Experimental Investigation of Wear Characteristics of Aluminum Silicon Carbide Reinforced with Basalt Fibre

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Abstract. Due to light weight and strength, Aluminium is a most widely used engineering material in various industrial and research fields. Aluminium-Silicon is made extremely useful in the area of combination materials in which the most important factor of high strength to weight ratio because the eutectic composition of Al-Si alloys is α and β structures.. Improved mechanical properties intensifying pure metals have proven their ability in Metal matrix composites. Reinforcement can expel the increased tensile and hardness properties of the composites with material mixed in proper ratio. There are different methodologies of fabricating composites like stir casting, liquid infiltration etc., while using these methods with proper parameters. Previous research papers specify better wear resistance and mechanical properties along with co-efficient of friction and dry sliding behavior of Al-Si-fly-ash metal matrix composite Al-Si as base metal in between 2-12% is acceptable. Hardness and tensile properties has been pragmatic in several cases of Al-Si-Fly-ash composites, whose weight percentage of fly-ash goes beyond 10% indicating continuous increment in hardness and tensile properties with certain limitations proposed. To overcome such a problem, it is proposed an addition of basalt fiber in certain weight percentage to test mechanical properties.

Keywords: Aluminium Silicon Carbide, Basalt Fiber, Wear Test, Pin On Disc Tribometer

1 Introduction

Intermetallic compounds or second phases, dissimilar metals are combination of metal matrix composites in which discrete phases are embedded [1]. With practical homogeneous distribution of basalt through stir casting liquid processing, Aluminium alloy and their composites have been effectively developed. Yield strength and ultimate tensile strength of aluminium alloy extensively improved with addition of short basalt when compared with that of unreinforced matrix. The ultimate tensile strength of A7075 with basalt composite when reinforced with 6 % is increased by 65.51% [2]. With increase in load over speed assortment the wear rate also gradually increases with exception of the composite with small particulate size where it fails when sliding exceeds 1m/s. Intricate speed methods would varies wear rate. Depending on the regime, increase in sliding speed may improve or worsen the wear rate[3].

Being there of SiC particles enhances the wear resistance of composites which decrease the predilection for the material flow at the surface and the iron rich layers on the surfaces of composites during sliding. With accumulation of graphite content upto 4%, the wear resistance increases and then decreases gradually[4]. Depending on the various factors such as wettability, boding between matrix, reinforcement consequent in decrease of hardness and wear values. With fortification of short basalt fiber, grain refinement resulted in the improvement of mechanical, damping, tribological and wear properties[5]. Wear rate increases and coefficient of friction decreases with increase in the applied normal load[6]. Experimentally it is evident that increased weight fraction and normal load of Silicon carbide resulted in decrease of wear rate , Coefficient of friction linearly[7].

Metal matrix composite of Aluminium with 15% weight percentage of fly-ash particulates are resistant to wear increases with increase in fly-ash percentage [8]. Silicate particles with fly ash materials were incorporated into aluminium alloy matrix to accomplish reduction in wear resistance and improve the mechanical properties [10]. Aluminium alloy 7075 composites containing short basalt fiber of content ranging from 2.5 to 10 percent by weight resulted significant increases in the ultimate tensile strength, hardness, compressive strength and Young's modulus [9]. Al-4.5%, Cu alloy, fly ash and silicon carbide (SiC) matrix components used as reinforcements which resulted in that there is an increase in hardness and dry sliding wear with increase in the particulates content [11]. Al-Cu particulate composite with the variation of weight percentage of mica reinforcement has high wear resistance and sliding increases upto 15 times [12]. In the present paper focused on the wear characteristics of the Aluminium Silicon Carbide reinforced with Basalt Fiber which minimizes wear rate. The present study deals with the wear characterization of aluminium based hybrid composites developed by stir casting for advanced applications. It has been proposed that application of these composites as secondary reinforcements is explored in wide range for the development of Aluminium Metal matrix composites.

