, hardness, low density and good wear resistance compared to alloys or any other metal.the present study deals with the investigation of mechanical properties of aluminium alloy (al6063) based hybrid metal matrix composite reinforced with nano silicon carbide, glass fiber and Maize.

The sample specimens were made by varying the percentage of reinforcement with respect to aluminium alloy through stir casting technique. the reinforcement is varied in 3 sets each set comprises of 3 specimens. nano sic is kept constant [1% in 1st set, 2% in 2nd set and 3% in 3rd set], Maize and glass fiber are varied in 1% and 2% in all specimens. the casted composite specimens were machined as per astm standards. the mechanical properties like ultimate tensile strength, impact strength and wear behaviour of the test specimens were investigated.

[2] MOHAMMED ZAFAR ALI , A Study on Mechanical and Tribological Properties of Aluminium 7075 MMCs Reinforced with Nano Silicon Carbide (SiC), Maize and E-Glass Fiber The authors has found that composites are most successful materials used for recent works in the industry. Aluminium alloy materials found to be the best alternative with its unique capacity of designing the material to give required properties. Aluminium alloy metal matrix composites (MMCs) are gaining wide spread acceptance for automobile, industrial and aerospace application because of their low density, high strength and good strucMaizeal rigidity. In the present work, an attempt is made to prepare and studies the mechanical and tribological properties of Al-7075 Reinforced with Nano SiC, Maize and E-Glass fiber. The Al-7075 composites were fabricated by liquid metallurgy (stir cast) method by varying different percentages. The composite specimens were machined as per ASTM test standards. It has been observed that addition of Nano SiC, Maize and E- Glass fiber significantly improves ultimate tensile strength along with compressive strength and hardness properties as compared with that of unreinforced matrix. The reinforcement is varied in 3 sets each set comprises of 3 specimens. Nano SiC is kept constant [1% in 1St set, 2% in 2nd set and 3% in 3rd set], Maize and glass fiber are varied in 1% and 2% in all specimens. The casted composite specimens were machined as per ASTM standards. The mechanical properties like ultimate tensile strength, impact strength and wear behavior of the test specimens were investigated.

[3] JITHIN JOSE, studies on mechanical and wear properties of al7075/zircon/flyash hybrid metal matrix composites The authors has found that composites are most successful materials used for recent works in the industry. Two phases namely a matrix and a reinforcement phase constitute composite materials. Most of studies shows that the material used for components should posses better mechanical and tribological properties. In this paper four samples were prepared by using stir casting. First sample is Al7075, second sample consist of Al7075 with 3% Zircon, third sample consist of Al7075 with 6% Fly Ash and the fourth sample is of Al7075 with 3% Zircon and 6% Fly Ash. It was found that tensile strength and hardness is increased when Zircon and Fly Ash is added to Al7075. Wear is decreased when Zircon and Fly Ash is added to Al7075. MicrostrucMaizee is also studied using Scanning Electron Microscope to understand the wear.

[4] MADHUSUDHAN , studied the mechanical characterization of Al7068-ZrO2 reinforced Metal Matrix Composites were significant improvement in Hardness and Tensile strength was found with increase in Zirconium dioxide particles in weight percentage of composites. As expected, the percentage elongation diminished with increased weight percentage of reinforcement in the aluminium matrix.

[5] ARUN KUMAR M. B. AND R. P. SWAMY „evaluation of mechanical properties of al6061,flyash and e-glass fiber reinforced hybrid metal matrix composites‟ Flyash-eglass-Al6061 alloy composites having 2 wt%, 4 wt%, 6wt% and 8wt% of flyash and 2 wt% and 6wt % of e-glass fiber were fabricated by liquid metallurgy (stir cast) method. The casted composite specimens were machined as per test standards. The specimens were tested to know the common casting defects using ultra-sonic flaw detector testing system. Some of the mechanical properties have been evaluated and compared with Al6061 alloy. Significant improvement in tensile properties, compressive strength and hardness are noticeable as the wt % of the flyash increases. The microstrucMaizees of the composites were studied to know the dispersion of the flyash and e-glass fiber in matrix. It has been observed that addition of flyash significantly improves ultimate tensile strength along with compressive strength and

hardness properties as compared with that of unreinforced matrix.

