ISSN: 2349- 5197
Impact Factor (PIF): 2.138

INTERNATIONAL JOURNAL OF RESEARCH SCIENCE & MANAGEMENT

POWDER METALLURGICAL PROCESSING AND CHARACTERIZATION OF GRAPHITE PARTICULATE REINFORCED COPPER MATRIX COMPOSITE

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Keywords: Composite material; Copper matrix; Graphite particulate; Powder metallurgy

Abstract
Composite materials are having greater demand in all the fields. In electrical components like motor brushes copper based composite material has more benefits. Graphite particulate reinforced copper matrix composite has been made using powder metallurgy in different weight fraction. Microstructure study has been done using optical microscope. A microscopic figure shows the distribution of graphite particulates in copper matrix. Brinell hardness test has been done to study physical properties of composite material. It has been resulted that hardness of composite material is decreased as graphite particulates percentage increased in copper matrix.

Introduction
Composite materials are playing an important role in metal component manufacturing. Composite materials offer higher specific strength and stiffness than other conventional materials. Metal matrix can be prepared by using various techniques including powder metallurgy, molten metal and spray deposition. Composites can be used to make complex shape without using high pressure tools, because composite is formed when matrix goes solid. Composites are also highly resistant to chemicals and will never rust or corrode. Graphite particulate reinforced copper matrix is good example of composite material which is made using powder metallurgy process. Copper–graphite metal matrix composites possess the properties of copper, i.e. excellent thermal and electrical conductivities, and properties of graphite, i.e. solid lubricating and small thermal expansion coefficient. They are widely used as brushes, and bearing materials because of the above properties. Copper-graphite with low percentages of graphite is also used for slip rings, switches, relays, connectors, plugs and low voltage DC machines with very high current densities. Properties of Cu-Graphite composites are it has a coefficient of thermal expansion between 4-6 ppm/ oC (depends on the temperature) and it is also have high resistance to thermal shock.
In presented paper different weight percentage of graphite particulates are reinforced into copper matrix. Samples has been produced using powder metallurgy process. Microstructure and Brinell hardness test has been done for studying mechanical and physical properties.

Experimental
Material
Copper matrix reinforced by graphite particulates as percentage weight fraction. Both copper and graphite material has been made into fine powder form. Four different samples has been made like copper (100%) at 8600C, copper (95%)+ graphite (5%) at 8600C, copper (100%) at 9000C, copper (95%)+ graphite (5%) at 9000C.
Fabrication Of composite
Powder metallurgy technique has been used making composite, because high strength, toughness and ductility can be obtained for composite and another benefit is particulates can be easily reinforced into metal matrix.

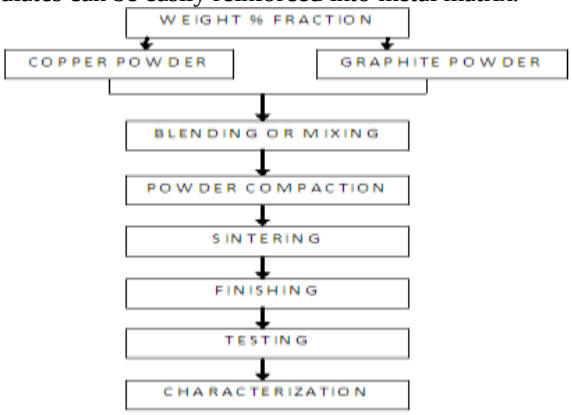

Figure 1. Powder metallurgy flow chart

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Copper and graphite powder blended using mortar. Polyvinyl alcohol (PVA) is used as a binder. After blending compositions, a pellet has been made using compaction process. Compaction pressure kept constant i.e. 150 Mpa. Two different sintering temperatures has been chosen for sintering process i.e. 860^0C and 900^0C. Each pellet was sintered for 1 hour. Finally finished product has made for characterization.

Study of microstructure and mechanical property

Study of microstructure of Copper-Graphite has been done using optical microscope of power AT 200X. Distribution of graphite particulates in copper matrix has studied using these microstructures. Brinell hardness test has done for studying mechanical properties. 100 Kgf load has applied to measure hardness of samples.

Results & discussion

Optical microscope was used to study microstructure of developed composite. Fig (2-4) shows the microstructure images taken from optical microscope at 200X magnification of copper (100%) at 860^0C, copper (95%)+ graphite (5%) at 860^0C, copper (100%) at 900^0C, copper (95%)+ graphite (5%) at 900^0C samples. Distribution of Graphite particulates in Copper matrix is clearly seen in the images.

