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WEAR CHARACTERISTICS OF AL 6061 REINFORCED WITH COPPER AND ZINC HYBRID COMPOSITE

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Abstract:

The objectives of this work is to be fabricate hybrid composites with the base metal as Al6061 Aluminum alloy reinforced with a different percentage of Volume of copper particulates and Zinc by stir casting manufacturing method. The Specimen for wear analysis prepared as per the requirements of testing. The mechanical properties like tensile strength and hardness will be analyzed and these results will compare with the conventional materials and existing composite material. Suggest the suitable volume proportioned in hybrid composites.

Key words: Hybrid Metal Matrix Composites; Cu, Zn; Al6061; Stir casting; wear analysis,

Reinforcement.

1. Introduction

Metal Matrix Composites are most preferred among the fastest growing families of new materials and have potential properties like more strength, toughness. due to their superior mechanical and Tribological properties .The MMCs are attractive materials for use in structural applications because they combine favorable mechanical behaviors such as better wear resistance and lower thermal expansion Particle-reinforced metal matrix composites (PMMCs) are very promising materials for structural applications due to their isotropic material properties, and metal forming processes to yield the finished products. However, the heterogeneous material systems in various forms of composites, precipitation- hardened alloys, and dispersion-strengthened alloys are not known well their macroscopic indentation responses are affected by the mechanical properties of the matrix and reinforcement material as well as the type of form, aspect, geometric arrangements, and weight fraction ofthe reinforcement. Particulate-reinforced metal matrix composites have paved a new path to produce high strength and high wear-resistant materials by introducing hard ceramic particles and solid lubricant in the metal matrix. Addition of reinforcements such as SiC, B_4C, Al_2O_3, ZrO_2 and TiC, these ceramics improves hardness and thermal shock resistance of the Metal Matrix. Aluminium alloys are mostly applicable in space and automobile industries because of their high Specific strength, modulus and high thermal conductivity. These materials display poor tribological properties that lead to seizure under adverse conditions. Hence there was a need to develop new materials with greater resistance to wear and good tribological properties which ultimately led to the development of aluminium metal matrix composites. A good number of works have been carried out on using SiCp, Al2O3 and soft graphite particles as reinforcements individually. The wear resistance and mechanical properties of MMCs increased with the increase in the content of hard ceramic particles, but the machining property was decreased.

Tjong et al. studied on the addition of a low volume fraction of SiCp from 2-8 vol. % to Al-Silicon alloys. He observed that the significant increase in wear resistance with increase in content of reinforcement.

Miyajima et al investigated the different volume fraction of reinforcements such as SiC whisker of 5-29 %, Al2O3 fibers of 3-26 %, and SiC particles of 2-10 % with Al-2024 matrix materials and investigated the dry sliding wear behavior by using pin-ondisk apparatus. Improvement in wear behavior was observed with reinforcement by particles.

Pramila Bai et al. observed that wear resistance improved with the addition of SiCp when compared with non-reinforced aluminium alloy. The increase of SiCp from 15 to 25 wt. % does not change any mechanisms and only quantitative improvement was observed.

Ravikiran et al. carried out the effect of sliding speed on wear behavior of A356 aluminium reinforced with 30 wt. % SiCp. The wear rate reduced continuously with increasing speed.

Prasad and Asthana reported that reinforcement of aluminum alloys with graphite solid lubricants and hard ceramic particles were used in automotive applications.

2. EXPERIMENTAL SECTION

2.1 Materials

Aluminium alloy, Al6061, was used as a matrix material and its chemical composition is presented in Table1.

Chemical composition of Al6061

%	Cu	Si	Mg	Mn	Fe	Ti	Zn	Al
Elements	0.2	7.2	0.32	0.1	0.20	0.2	0.1	Bal.

The boron carbide particles with size of 23µm and fly ash with average size of 40-90µm were used as the reinforcement materials. The composites were fabricated

Table 2.Reinforcement details

S.no	Matrix	Wt% of Reinforcement one	Wt% of Reinforcement two	Al 6061 Remain
1	Al 6061	2% Cu	3% Zn	95%

2	Al 6061	2.5% Cu	5% Zn	92.5%
3	Al 6061	4% Cu	6% Zn	90%

The composites were fabricated by stir casting method to ensure uniform distribution of the reinforcements. The LM 25 alloy, initially in the form of ingot, which was cut into small pieces then it is placed in the Teflon coated crucible, Aluminum alloy was first melted in an electric furnace. flyash and B_4C, pre heated to a temperature of about 600°C, were added to the molten metal at 850°C and stirred continuously. The stirring was carried out at 60rpm for 10min. Then the preheated reinforcement was poured into a permanent metallic mold. Casting setup is presented in Fig.1

Fig.1 Experimental setup used for stir casting

2.2 Experimental procedure

Wear studies of the composites leads to following discussions. Sample size was 240mm length and 20mm dia. fabricated work pieces are shown in Fig 2.

