International journal of basic and applied research
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)
Cosmos Impact Factor-5.86

Optimization of Machining Parameters for Composite Copper Fly Ash Alloys

[1]Amarthaluri Vamsi Krishna, [2]Prof.Dr.D.Venkat Rao
[1](B.Tech Student),Dept of Mechanical Engineering, St.Peter's University, Avadi, Tamil Nadu - 600077
[2]Professor, Dept of Mechanical Engineering, St.Peter's University, Avadi, Tamil Nadu - 600077

Abstract:
Copper alloys have a good strength but the copper is soft and not suitable for hard application such as cutting tool. Due to the limitation on properties of copper alloy, it is vital to embed it with others hard materials. Among hard material which include metal and ceramic, tungsten carbide has attractive features to combine with copper alloys such as hardness and wear resistance. The present work is focused on the preparation of copper fly ash composite through powder metallurgy technique and performance studies of the composite prepared in some of the physical and mechanical properties, wear and corrosion behavior. The influence of various processing parameters such as compaction pressure, sintering temperature and sintering time on the composite prepared with reinforcement of2.5, 5, and 7.5 wt. % were studied based on design of experiments. The combination of processing parameters and reinforcement percent is identified through design of experiments, the output responses namely green density, sintered deity, relative density, Vickers hardness and compression strength was found out by experimentation. Wear studies were carried out using pin on disc setup as per ASTM G99-2010. The wear test was carried out in the load range of 10-50N for the sliding velocity of 1, 2 and3m/s Corrosion studies also performed on the composites prepared with varying proportions of flyash (2.5, 5, and 7.5 wt.%). Corrosion behavior was studied on the basis of results obtained through potentio dynamic polarization studies and it is was found that the corrosion rate decreases with the increase in fly ash content addition to the copper matrix.

*Key words: **Keywords: ANSYS, Flyash,Vickers, density, ASTM, Copper matrix, Corrosion.***

I. INTRODUCTION

Copper is mostly used industrial and functional metal for thermal and electronic packaging, electrical contacts and resistance welding electrodes as it has very good electrical and thermal conductivity. During the operation of a large class of electrical machinery one is faced with the problem of transferring electric current from a stationary conductor to another conductor moving relative to it. The chief method of current transfer used today is that in which one conductor slides on the other, the current being transferred across the sliding interface. This form of contact at once imposes a conflict of requirements; on the one hand a large contact force is desirable to maintain effective current transfer, whilst on other hand it is advisable to have as small a contact force as possible in order to reduce the wear of the sliding components.

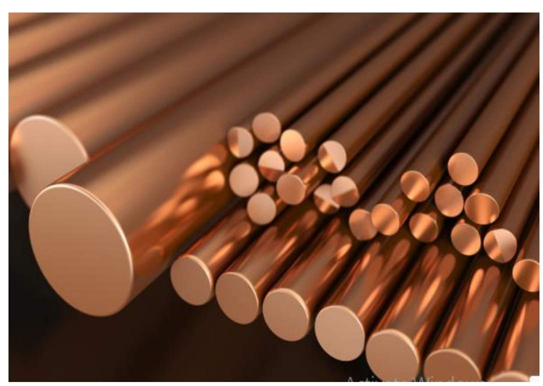


Figure1: Copper Alloys.

Two of the main problems associated with the operation of sliding contacts are the transfer of current across the sliding interface and the wear of the material. These two problems cannot be treated in isolation from one another; not only is the rate of wear

