Effect of Addition of Graphite on Tribological Behaviour of Sic and Fly Ash Reinforced Copper Based Self-Lubricating Composites

P. Balamurugan, M. Uthayakumar

Abstract - In the present study 4 different combinations of composites are prepared with varying proportions of graphite content by keeping the same proportion of copper, SiC and Fly ash through powder metallurgy process. hardness, Microstructure and tribological properties are studied with varying sliding velocities(1, 2 & 3m/s) and loading conditions (10, 30 and 50N). The addition of graphite reduces the hardness, but the wear behaviour is enhanced with its addition.

Keywords : Copper, Flyash, SiC, Composite

I. INTRODUCTION

Friction in the mating surfaces is the major problem in machine components, in order to reduce the friction lubrication is provided between the mating surfaces. The lubrication in the form of liquid or semisolid cannot be used in various conditions such as extreme temperature or pressure, vacuum and radiation etc., under the above circumstances material with self-lubricating property is preferred. Self-lubricating property can be achieved in the metal matrix composites by adding solid lubricants as reinforcements during processing of composites. Soft reinforcement materials such as graphite[1], molybdenum di-sulphide[2] and carbon nano tubes[3] having the self-lubricating characteristics are added in the metal matrix to reduce the friction coefficient. Generally, materials with high hardness such as SiO_2[4], SiC[5], Fly ash[6], B4C[7], WC[8] and TiC[9] are added to the matrix to reduce the loss of material from the surface, but the addition of above reinforcements to the metal matrix based on aluminium or copper increases the coefficient of friction which may lead to greater noise at higher loading conditions. The addition of solid lubricants along with the oxide or carbide reinforcements reduces the coefficient of friction[10]. In the present study, the tribological properties of the composites prepared with constant reinforcement proportion of silicon carbide, fly ash with different proportions of graphite on copper matrix is studied.

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II. MATERIALS AND METHODS

Copper with 99.7% purity is mixed along with 5%(vol.) of Sic and 5%(vol.) of Fly ash is used as the base proportion. In addition to it, graphite with varying volume proportions of 1%, 2% and 3% is used to form different composites. The average particle size of the copper, SiC, fly ash and graphite are 30µm, 50µm, 10µm and 100µm respectively. The composites were prepared by powder metallurgy technique, in which the compaction pressure is considered as 450MPa for compaction of the materials after blending the powders of Cu, SiC, Fly ash and Graphite manually in a mortar. The green specimen was sintered at 900°C for 60 minutes[11]. Microstructure of the prepared composites is analysed using optical microscopy and the hardness is measured using vicker's hardness tester for a load of 0.5kgf. Tribological tests were conducted for loads of 10N, 30N and 50N for the sliding velocity range of 1-3m/s in steps of increase of 1m/s. Wear tests were conducted on pin on disc setup to find the friction coefficient and wear rate under the stated loading and sliding velocity conditions

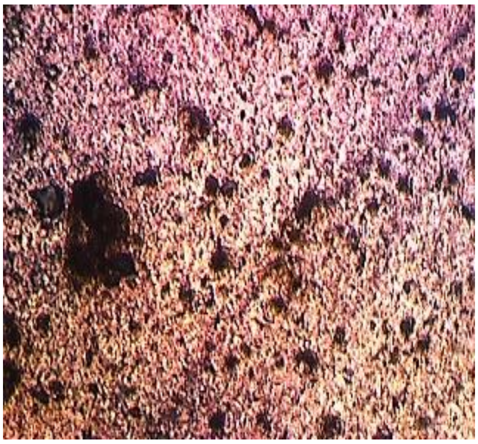
III. RESULTS AND DISCUSSION

Microstructure of the composites prepared is shown in the Fig. 1. Microstructural results as shown in fig. 1indicates that with the rise in graphite content, more agglomeration of the graphite is witnessed due to its soft nature. The hardness test results are shown in the Table - I. It is noted that there is a drastic downfall in the hardness value with addition of graphite content.