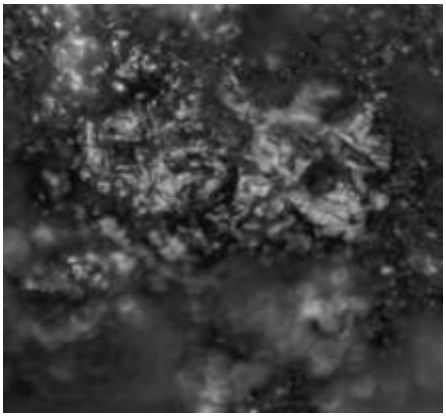

Figure 2: Optical micrograph of Copper (100%) at 860^0C

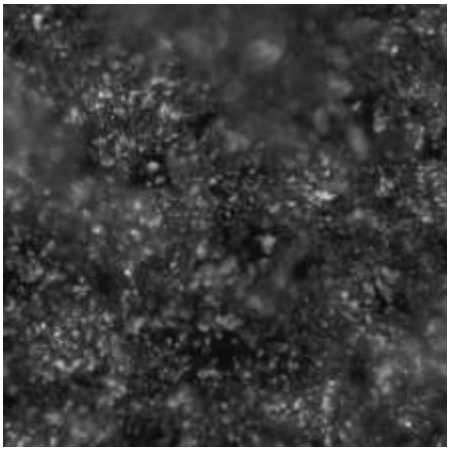

Figure 3: Optical micrograph of Copper (95%)+Graphite(5%) at 860^0C

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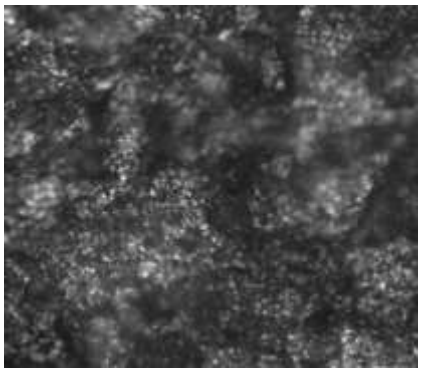

Figure 4: Optical micrograph of Copper (100%) at 900^{0}C

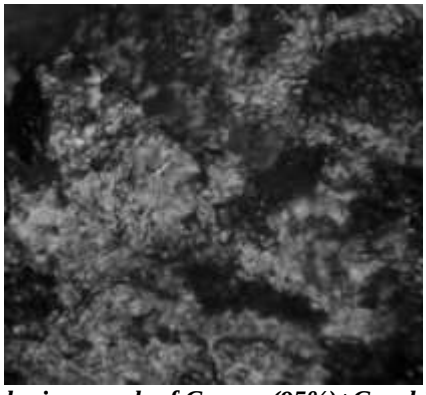

Figure 5: Optical micrograph of Copper (95%)+Graphite(5%) at 900^{0}C

Table 1: Brinell hardness test results

	COMPOSITION	BHN(BRINELL HARDNESS NO.)
1	COPPER (100%) AT 860^{0}C	62
2	COPPER (95%) + GRAPHITE (5%) AT 860^{0}C	32
3	COPPER (100%) AT 900^{0}C	68
4	COPPER (95%) + GRAPHITE (5%) AT 860^{0}C	37

Hardness test was carried out with help of Brinell hardness test machine. 100kgf load is applied specimen. Table given above shows the hardness values measured for specimen

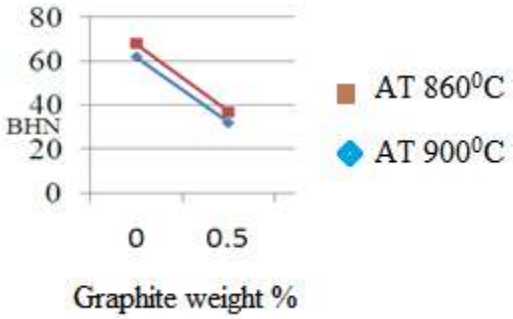

Figure 6.Graph BHN Vs Graphite weight %

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As per the graph Brinell hardness number decreasing as weight % of Graphite particulates has increased in the composition.

Conclusion

Composite material of Graphite particulates reinforced in the Copper matrix has been made. For Copper-Graphite composites:-

1. Copper-Graphite composite has been made successfully fabricated using powder metallurgy process.
2. Hardness of Copper-Graphite composite decreases as weight percentage of graphite particulates increase.

Acknowledgement

The authors express their thanks and gratitude to the school of mechanical and building sciences, VIT University Chennai.

References

1. F. F. O. Orumwense, B.A.Okorie, E. O. Okeakpu, E. N. Obiora, and L. I. Onyeji, "Sintered copper graphite powder compacts for industrial applications", Powder Metallurgy, vol. 44,(2001) 62-68
2. S. F. Moustafa, S. A. El-Badry, A. M. Sanad, B. Kieback,Friction and wear of Copper–Graphite composites made with Cu-coated and uncoated graphite powders, Wear, 253,(2002) pp. 699-710.
3. M. Kestursatya , J.K. Kim , P.K. Rohatgi , "Wear performance of Copper Graphite composite and a leaded copper alloy", Materials Science and Engineering, A339, pp.(2003) 150-158
4. Rajkumar, K., Aravindan, S., Microwave sintering of copper–graphite composites, Journal of Materials Processing Technology 209 (2009) 5601–5605.