International journal of basic and applied research
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)
Cosmos Impact Factor-5.86

clearly dependent upon the current passing but the manner in which the contacts wear can, in certain circumstances, influence the mode of current transfer. Copper–graphite particulate composites possess the properties of copper ,i.e. excellentthermal and electrical conductivities, and properties of graphite, i.e. solid lubricating and small thermal expansion coefficient. Copper matrix containing graphite are widely used as brushes, and bearing materials in many applications due to the excellent thermal and electrical conductivities, and the favorable self-lubricating performance. Copper-graphite with low percentages of graphite is also used for slip rings, switches, relays connectors, plugs and low voltage D.C. machines with very high current densities. For lower current densities and better cooling conditions, higher percentages of graphite are also used because of their lower wear rate. It has been reported that the addin of solid lubricant particles into a metal matrix improves not only the anti- friction properties, but also wear and friction properties. Most of the bearing alloys that are presently used contain a soft phase like lead, which give the required anti-friction property. Due to its harmful effects, restrictions have been imposed on the use of lead. This has prompted researchers to find alternative materials, which impart tribological properties similar to those of lead. Certain metal matrix composites (MMCs) containing soft particles have been investigated for tribological properties. These MMCs have not only reduced friction but also lead to reduced wear of the counter face. Faced with all these challenges like low mechanical properties of pure Cu, Cu based alloys and harmful effects of Pb, a suitable alternative material copper-graphite metal matrix composite has been developed in the present investigation.

1.1 Objectives of the Work:

- To prepare composites withcopper as matrix and fly ash with varying percentage as reinforcement through powder metallurgy technique.
- To study the influence of various Optimal parameters on physical (density) and mechanical properties (hardness, compression strength)
- To study the wear behavior of the prepared composites for different reinforcement percentage under various sliding velocities and load
- To analyse the wear mechanism through SEM/EDX
- To study the effect of addition of fly ash on corrosion behavior of copper fly ash composite.

II. LITERATURESURVEY

One such reinforcement is fly ash. When the difference in density between the matrix and reinforcement is high, for processing the particulate reinforced MMC, powder metallurgy technique is preferred over other processing methods. It was found that research work on fly ash as reinforcement in copper-based composites through powder metallurgy route is scarce. Friction and wear studies on copper fly ash composite is not yet studied, Corrosion studies on copper fly ash composite is so far not addressed by the researchers and hence this work is proposed.

[1] Abhik, R., Umasankar (2014) Copperis having higher thermal conductivity, which is important property required for making components require fast heat dissipation, however the properties such as high deformability and low strength makes the copper as not suggested for many industrial applications to increase the strength, wear, and frictional resistance, an additional reinforcement is essential to be added to the copper matrix. Copper based composites are commonly used in electrical and thermal based applications

[2] Ahmad, F., Lo, S. H. J (2013) reported in their study that high electrical conductivity and excellent lubrication properties makes the copper –graphite composites can

International journal of basic and applied research
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)
Cosmos Impact Factor-5.86

be used to manufacture for sliding contacts.

[3] Ahmad, F., Lo, S. H. J(2014) reported that copper-based composites have applications in making components like connectors, electrodes for spot welding processes, lead wires and other electronic components because of exclusive property combination of strength and conductivity at high temperatures.

[4] Alaneme, K. K., & Odoni (2016) elaborated that copper-based composites made by powder metallurgy is commonly used for making components like bushes and bearings. Copper tin composites have been developed tomake self – lubricating bearings working in extreme load and temperature conditions.

[5] Ali, M., Suppiah, B., & Muayaduldeen (2016) investigated the copper – alumina composites prepared through mechanical alloying and ball milling for studying the spot-welding behavior and mechanical properties, their results revealed that mechanically alloyed composite shows good performance on spot welding behavior, since the electrical current is constraining with in small weld region due to higher hardness achieved through mechanical alloying.

[6] Ayyappadas, C., Muthuchamy (2017) reported that the potential use of copper- based composite for the applications such as clutches and brakes and recommended Copper hybrid composites prepared with SiC and Graphite as reinforcements for brake friction applications.

III. METHODOLOGY

Fly ash is used as the reinforcement material. Fly ash is one of there is dues generated in combustion and the fine particles that rise with the flue gases as flue particles. Fly ash is usually referred to the ash produced during combustion of coal. Melting point of fly ash is 1400ºC and its density is 890 kg/m3. The properties of fly ash are low density, high wear and abrasion resistance. Fly ash obtained from Tuticorin Thermal Power Station, India with the average particle size of 10µm is used as reinforcement. The composition oftheflyashobtainedisasfollowsSiO2 -61.75%,Al2O3-25.24%,Fe2O3+Fe3O4 -4.77%, CaO -1.3%,MgO-0.87%.