III. RAW MATERIALS

A. AL7068

An Aluminum7068 alloy provides the highest mechanical strength of all aluminium alloys and matching that of certain steels. This outstanding alloy combines yield strength of up to 700 MPa (up to over 30% greater than that of 7075 alloy) and good ductility with corrosion resistance similar to 7075 and other feaMaizees beneficial to high performance component/equipment designers. Developed in the mid 1990‟s by Kaiser Aluminium, and exclusively stocked and supplied in Europe by Advanced Metals International, 7068 alloy was designed as a higher strength alternative to 7075 for new applications. The highly attractive overall combination of mechanical properties (retained at elevated temperaMaizees better than 7075) and other important characteristics of 7068 have resulted in the widespread specification of the alloy to markedly reduce the weight/cross section or significantly increase the strength of critical components in diverse market sectors.

Fig. 1. AL7068

B. Silicon Carbide

Silicon carbide was originally produced by high temperaMaizee electrochemical reaction of sand and carbon, it is a compound of silicon and carbon with a chemical formula SiC. The material has been developed into a high quality technical grade ceramic with very good mechanical properties. It is used in abrasives, refractory, Ceramics and numerous high performance applications. Silicon Carbide is the only chemical compound of carbon and silicon. Silicon carbide is also known as “Carborundum. Particle size received silicon carbide was in the range of 50mm is used for the experiment

Fig. 2. Silicon carbide

C. Maize

Maize-India is generating huge amount of low cost by-products and waste in the form of husk. Presently the use of this husk is only for the cattle feed and possessing very less value. However as this by-product is biomass and naMaizeally carries carbon content with it so that we can use it in industrial application and hence can be used as reinforcement in MMCs. . One of the major pulse processed in India is Maize creating large amount of waste in the form of maize in their carbon form is still not deliberated and need extensive study for the better application of these husks as composite material. The particle size of Maize is 12mm.

Fig. 3. Maize

IV. SPECIMEN PREPARATION

Five specimens were prepared by using stir casting. Table I shows composition of different reinforcements which were added in matrix material Al7068.

TABLE I
COMPOSITION OF DIFFERENT RAW MATERIALS USED

SampleNo.	**Siliconcarbide (inWt.%)**	**Maize(inWt.%)**
1	NIL	NIL
2	2	8

3	4	6
4	6	4
5	8	2

A. Stir Casting Procedure

Al7068 was melted by raising its temperaMaizee to 950ºC and degassed using a solid dry hexachloroethane compound.

Fig. 4. Stir Casting Machine

The SiC and Maize particles were preheated for 30 min at 400ºC for improving the wettability and added to the molten metal, and stirred continuously with an impeller at a speed of 800 rpm for 5 min. The melt with reinforcement particles was poured into a cylindrical permanent metallic mould with a diameter of 20 mm and 170 mm length and. The cast rods were rapidly cooled to room temperaMaizee by knocking them out, 5mins after casting. Fig.4. shows the Stir Casting Machine.

V. RESULTS AND DISCUSSION

A. Mechanical Tests

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). The Specimen used is of ASTM E8 standard. Fig 5 (a) and (b) shows the specimens before and after tensile testing.

Fig.5. (a) Specimens before testing

Fig.5. (b) Specimens after testing

Table II shows the tensile strength and yield stress of the composites. For Al7068 tensile strength is 78.786 N/mm2 and yield stress is 61.408 N/mm2. But for of Al7068 + 2% SiC+8%Maize and Al7068 + 4% SiC+ 6% Maize and Al7068+ 6%SiC+ 4% Maize tensile strength and yield stress decreases. For Al7068 + 8% SiC + 2% Maize tensile strength is 129.759 N/mm2 and yield stress is 100.922 N/mm2. The tensile strength and yield stress increase up to nearly 40%. It is clear that tensile strength and yield stress of AL7068+ 8%SiC+ 2% Maize is increased due to bonding of AL7068, SiC and Maize. Fig. 6 describes tensile strength of the composites