2 Literature Review

From [1] and [3] Wear resistance of SiC reinforced AMCs showed an increase with increasing SiC content in Al matrix. 20 wt. % SiC reinforced AMC showed maximum wear resistance. Wear rate increases with increasing load over a range of speed of Al/SiC group, with the exception of the composite with the smallest particulate size (PM3) where it fails readily when sliding exceeds 1 m/s. Wear rate varies in a rather complex manner with speed. Depending on the regime, wear either increases or decreases with increasing sliding speed. The results obtained suggest that a small particle size leads to inferior high-speed wear resistance, with the composite experiencing extensive melting even when a relatively low load is applied.

From [2] and [9] Aluminium (7075) alloy composites containing different volume fraction of short basalt fibre were successfully developed through the stir casting process. The addition of short basalt fibre significantly improves the yield strength and the ultimate tensile strength of Al7075, when compared with that of unreinforced matrix.

3 Material Preparation

3.1 Material Selection

Al 6061 was chosen as the matrix metal reinforced with silicon carbide SiC powder. Hardness, Ultimate Tensile strength, Sliding wear resistance and Tribological properties of Al-SiC are enhanced with the addition of Basalt Fiber in different weight percentages (5,10,& 15). It is identified that with addition of Basalt Fiber, the above characteristic properties would be increased. The chemical composition Basalt fiber is shown in the below Table 1 respectively:

Table 1. Chemical composition of Basalt Fiber

Element	SiO_2	Al_20_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	Others
Basalt Fiber (%)	51	18	11	5	8.5	3.3	1.5	1.4	0.3	0.16	0.06

3.2 Fabrication AlSiC with Basalt Fiber by Stir Casting method

The matrix composite of Aluminium is reinforced with Basalt Fiber in different weight percentages Al6061 + 10% SiC + % Basalt Fiber (0, 5,10 & 15). The reinforcement is done by Stir Casting Technique. Sample measurements are taken as follows:

Specimen	Al 6061 (g)	SiC	Basalt fiber	Total
Sample 1	900	100	0	1000
Sample 2	855	100	45	1000
Sample 3	810	100	90	1000
Sample 4	765	100	135	1000

The first sample is without any additives, Aluminium matrix composite is melted in crucible muffle furnace with addition of samples with different weight percentage of basalt fiber as mentioned in the table , the molten slurry is stirred for 10 minutes at 400rpm and poured into a cylindrical casting ingot to obtain the required specimens. The dimensions of the round specimens are Ø30 and thickness 25mm as per ASTM standards

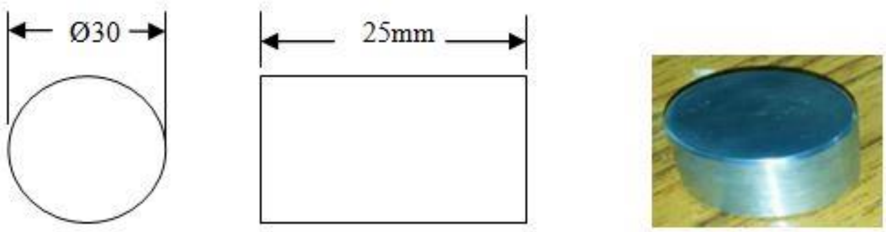

Fig.1. Dimensions of the Specimen

3.3 Wear Test

The wear test conducted for samples having different weight percentages under dry sliding conditions using pin on disc Tribometer under various applied load 2, 4, 6 8 N under the speed of 500 rpm. The wear rate of the specimen is calculated as ratio of wear loss to the sliding distance (W.R= W.L / S.D). The parameters considered are Speed and Load. The results obtianed shows the reduction of wear rate upon with the reinforcement in different samples

4 Result & Discussions

By the wear test the Tribological properties of the specimen were evaluated, the specimens are prepared as per the standards. It is observed that upon with the addition of Basalt fiber reinforced with Aluminium matrix composites with different weight percentages, the wear rate of the unreinforced aluminium matrix is higher than those of the reinforced composites. The graph shown below reveals the behavior of the Al 6061 reinforced with the 10 % Silicon Carbide and different weight percentages of Basalt fiber. The tests were conducted under various load conditions in which the results shows that upon with the addition of different weight percentages of basalt fiber the wear rate decreases. The minimum wear rate obtained at 15% of Basalt Fiber. By observing graph we can conclude that wear rate increases with increase in applying load. In the metal matrix the decrease in the wear rate mainly happens due to the reinforced particles. With the increase in hardness of the material the wear rate decreases The hard particles present in the reinforcement materials minimize the material loss when a metal contact with the moving surface and increases the wear resistance.