The morphology of copper and fly ash is obtained through scanning electron microscope that is shown in the Figure from the SEM images it is found out that copper powder is in the form of dendrite structure and fly ash is in the form of hollow sphere.

3.1 Processing Parameters and Design of Experiments

Besides pure copper, composite with (2.5, 5, 7.5 and 10% fly ash as reinforcement) is prepared with combination of varying processing parameters such as compaction pressure (350, 400 and 450 MPa), sintering temperature(700C,800Cand900 C) and sintering time (30, 60 and90min). The design of experiment is carried out with the various control factors and level as shown in the Table3.1. Based on the input parameters namely percentage reinforcement, compaction pressure, sintering temperature and sintering time the output responses such as sintered density, Vickers hardness and compression strength were found out by experimentation. The results of hardness values of composites specimen prepared with 350MPa compaction pressure sintered on the temperature of 700˚C, 800˚C and 900˚C for the time of 30min, 60min and 90min have the reinforcement of 2.5 wt. % fly ash. The results indicated that the hardness value increases asthe sintering temperature increases for all sintering time.

Control factors	Level 1	Level 2	Level 3	Level 4	Level 5
% Of reinforcement	0%	2.5%	5%	7.5%	10%
Compaction pressure (MPa)	350	400	450	NA	NA
Sintering Temperature(°C)	700	800	900	NA	NA
Sintering Time (in Minutes)	30	60	90	NA	NA

Figure 2: Control factors and its optimum levels.

International journal of basic and applied research
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)
Cosmos Impact Factor-5.86

For the composites with other reinforcement combinations (2.5%, 5% 7.5%) also shown similar results except the condition with the sintering temperature 900˚C and sintering time 90 min. The result shows that hardness value of the specimen with the sintering temperature of 900˚C for 90min is lesser than that sintered at 900˚C for 60min. This slight reduction in hardness is due to more exposure of copper matrix during the loading because of more copper diffusion during the sintering providing enough time to cover over the reinforcement. The maximum hardness value obtained for the composite with 2.5%, 5%, and 7.5% fly ash are 142, 152, 161 and 171HV respectively.

Effect on hardness of copper – 2.5 % fly ash composite:

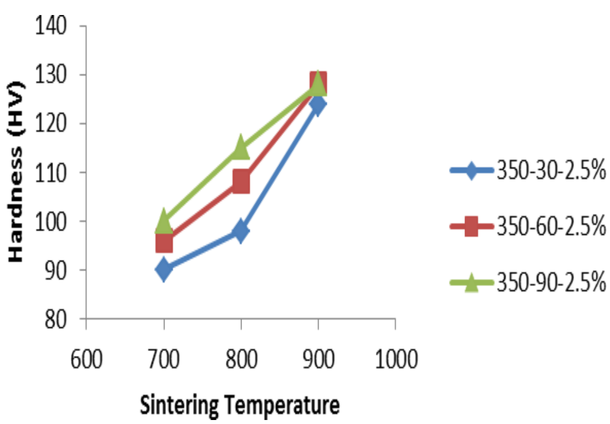


Figure 3: Compaction pressure 350MPa.

Figures (As of order):