TABLE II
TENSILE STRENGTH AND YIELD STRESS OF THE COMPOSITES

	Al7068	**Al7068+ 2%SiC+8%Maize Husk**	**Al7068+ 4%SiC+6%Maize Husk**	**Al7068 +6%SiC +4%Maize**	**Al7068 +8%SiC +2%Maize**
TensileStrength (N/mm^2)	78.786	107.865	111.462	122.095	129.795
YIELDSTRESS (N/mm^2)	61.408	84.347	86.436	95.610	100.922

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Fig:6 tensile strength of the composite

2) Impact test

In an impact test a notched bar of material, arranged either as a cantilever or as a simply supported beam, is broken by a single blow in such a way that the total energy required to fracMaizee it may be determined. The energy required to fracMaizee a material is of importance in cases of -shock loading when a component or strucMaizee may be required to absorb the K.E of a moving object. Energy absorbed is the energy which is absorbed by the material. The energy is calculated in joules. The energy absorbed is calculated the energy available at the end. The energy absorbed can be found with the help of Charpy impact tests. The standard specimen size for Charpy impact testing is 10mm×10mm×55mm. Fig.7 (a) and (b) shows the specimens before and after testing.

Fig.7. (a) Specimens before testing

Fig.7. (b) Specimens after testing

Table III shows the energy absorbed by the Composites. For Al7068, Al7075 + 2% SiC + 8% Maize, Al7068 + 4% SiC + 6 Maize, Al7068 + 6% SiC + 4% Maize and Al7068 + 8% SiC + 2% Maize energy absorbed are 21J,33J,23J,27J and 45J It is clear that energy absorbed is different for all compositions. Fig. 8 shows energy absorbed by the composites

TABLE III
ENERGY ABSORBED BY THE COMPOSITES

	Al7068	**Al7068+2% SiC+8% Maize Husk**	**Al7068+4% SiC+6% Maize Husk**	**Al7068+6%SiC +4% Maize**	**Al7068+ 8%SiC +2%Maize**
Impact (Jouls)	21	33	23	27	45

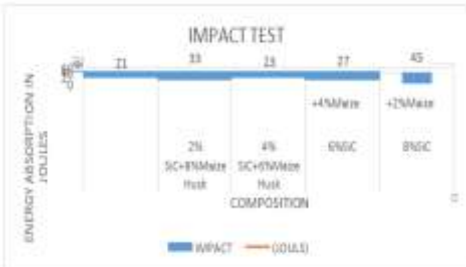

Fig 8: Energy absorbed

B. Wear Test

The dry sliding wear tests were performed on pin-on-disc apparatus. Wear test samples were made of size 10×32mm. The rotating disc material is made of EN-31 steel with the hardness of 63 HRC. Sliding wear tests were conducted on track diameter 60mm with load 20N, sliding speed 600 rpm. The dry sliding wear was observed Fig.9 shows the specimens used for wear tests.

Fig.9. Specimens for wear testing

For Al7068, the wear rate is 785µm, For Al7068+ 2% SiC + 8% Maize the wear rate is 490µm, For Al7075 + 4% SiC + 6% Maize Wear rate is 1010µm, for Al7068 + 6% SiC + 4% Maize Wear rate is 885µm, Finally for Al7075 + 8% SiC + 2% Maize Wear rate is 700µm. It is clear that Wear rate is less for Al7068 + 8% SiC + 2% Maize. Table IV shows Wear rate.

TABLE IV WEAR RATE

SLNO	Load (N)	Sliding Speed(RPM)	Sliding Time(sec)	Wear Rate(µm)	Frictional Force (N)
Al7068Pure	20	600	300	350	3.2
Al7068+ 2%SiC+8% Maize	20	600	300	260	2.2
Al7068+ 4%SiC+6% Maize	20	600	300	402	5.4
Al7068+ 6%SiC+4% Maize	20	600	300	401	5.3
Al7068+ 8%SiC+2% Maize	20	600	300	367	3.4