Fig 2.Fabricated work piece

The sliding Pin-on-disc type Friction and Wear monitor (DUCOM; TL-20) with data acquisition system, which was used to evaluate the wear behaviour of the composite, against hardened ground steel disc (En-32) having hardness 65 HRC and surface roughness (Ra) 0.5 µm. It is versatile equipment designed to study wear under sliding condition only. Sliding generally occurs between a stationary Pin and a rotating disc. The disc rotates with the help of a D.C. motor; having speed range 0-2000 rev/min with wear track diameter 50 mm-180 mm, which could yield sliding speed 0 to 10 m/sec. Load is to be applied on pin (specimen) by dead weight through pulley string arrangement. The system has a maximum loading capacity of 200N. Initially, pin surface was made flat such that it will support load over its entire cross- section called first stage. This was achieved by the surfaces of the pin sample ground using emery paper (80 grit size) prior to test. Run-in-wear was performed in the next stage/ second stage. This stage avoids initial turbulent period associated with friction and wear curves. Final stage/ third stage is the actual testing called constant/ steady state wear. This stage is the dynamic competition between material transfer processes (transfer of material from pin onto disc and formation of wear debris and their subsequent removal). before the test, both the pin and disc were cleaned with ethanol soaked cotton,The vertical height (displacement) of the specimen was continuously measured using linear variable differential transformer (LVDT) of accuracy 1µm during the wear test and the height loss was taken as wear of the specimen.

3. Results and discussion

3.1 Wear characteristics

The wear rate of as-cast hybrid composites was carried out on pin-on-disc technique to verify the wear resistance characteristics, wear rate of as-cast composites as a function of constant sliding speed 286rpm, and applied load varied of 30 N. The difference in the weights of the specimen between before and after the test, gives the weight loss of the specimen. All these experiments were conducted at room temperature.

3.2 Effect of Sliding Distance on Wear Rate

The wear rate increased linearly with the increase in sliding distance. This is due to improper precipitation to form good hardening characteristics in composite and alloy materials. The increase in the hardness and also increase in wear resistance.

Table 2 Test parameters for wear test

Test Parameters	Units	Values
Volume fraction of composites	%	5,10,15
Load (L)	N	30
Sliding speed	Rpm	286
Track dia (d)	Mm	80

3.3 Effect of load and sliding distance on wear rate

The wear rate of the composite specimen increases with increasing sliding distance and load. The fig 3.graphs shows that the reinforced alloy specimen increases more rapidly with applied load compared with the composite specimen. The graph exhibit two regions which is ‘running in’ and ‘steady state’ periods. During running-in period the wear rate increased very rapidly with increasing sliding distance. During steady state period, the wear progressed at a slower rate and linearly with increasing sliding distance. The higher wear rate at the initial stage is due to the adhesive nature of the sample to the sliding disc. The results show that the particulate reinforcement Cu and Zn has a marked effect on the wear rate .The wear rate of the composite specimen decreases with the increasing weight percentage of particulate reinforcement.

Fig.3 Wear rate graph for 5% of Reinforcement

The above graph shows that the percentage of reinforcement B_4C and fly ash increases there is reduction in the percentage of weight loss of the composite material in pin on disc wear tester. The wear resistance increases with the increases in the weight percentage of the reinforcement.

3.4 Effect of sliding time on wear rate

When the sliding time increases respectively the wear rate also increases, we have conducted the experiments with the sliding time of 15min and 10min. the wear rate for the sliding time of 15min leads to the higher wear rate than the sliding time of 10min.Fig 4 shows the wear rate of the composites. If the percentage of reinforcement increases weight loss decreases

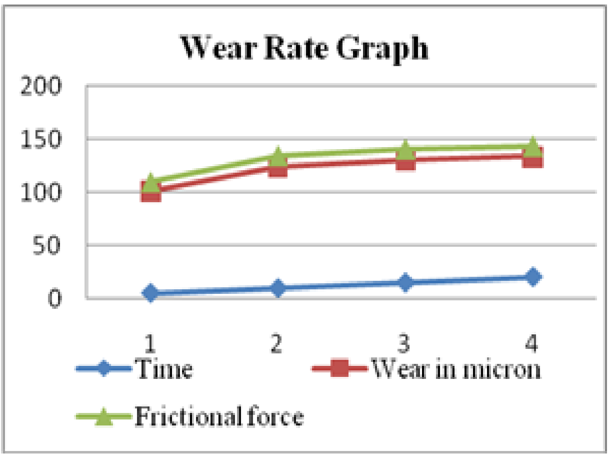

Fig.4 Level of reinforcement and weight loss graph

4. Conclusion

1. As load is increased, the change from mild to severe wear takes place much faster in alloy than composites.

2. The wear rate decreases with increasing volume content of the reinforcement.

3. The coefficient of friction decreases with increase in particle reinforcement and load. The coefficient of friction and wear rate of the hybrid composite are less when compared with the binary composite.

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