

Determination Of Electrical And Mechanical Property Of Graphite Reinforced Copper Composites

Himanshu Dusane¹, Puneeth Thati¹

¹School of Mechanical and Building Science, VIT University, Vellore -632 014. India

Abstract

In the present experiment copper- graphite metal matrix composite is produced with powder metallurgy method with 35 μm of graphite powder .the electrical conductivity is increase till 5% of grafite by wt. And then decrease . vicker hardness decrease as %wt.of grafite increase

I.INTRODUCTION

Electrical conductivity is vital property for high performance conductive wire and high strength binding material in automotive and aero space field.

Copper is known for its high electrical conductivity and posses good hardness.

Here we are using graphite as it has a fourth valence electron free it allows the flow of electrons freely and thus provide possitive responce towards electrical conductivity and it is easily available and cost effective.

The purpose of present paper is to determine the effect on the electrical conductivity of Cu-Graphite MMC by increasing the wt.% of graphite. The study of microstructure using microscope and hardness using vicker hardness test was carried out. Metal matrix composite is produced by powder metallurgy route.

II. LITERATURE REVIEW

As the review of previous paper shows that uptill now following studies are been done, like wear properties, friction properties, thermal resistance and hardness. By the ref. [1] it was found out that the effect of adding graphite into copper does not have a much influences on hardness of composite due to the soft nature of graphite. Wear depth decrease with increase in graphite context. According to ref. [2] determine the threshold value for Cu-Graphite composites. According to ref. [3] the microstructure of the composite was studied.

III. PRIPRATION OF COMPOSITE

The proress used for making specimen of Cu- graphite MMC was Powder metallurgy. Powder methodology is best method of producing composite of non reacting materials. Commercial copper powder of 50 μm and graphite of 35 μm is used in experement. For evenly mixing process rotating drum mixture has been used and cold compaction process was performed to get required shape under different applied pressure. .After compacting the resultantthe green compacts were sintered at a temperature below the melting point of the copper powder used.

Total nine samples were prepared using the taguchi L9 array method where the composition is varied to reduce the weight of the total metal matrix composite. For each composition three different specimens were made with different compacting pressures and the sintering temperatures and different sintering times. For specimens in order Cu-2%Gr, Cu-5%Gr, Cu-10%Gr

Sample number	Sample Composition	Pressure (MPa)	Temperature ($^{\circ}\text{C}$)	Time (hour(s))
1	Cu-2%Graphite	400	650	1
2	Cu-2%Graphite	500	700	2
3	Cu-2%Graphite	600	750	3
4	Cu-5%Graphite	400	700	3
5	Cu-5%Graphite	500	750	1
6	Cu-5%Graphite	600	650	2
7	Cu-10%Graphite	400	750	2
8	Cu-10%Graphite	500	650	3
9	Cu-10%Graphite	600	700	1

IV. EXPERIMENTAL PROCEDURE

the present paper deals with effects of graphite wt.% on electrical conductivity of the metal matrix as well as experiment also shows result on mechanical properties like Vickers hardness, density and microstructure .

For calculation of volume, diameter and length of all the specimens were measured by using vernier caliper. The mass of all the specimens were measured by using the digital weighing machine and calculation of density is done by given formula.

$$\text{Density} = \text{mass/volume (gram/cc)} \quad (1)$$

For measurement of hardness a Vickers hardness test equipment was used and the hardness was measured to be 100 kgf load by using diamond indenter tool of HV scale.

For observation of microstructure all the nine specimens were polished with emery paper of following grades 220,400,600,800, 1000. microstructure of each specimen was studied under electronic microscope and image were captured and microstructure was studied.

For the electrical conductivity, Resistance (R) was measured with the help of multimeter of all nine specimens and then calculation of electrical resistivity (ρ) is given by.

$$\rho = (R \times A) / L \quad (\text{ohm-m}) \quad (2)$$

Where L= length of specimen

A= Area of cross-section

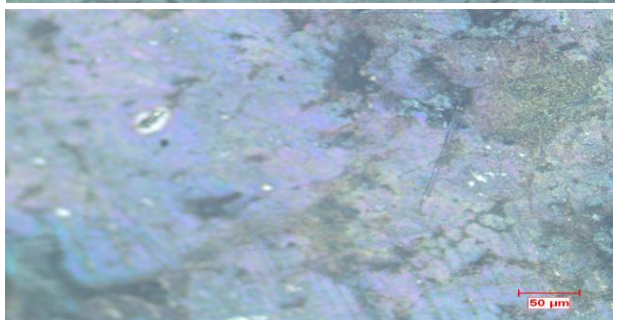
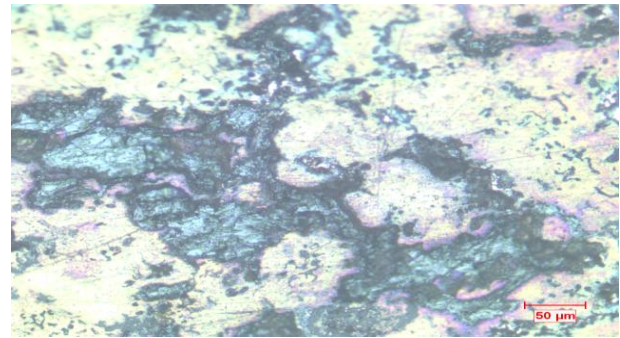
The electrical conductivity given by (σ).

