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AGEING EFFECT ON SLIDING WEAR BEHAVIOR OF AL-CU ALLOY AND COMPOSITE - A COMPARATIVE STUDY

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ABSTRACT

Work has been carried out to study the effect of alloying element dispersion in the base metal by using composite fabrication technique. Al- 5% Cu particulate composite prepared by stir cast method by dispersing copper powder (filings) in molten aluminium. Sliding wear studies are carried out at homogenized and aged conditions. Results are compared with the alloy having same composition. Composite show better wear resistance compared to the alloy in homogenized condition. Typical behaviour of higher wear is observed with the composite in T_6 (aged) condition. This may be attributed to the formation of alloy during heat treatment. Microscopy corroborates the above results.

Keywords: *Stir Casting, Dispersion, Sliding Wear and Ageing.*

1. Introduction

Al matrix composites are finding wide range of applications in automobile sectors because of higher specific strength and stiffness, good wear and seizure resistance and improved high temperature properties as compared to the virgin alloy. Potential use of these materials is found to be in brake drums, pistons cylinder heads etc. Most of these components are subjected to sliding type of wear in such applications.

Extensive works have been conducted on the sliding wear behavior of aluminum hard particle composites and it has been reported in general that composite exhibits higher wear as compared to the alloy [1-7]. It has been reported by the several investigators that mechanism of sliding wear is associated with formation and removal of oxide layer or mechanically mixed layer as a function of applied load and sliding distance. During sliding wear there is a possibility of mutual transfer of material between the contacting surfaces and this may lead to the increase in counter surface material on the specimen surface.

The present investigation aims in fabrication of metal-metal composite which is chemically in tune with the conventional alloy by dispersing solute metal as particulates, which posses the useful properties of the metal, alloy and the resultant composite. Comparative sliding wear studies are made between alloy and composite with different sample conditions and also for pure Al, pure Cu.

2. Experimental Details

2.1 Fabrication of alloy and composite

Al-5 wt% Cu alloy is prepared by adding EC grade copper in the form of chunks to the IE grade molten aluminium [8]. Copper powders are produced by filing a rotating copper rod at high speeds with different grades of files. Powders are classified by sieving methods. Composite metals are prepared by stir cast technique, adding preheated (200^{0}C) copper powders to the molten aluminium at 720^{0}C [9]. Composite metals with 5, % Cu, by weight, are produced with combination of particle sizes -50 +100 (0.225 microns). Both alloy and the composite are cast into fingers of 150mm X 18mm Φ. Castings are homogenized at 100^{0}C for 24 h.

2.2 Sliding wear studies

Contact sliding wear studies are carried out using Ducom wear Pin on disc apparatus against EN 32 steel disc at 2 kgf load and a sliding distance up to 5 kms. To study the effect of heat treatment on sliding wear, ageing treatment is carried out for both alloy and composite. Ageing at 190^{0}C is adopted. The wear tracks are recorded using SEM.

3. Results and Discussion

Fig. 1(a) and (b) show the optical microstructure of alloy and composite. Alloy shows a well defined dendritic structure, where as composite show a copper particle in aluminium matrix [10].

Fig. 2 shows the sliding wear behavior of pure aluminium, pure copper, alloy and composite. Higher wear can be observed for pure aluminium compared to alloy, composite and pure copper. This behavior is natural as pure aluminium is soft in nature. In case of

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alloy copper dissolved in aluminium showing better wear resistance compared to pure aluminium. As copper particles added as reinforcements in aluminium, composite exhibiting better wear resistance as compared to alloy and pure aluminium. As pure copper is hard very less amount wear loss can be observed, Fig. 2.

Fig. 1 (a) Optical Microstructure of Al-Cu Alloy (100X)

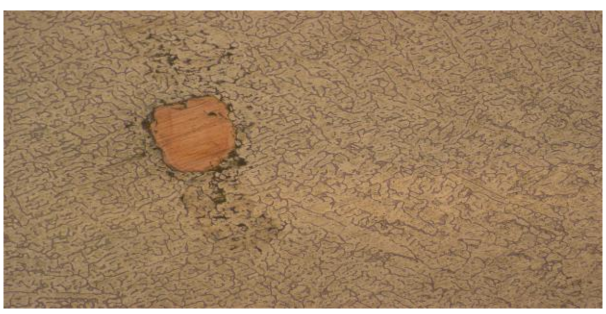

Fig. 1 (b) Optical Microstructure of Al-Cu Composite (100x)

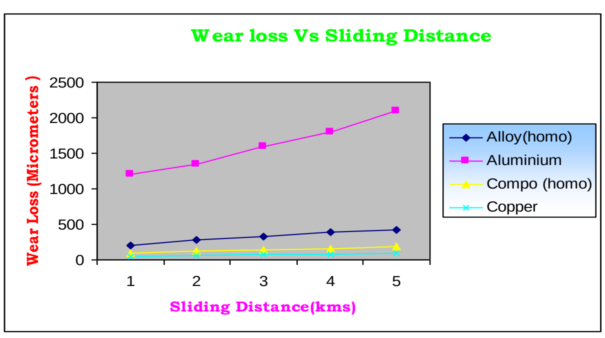

Fig. 2 Sliding Wear Behavior of Pure Copper, Pure Aluminium, Al-5 Cu Alloy and Al-5 Cu Composite

Fig. 3 shows the sliding wear behaviour of alloy in homozenized and aged (T_6) condition. Alloy with aged condition show better wear resistance compared to homozenized condition. Hard and wear resistant interdendritic regions present in as cast structure are eliminated during homogenizing treatment, causing high wear with the homogenized structures.