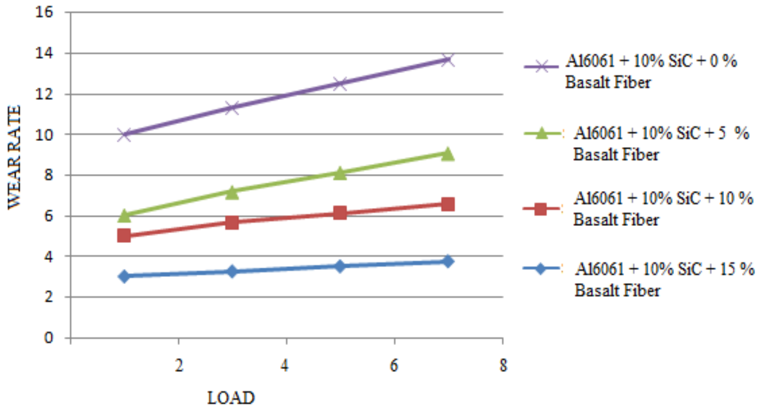

Fig.2. Load Vs Wear Rate

The surface study of the specimen clearly perceptible the bonding between AlSiC and Basalt Fiber. The below figure show the surfaces of the sample specimens of the reinforced matrix composites. Surfaces are represents the stability of basalt fiber are highly stable in the AlSiC are thermodynamically strong enough in the results. Patching shows very less and abrasive has not acted on the worn surface, upon with the addition of basalt fiber.

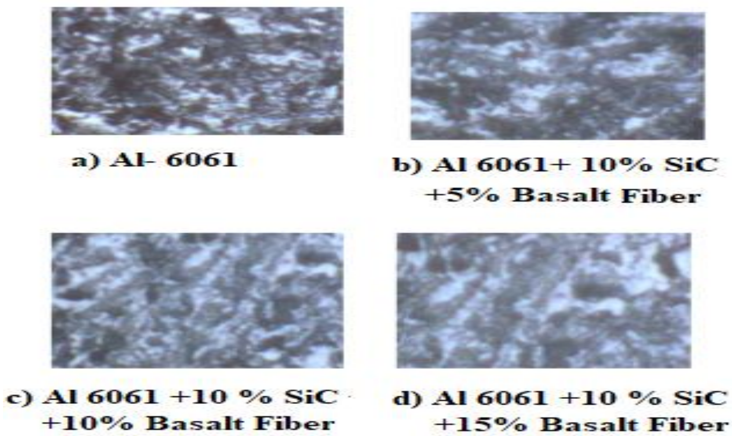

Fig.3. Microstructure of Aluminium matrix reinforced with Basalt fiber at different percentages

The microstructure images of reinforced material clearly shows the uniform distribution of Basalt fiber particles in the Aluminium matrix. The basalt fiber particles improve the mechanical characteristics of the matrix composites. The hardness present in the basalt fiber helps in wear resistance of the material.

5 Conclusions

The experimental study has been carried for the investigation of the mechanical and tribological properties of Aluminium 6061 reinforced with various 10% SiC + % Basalt Fiber (0, 5,10 & 15). The specimen has been fabricated through stir casting technique. Wear test has been carried out for determination of mechanical and tribological properties. It is concluded that wear rate decreases with increase in weight percentage of basalt fiber. Maximum wear rate obtained for 15% of basalt fiber upon with the increase of the applied load the wear rate also increases. The presence of the hard particles minimize the material loss and increases the wear rate. The microstructure images shows the uniform distribution Al 6061 reinforced with Basalt fiber

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