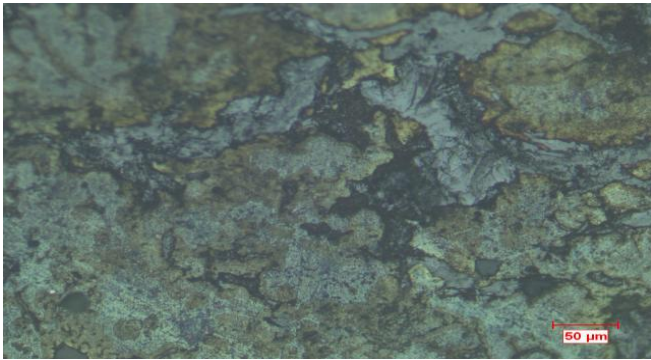
$$\sigma = 1/\rho \quad (\text{mho/m}) \quad (3)$$

V. RESULTS AND DISCUSSION

A. Microstructure

The following pictures represents the microstructure of all the nine samples and conclusions are drawn.





From the observation of microstructure of all the samples it is found out that graphite reinforced particles are spread evenly throughout the copper matrix. As we increase the wt.% of graphite in the matrix, particles get agglomerated at a single location in the matrix.

B. Density

The graph of density w.r.t wt.%, pressure, temperature, sintering time is being plotted

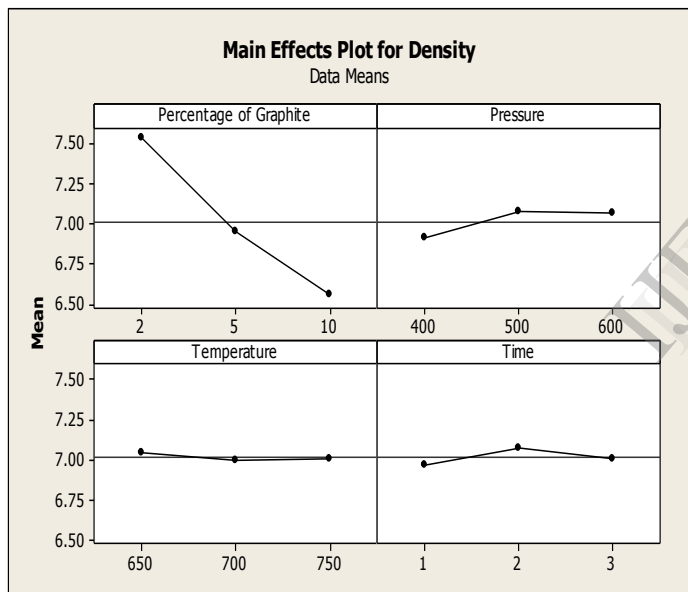


Fig.5 Density vs. Percentage of Graphite, Pressure, Temperature, Time

By the observation it is found out that as we increase wt.% of graphite particles in the copper matrix the density decreases. It has a minimum density at Cu-10% graphite and maximum density at Cu-2% graphite. This is because as the wt% of graphite increase and simultaneous decrement in the wt.% of copper amount ultimately drop down the density as the density of graphite is 2.23 gm./cc which is lower than that of copper which is about 8.9 gm./cc.

Pressure does have a role in the change in density from the graph studies. . At 500MPa pressure the density is optimum.

From the Fig.5 it is observed that density decreases as the temperature of the sintering process increases as it reduces porosity from the MMC. it is minimum at 700°C and maximum at 650°C.

Density level get optimized at 2hours time of sintering.

By the experementaion itis measured that maximum density is observed value of 7.64gm./cc and minimum density value of 6.456gm./cc.