Fig. 3 Sliding Wear Behavior of Alloy (Homogenized and Aged)

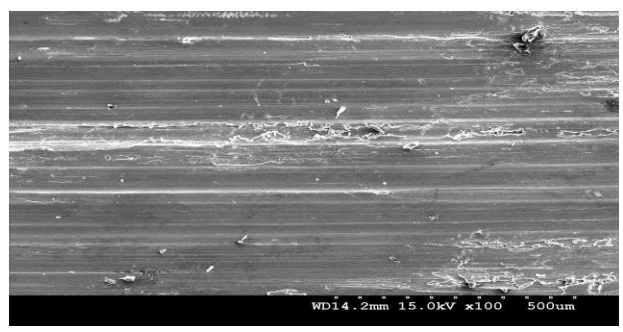

Fig. 4 (a) SEM showing Sliding Wear Tracks of Al-5Cu Alloy (Homogenized) 500 µm

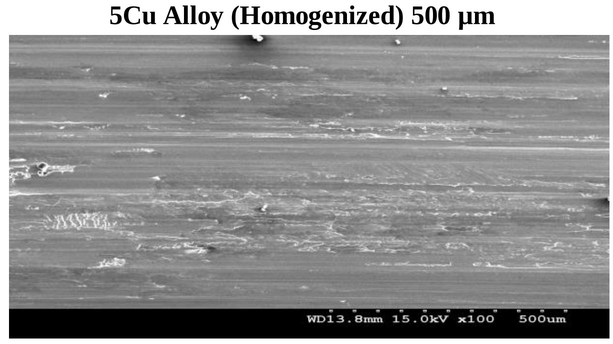

Fig. 4 (b) SEM showing Sliding Wear Tracks of Al-5Cu Alloy (Aged, T_6) 500 µm

Fine, hard, wear resistant and coherent $CuAl_2$ particles present with the aged, T_6 condition enhances the wear resistance of the alloy. Wear tracks of the same are shown in Fig's. 4.a, 4.b. Figure show a damaged wear track in the homogenized condition, which might have occurred due to galling and seizure, while a score free track is observed with the alloy in the T_6 condition, Fig. 4a, 4b.

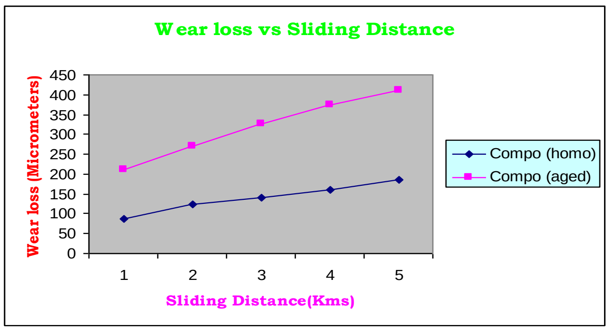

Fig. 5 Sliding Wear Behavior of Composite (Homogenized and Aged, T_6)

Fig. 5 show sliding wear behaviour of composite with homogenized and aged condition. Aged composite show a higher wear compared to homogenized structure. Wear found to be increasing with the sequence of treatment that is homogenized and aged.

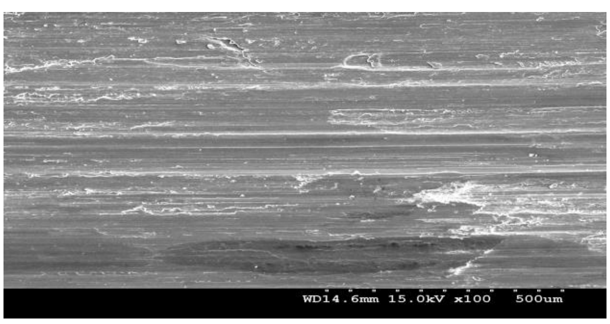

Fig. 6 (a) SEM showing Sliding Wear Tracks of Al-Cu Composite (Homogenized) 500 µm

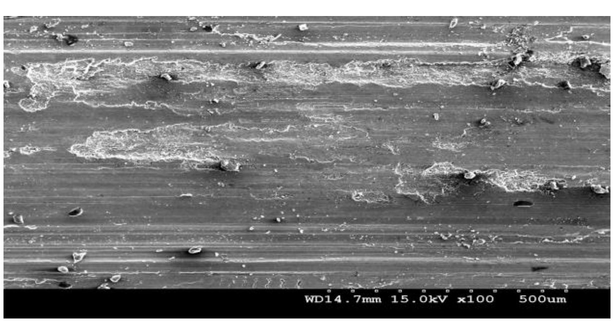

Fig. 6 (b) SEM showing Sliding Wear Track of Al-Cu Composite (Aged, T_6) 500 µm

It is apparent that, as the treatment cycle is increasing, more and more alloying occurs. This results in decreasing tendency of oxidation, formation of alumina layer, which drops the resistance towards wear.

Fig. 6(a) shows the microstructure of the sliding wear track of the composite, showing minimum scored regions where as Fig. 6(b) shows the damaged wear track due to the effect of heat treatment on the composite.

4. Conclusions

Production of metal matrix composites through foundry route is established and very common. In the present work an attempt has been made and proved that METAL-METAL composites can also be produced through conventional foundry technique, with restricted mutual solubility.

The reinforcements (filings) used in the present work for the fabrication of composite are produced through conventional filing technique to get moderately higher particle size.

METAL-METAL composite showing better wear resistance properties than the conventional alloy.

Composite metal observed to be responding to ageing treatment, resulting in decreased wear resistance.

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