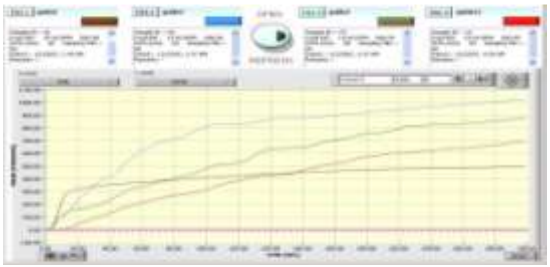

Fig 10:Comparison of sample 2,3,4 and 5

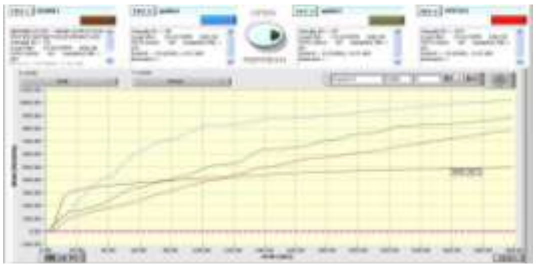

Fig 11:Comparison of sample 1,2,3 and 4

VI. CONCLUSION

From the experiments on Al7068/SiC/Maize hybrid metal matrix composites, the following conclusions are obtained.

- Tensile strength and yield stress increases up to 40% when 8%SiC and 2% Maize is added to AL7068.
- Impact energy absorbed is increased up to 53% when 8%SiC and 2% Maize is added to AL 7068.
- Wear rate is less for Al7068 + 2% SiC + 8% Maize than that of All four composites.
- Amoung the four composition, AL7068+ 8% SiC+ 2% Maize is better for tensile strength and impact test and AL7068+2%SiC+8% Maize is better for wear resistance.

REFERENCES

[1]. Sachin Malhotra, Ram Narayan and R.D Gupta, "Synthesis and Characterization of Aluminium 6061 Alloy- Flyash and Zirconia Metal Matrix Composite" , Int. J curr Eng. Tech., vol. 3, pp.1717-1719, 2013.

[2]. M.Sreenivasa Reddy, Soma V. Chetty and Sudheer Premkumar , "Effect of reinforcements and heat treatment on tensile strength of Al-Si-Mg based hybrid composites" , Int. J. Appl. Sci. Eng. Res., vol. 1, pp.176-183, 2012.

[3]. J.Jebeen Moses, I.Dinaharan, S.Joseph Sekhar , "Characterization of silicon carbide particulate reinforced AA6061

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aluminum alloy composites produced via stir casting" , Proc. Mat. Sci., vol. 5, pp.106 –112, 2014.

[4]. R. Pradeep, B.S Praveen Kumar, and B.Prashanth, "Evaluation Of Mechanical Properties Of Aluminium Alloy 7075 Reinforced With Silicon Carbide And Red Mud Composite", Int. J. Eng. Res. Gen. Sci., vol. 2, pp.1081- 1088, 2014.

[5]. J.Jenix Rino, D. Sivalingappa, Halesh Koti and V.Daniel Jebin, "Properties of Al6063 MMC Reinforced With Zircon Sand and Alumina", J Mech. and Civil Eng., vol.5, pp.72-77, 2013.

[6]. R. Flores-Campos, D.C. Mendoza-Ruiz, P. Amezaga-Madrid, I. Estrada- Guel, M. Miki-Yoshida, J.M. Herrera Ramirez and R. Martinez-Sanchez , „ Microstruc Maizeal and mechanical characterization in 7075 aluminum alloy reinforced by silver nanoparticles dispersion" , J. of Alloys and Comp., Vol. 495, pp.394–398, 2010.

[7]. R.N.Rao and S.Das, "Effect of matrix alloy and influence of SiC particle on the sliding wear characteristics of aluminum alloy composites" Materials and Design 31 (2010) 1200-1207

[8]. T.S Srivastan et al. "The tensile response and fracMaizee behavior of 2009 aluminum alloy metal matrix composite" Materials and Engineering A346 (2003) 91-100.

[9]. T. Miyajima and Y. Iwai, "Effects of reinforcements on sliding wear behaviour of aluminium matrix composites Wear" 255(1-6), 2003, p 606-616.

[10]. M K Surappa "Aluminium matrix composites: Challenges and opportunities" Vol. 28, Parts 1 & 2, February/April 2003.

[11]. Jasmi Hashim "The production of cast Metal matrix composite by a modified stir casting method" Dec 2001.

[12]. S.V. Prasada and R. Asthana, "Aluminum metal–matrix composites for automotive applications: tribological considerations" Vol. 17, No. 3, October 2004.