C. Electrical Conductivity

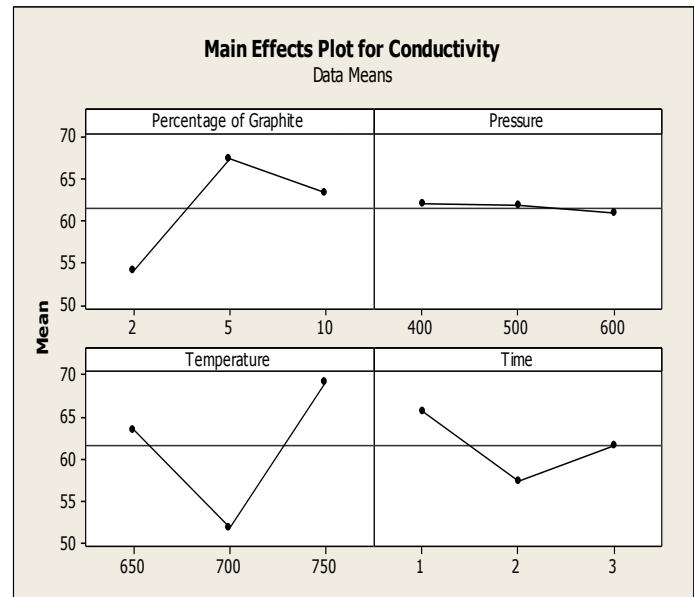


Fig.6 Electrical Conductivity vs. Percentage of Graphite, Pressure, Temperature, Time

From the Fig.6 it is observed that as we increase the wt% of graphite the electrical conductivity increases up to Cu-5% graphite and start decreases further. as graphite wt% is increased resistance between material increase because of bad affinity of material towards each other and clustering effect .

Electerical conductivity is almost constant as we increase pressure of compacting.Fig.6 It has a minimum value at 600MPa and maximum value at 400MPa pressure.

The Fig.6 shows that temprature of sintering increase conductivity increase maximum electrical conductivity is obtained at 750°C and a minimum at 700°C.

From the measurement of specimense electrical conductivity maximum electrical conductivity is observed value of 79.3mho/m and a minimum value of 40.5mho/m.

D. Vickers Hardness

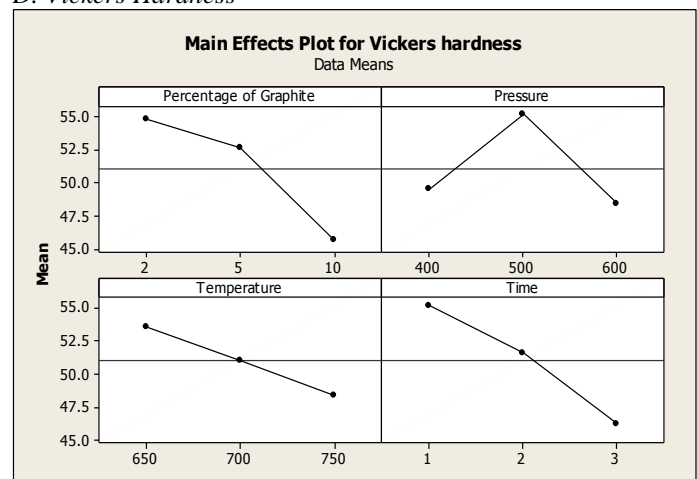


Fig.7 Vickers hardness vs. Percentage of Graphite, Pressure, Temperature, Time

From the Fig.7 it is observed that as wt% of graphite in the copper matrix increases the hardness of the compound decreases. . This is because of that graphite has less hardness than that of copper . The partical of graphite does not provide enough hardness to overcome the crack propagation in the copper matrix and reduces the hardness.

from Fig.7 it is observed that as sintering temprature increase the value of hardness decrease shows that the maximum hardness is observed at 650°C and minimum at 750°C.

as the sintering time increases hardness of composite decreases. Maximum hardness is observed at 3 hours of sintering .

Upon the observation maximum Vickers hardness is observed value of 60.05HV and a minimum value of 44.8HV.

VI. CONCLUSION

The following conclusions are drawn from the results obtained in the experiments:

1. generation of copper-graphite metal matrix composite by powder metallurgy raute is done successfully.
2. Distribution of graphite partical in MMC is even thrughout the specimen reinforcement .
3. Density decreases as wt% of graphite increases .
4. Electrical conductivity diceases as wt% of ghite increases . Conductivity remains almost the same with increase in the pressure.
5. Vickers hardness measurement show that with the increase in the graphite value the hardness decreases.

ACKNOWLEDGMENT

We authors thank our guide V. Uma Sankar, Professor in VIT University for guiding us in the project.

REFERENCES

- [1] Synthesis & Characterization of copper graphite metal matrix composite by powder metallurgy route by Sibabrata Mohanty.
- [2] Electrical Conductivity of Cu-Graphite composite materials as a function of structural characteristics by J.Kováčik and J.Bielek
- [3] Wear properties and effect of molds on microstructure of graphite reinforced copper alloy composites made by centrifugal casting by J. K. Kim, P. K. Rohatgi, J. O. Choi, C. O. Choi
- [4] Effect of Processing Parameters and amount of additives on the Mechanical Properties and Wear Resistance of Copper-based Composite by Montasser Dewidara, G.T. Abdel-Jaberb, Mahmoud Bakreya , and Hussien Badrya