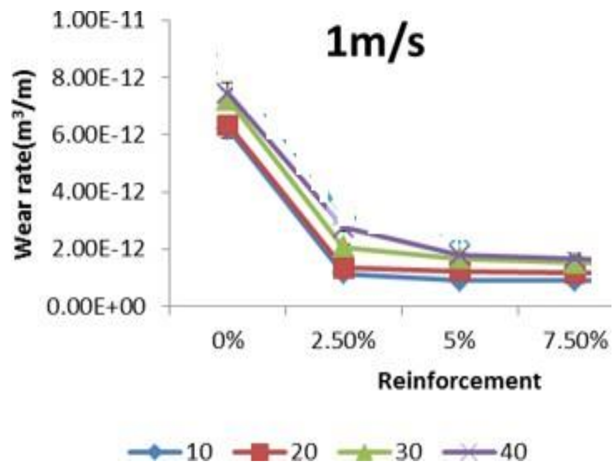
(1) Compaction pressure 400MPa

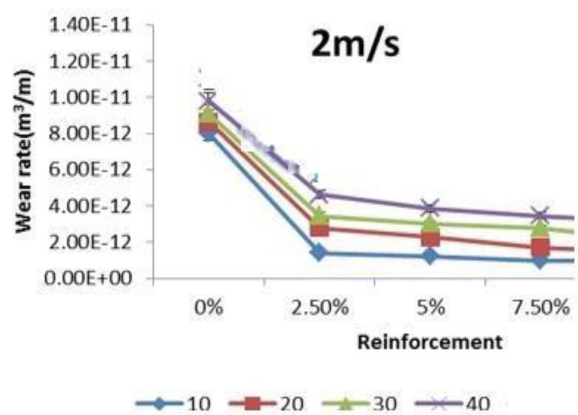
(2) Compaction pressure 450MPa

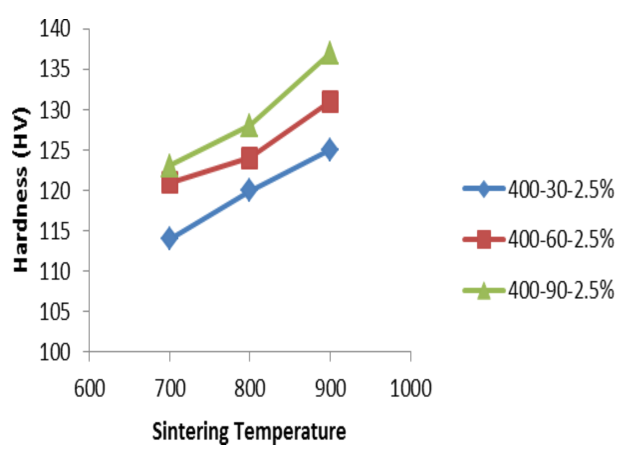
(3) Wear rate for the sliding velocity of 1m/s

(4) Wear rate for the sliding velocity of 2m/s

(5) Wear rate for the sliding velocity of 3m/s



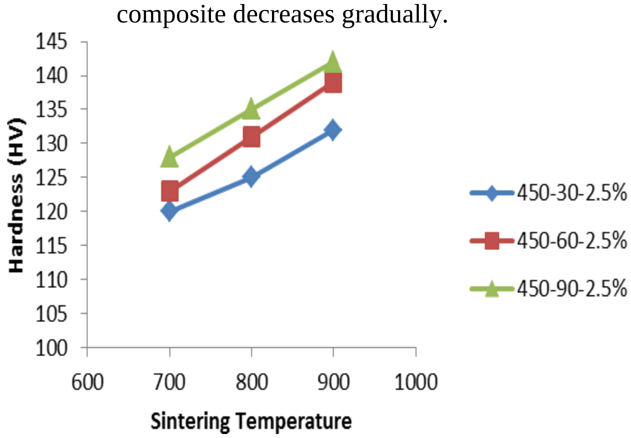




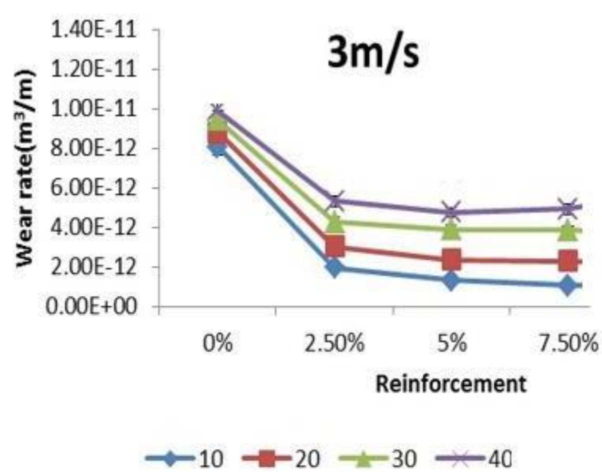
CONCLUSION

Copper fly ash composite with different reinforcement proportions were successfully fabricated through powder metallurgy technique and the following conclusions are derived:

