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XRD ANALYSIS FOR COPPER-GRAPHITE METAL MATRIX COMPOSITES

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ABSTRACT

In the present examination, endeavors have been made for the creation of Cu-graphite MMC by customary and sparkle plasma sintering (SPS) methods. The MMCs were described by x-beam diffraction (XRD). Diverse mechanical properties like thickness, mass hardness and wear study were likewise led. XRD spectra demonstrate the nearness of Cu, graphite and Cu_2O crests which demonstrates that no communication amongst Cu and graphite happens amid creation. The nearness of a frail pinnacle of Cu2O demonstrates that slight oxidation of Cu happens amid sintering. It has been found that expansion of graphite into copper does not bring about much change in hardness because of the delicate way of graphite. Nonetheless, 90% and 97 % of hypothetical thickness have been acquired for routine sintered and SPS tests individually. Greatest Vickers hardness estimation of around 100 has been accomplished for Cu-1 vol. % graphite MMC when it is created by SPS. Be that as it may, a hardness estimation of 65 has been acquired for the same composite when it is created by ordinary sintering at 900°C for 60 minutes. The micrographs of Cu-graphite mirror the perfect interface and great similarity amongst lattice and support.

Keywords

Metal-Matrix Composites; Copper-Graphite Composites; Powder Metallurgy; conventional sintering; Spark-Plasma Sintering; X-ray Diffract meter

1. Introduction

Metal-graphite composites are attractive materials for many applications such as engine brushes and generators or sliding contacts,(1) self-lubrication parts for automotive pistons,(2) and heat sink elements in multi-functional electronic packaging systems.(3) Copper-graphite composites are widely used in tribological engineering parts.(4) Copper-graphite composites combine the positive characteristics of both components, i.e., high thermal and electrical conductivity of the copper with the low thermal expansion coefficient and good lubricating properties of the graphite.(5) Copper-graphite composites are typically prepared by a powder metallurgy (PM) process as the PM process offers the possibility of obtaining uniform parts and reducing production costs. However, PM has certain limitations primarily related to the poor affinity between copper and graphite, which gives rise to weak interfaces with a negative effect on the structural, mechanical, and electrical properties of the material.(5, 6) The lack of wetting between ∗Author to whom correspondence should be addressed. copper and graphite during composite processing can be overcome by coating the graphite particles with copper before consolidation. Moustafa et al.(7, 8). In this research work, fabricated copper graphite composites by a PM route using Cu-coated graphite powders and a mixture of copper and graphite powders. The copper-coated graphite powders possessed lower wear rates and friction coefficients than those made from pure copper and non-copper-coated graphite. Moreover, the copper-coated composites show a higher density and yield strength. In this present research work, fabrication of copper-graphite composite by powder metallurgy route and the improvement of mechanical properties of the composite by using different sintering techniques such as conventional and spark plasma sintering. The optimization of various sintering parameters like temperature, time and pressure etc and study the interface between Cu and graphite.

2. Experimental Work

2.1 Sample Preparation

As received copper and graphite powders of 25g were blended to such an extent that the volume portions of graphite in the blends were 0% (immaculate copper), 1%, 3%, 5% and 10 % individually. At that point, the specimens were taken and mixed together legitimately utilizing a pestle and mortar for 30 minutes to guarantee uniform dissemination of the graphite particles all through the copper grid. The mixed specimens were then cool compacted by applying a heap of 700 MPa for 2 minutes in a kick the bucket of 25 mm breadth.

2.2 Sintering

The compacted pellets were taken and warmed in a tubular heater in a latent air (99.99% immaculate argon gas) at temperature 900˚ C and 950˚C to thickness the compacted powder tests. A warming rate of 5^o C/moment was kept up and the holding time for the specimens was 60 minutes. Pellets of 25mm width and 15mm thickness were acquired in the wake of sintering. The densities of the sintered specimens were figured and noted.

In another arrangement of investigation, Cu-1 vol. % graphite and Cu – 5 vol. % graphite powders were compacted at 700°C for 5 minutes under vacuum at a warming rate of 80^o C/minute by flash plasma sintering system.

2.3 Density Measurement

The theoretical density of the samples was calculated. The sintered density for each of the samples was measured using Archimedes' Principle. The densification parameter was also calculated to get an idea of amount of densification.

Densification Parameter (DP) = Sintered Density – Green Density / Theoretical Density−Green Density

Percentage Densification = Experimental Density/Theoretical Density×100%

2.4 X-Ray Diffraction Analysis

XRD was studied in P ANalytical X-ray Diffractometer. The 2θ angle was varied from 20^{o} to 80^{o} and the scanning rate used was 3^{o} per minute. Copper target was used.

3. Result and Discussion

3.1 XRD Analysis

XRD plots of copper-graphite composite samples with 0%, 1%, 3%, 5% & 10% by volume of graphite prepared by conventional sintering method are shown in figure 1.