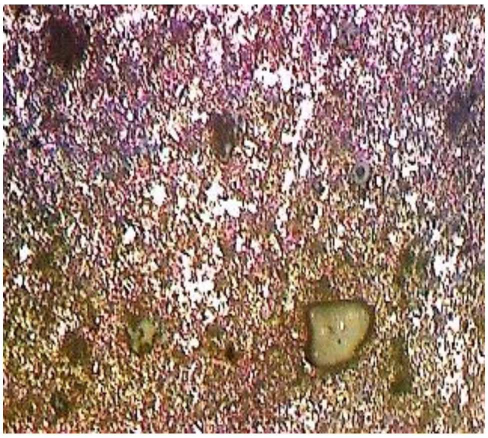
Table - I. Vickers hardness test results

Sample	Hardness measured in HV
Composite with no graphite	60
Composite with 1% of graphite	52
Composite with 2% of graphite	45
Composite with 3% of graphite	38

Results of the tribological test is shown in Fig. 2. From the results it is noted that as the sliding velocity rises from 1m/s to 3m/s for all combinations of composites the wear rate decreases, this might be due to the formation of thin lubrication layer due to plastic deformation of the graphite, as the load increases the film formation breaks and the bare metal comes in contact with the counterpart which increases the wear volume removed from the material being tested.



a. No Graphite



b. 1% Graphite

c. 2% Graphite

d. 3% Graphite

Fig. 1. Optical micrographs of the composite with varying graphite content: (a) no graphite, (b) 1% Graphite, (c) 2% Graphite and (d) 3% Graphite

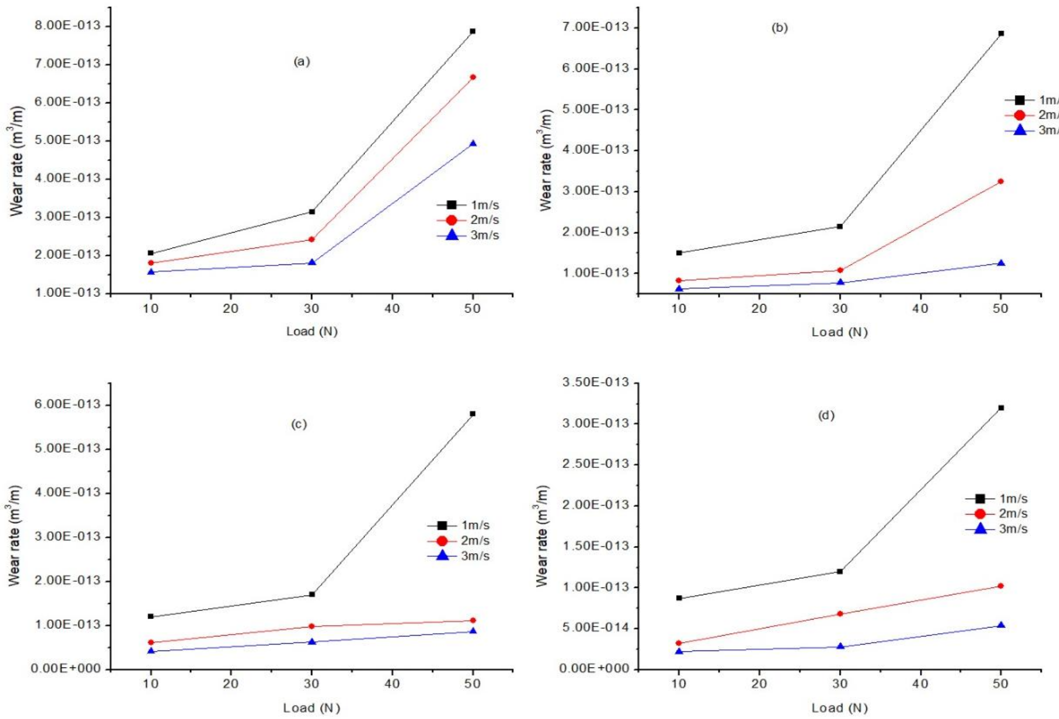


Fig. 2. Wear studies under varying sliding velocities for the composites with (a) no Graphite, (b)1% Graphite, (c) 2% Graphite and (d) 3% Graphite

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IV. CONCLUSION

- Hardness of the composite reduces with the rise in graphite reinforcement to the composite due to its soft nature
- Addition of graphite content to Cu-SiC-Fly ash composite decreases the wear rate due to formation of lubrication layer over the sliding surface
- The wear rate of the composites irrespective of the combination increases with the increase in load

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