- Uniform dispersion of composites is witnessed through optical and scanning electron microscope.
- It was also inferred that with the increase in fly ash content the agglomeration of the fly ash in the matrix increases to some extent.
- With the increase in reinforcement content the density of the composite decreases, alternately densification of the composite increases with the increase in reinforcement content due to closer packing of molecules because of lesser particle size of the reinforcement.
- With the rise in compaction pressure, sintering temperature and sintering time, the densification, hardness and compression strength of the composite increases, on contrary with the rise in percentage reinforcement the compression strength of the composite decreases gradually.



- For sliding velocity of 2m/s the wear rate of all composites shows the decreasing trend with the increase in fly ash content except forcu-7.5%flyashcomposite,for which the trend reverses after 30N load. When the sliding velocity increases to 3m/s composite with 5% and 7.5 % fly ash shows the increasing trend after 30N load
- Corrosion resistance increases with the increase in flyash content due to the resistance towards the chloride formation which increases with the increase in fly ash content. SEM results indicate the cavity created due to corrosion that decreases with the increase in fly ash content which is a witness for corrosive application.



IV. REFERENCES

1. Abhik, R., Umasankar, V., & Xavior, M. A., Evaluation of Properties for Al-SiC Reinforced Metal Matrix Composite for Brake Pads. Procedia Engineering, 97(2014), 941–950.

2. Ahmad, F., Lo, S. H. J., Aslam, M., & Haziq, A., Tribology Behaviour of Alumina Particles Reinforced Aluminium Matrix Composites and Brake Disc Materials. Procedia Engineering, 68 (2013), 674–680.

4. Alaneme, K. K., & Odoni, B. U., Mechanical properties, wear and corrosion behavior of copper matrix composites reinforced with steel machining chips. Engineering Science and Technology, an International Journal, 19(3) (2016) 1593–1599

5. Ali,M.,Suppiah,B.,&Muayaduldeen, Preparation and Corrosion Behavior of Bronze -40 % w Composite. Jordan Journal of Mechanical and Industrial Engineering, 10(2) (2016), 141–147.

6. Ayyappadas, C., Muthuchamy, A., Annamalai, A. R., & Agrawal, D. K.,An investigation on the effect of sintering mode on various properties of copper-graphene metal matrix composite. Advanced Powder Technology, 28(7) (2017), 1760–1768

7. Chen,B.,Yang,J.,Zhang,Q.,Huang, H.,Li,H.,Tang,H.,&Li,C.,Tribologicalpropertiesofcopper-based composites with copper coated NbSe2and CNT. Materials and Design, 75(1) (2015), 24–31

8. Fan, L. J., & Juang, S. H., Reaction effect of fly ash with Al-3Mg melt on the microstructure and hardness of aluminum matrix composites. Materials and Design, 89(2016), 941–949

9. Mallikarjuna, H. M., Ramesh, C. S., Koppad, P. G., Keshavamurthy, R., & Kashyap, K. T., Effect of carbon nanotube and silicon carbide on microstructure and dry sliding wear behavior of copper hybrid nanocomposites. Transactions of Nonferrous Metals Society of China, 26(12) (2016), 3170–3182

10. Vogiatzis, C. A., Tsouknidas, A., Kountouras, D. T., & Skolianos, S., Aluminum-ceramic cenospheres syntactic foams produced by powder metallurgy route. Materials and Design, 85(1) (2015), 444–454.

11. Uzun, M.; Usca, U.A. Effect of Cr particulate reinforcements in different ratios on wear performance and mechanical properties of Cu matrix composites. J. Braz. Soc. Mech. Sci. Eng. 2018, 40, 197.