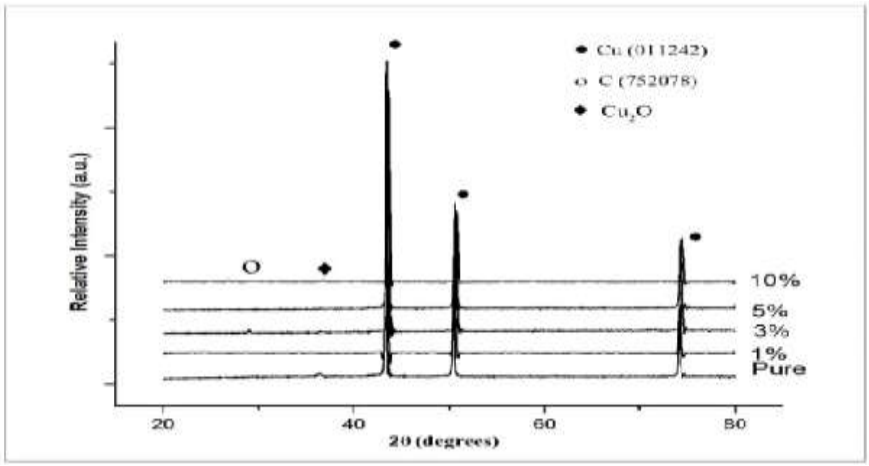

Figure: 1 XRD plots of pure Cu, Cu- 1 vol. %, Cu- 3 vol. %, Cu-5 vol. % and Cu-10 vol. % graphite MMC sintered at 900°C for 1 hour

From the graph, very distinct peaks of copper can be observed. Whereas feeble peak of graphite is observed as amount of graphite is very less as compared to Cu. Also, some amount of copper oxide is detected which is undesirable. It may have been formed due to the presence of atmospheric oxygen during conventional sintering in the tubular furnace. It is also seen that no reaction takes place between copper and graphite during fabrication of composites. This is due to the fact that spark plasma sintering was carried out in vacuum in the absence of atmospheric oxygen. So, oxide formation is inhibited.

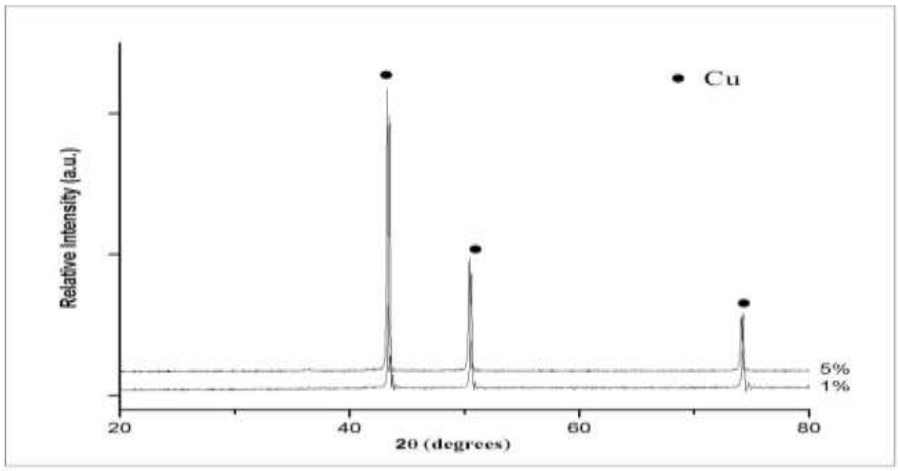

Figure 2: XRD plots of spark plasma sintered samples of 1% & 5% Graphite by volume

3.2 Density Measurement

Figure shows the variation of % theoretical density with volume % of graphite in the samples. Densification % increases with the increase in the volume % of graphite. This is due to the fact that the addition of graphite leads to the better encapsulation of matrix and reinforcement within the sample. The softer graphite covers up all the gaps and voids present in the original microstructure. Also the particle packing and particle–particle contact increases, between the copper and graphite at the interface. Densification Parameter also increases with graphite.

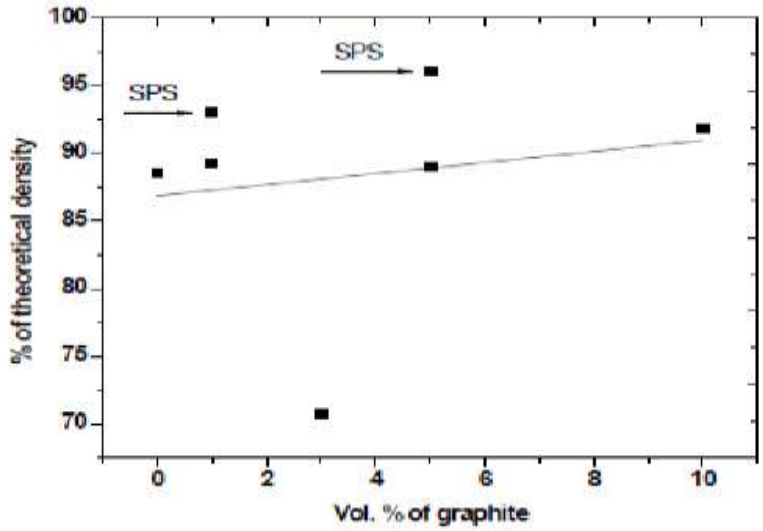

Figure 3: Variation of % theoretical density with volume % of graphite

CONCLUSIONS

The following conclusions were drawn after analyzing the results obtained from the research:

1. Copper-graphite composite has been successfully fabricated by powder metallurgy process using conventional and spark plasma sintering techniques.

2. XRD study shows the existence of both copper and graphite (carbon) phases along some copper oxide in conventionally sintered samples. The SPS samples were devoid of any oxide inclusions because of the vacuum conditions.

3. Density study shows an increasing trend with increase in content of graphite.

4. In general, the samples prepared by spark plasma sintering showed superior properties compared to those prepared by conventional sintering.

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