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The Wear characteristics of Cu-Sn alloy based composite prepared through powder metallurgy

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***Abstract*:**The application of Cu-Sn alloy in the industry have been increasing due to their characteristics. In this research work, Cu-Sn alloy based composite with varying weight percentage are prepared through powder metallurgy. The hardness of Cu-Sn alloy reinforced with 5% of SiO2 composite and Cu-Sn alloy with 5% SiO2 composite was determined. The microstructure of the fabricated composites are also examined to ensure the uniform dispersion of reinforcing particles. Further, abrasive wear studies on both composites are also done using pin on disc apparatus and the influence of sliding distance, sliding velocity, and load on wear loss were investigated. The worn surface is examined through Scanning Electron Microscopic (SEM) and XRD to characterize the mechanism of wear.

I. Introduction:

Industrially important, due to high corrosion resistance, high ductility, moderate to high hardness and strength behavior, high thermal and electrical conductivity and high fatigue and abrasion resistance, metal matrix composites (MMC) have received much attention. In addition to that MMCs has the properties of light weight structural materials. Cu-Sn composites are widely used as self lubricant materials. Researchers have paid much attention on Cu-Sn composites due to its advantageous applications in industry, aircraft and defense sector, etc. The melting temperature of the reinforced tin is comparatively lower than the copper. There are several methods to produce Cu-Sn based composites and the selection of the method is based on the interest of application. Berry clearly depicted the background of copper based composites.[1-8] Sato et al studies clearly illustrated that the hardness of the copper composite is very much depend on the reinforced tin. The existence of graphite on the Cu-Sn alloys, prepared by power metallurgy process, gave the better wear resistance properties as well as lead enhanced the densification parameter. Wen et al used powder metallurgy process to made Cu-Sn-Si alloys with homogenous composition and microstructure. The appropriateness of the standard calibration curve using powder metallurgically fabricated Cu-Sn-Si alloys as the standard samples for X-ray fluorescence (XRD) are calculated effectively. Ragab et al, prepared bronze based composites with different amount of graphite as slide additive and SiC, SiO2 as friction additive by powder metallurgy process and studied the electrochemical behavior of bronze composites in neutralized as well as acid rain. The results were compared with un-reinforced bronze. In the present study, the authors prepared the different amount of silica and graphite introduced Cu-Sn composites with the aid of powder metallurgy technique. The influence of the additives on the properties of the investigated composites are characterized by abrasion wear test using pin on disc apparatus and sliding distance, sliding velocity, and load on wear loss experiments and the results are discussed effectively.[9-10]

II. Materials and Methods

The tin and copper powders are of great purity (99,98%) and a granulometry lower than 40 µm. The composition of our alloy is fixed at Cu-8%Sn. This choice is taken after a first study related to the compositions Cu- 2%Sn, Cu-5%Sn and Cu-10%Sn where we notice that the addition of tin improves the mechanical properties, in particular hardness, but this last light marks a low for a content of 10%Sn The proportioning of the powders was carried out by means of a balance of precision to digital posting "Sartorius" of an error of measurement 0,1mg. The mixing of the powders has been carried out in a revolving earthenware jar at a speed of 100trs/min during 6 hours.

III. Characterization

Characteristics of the samples with respect to density and hardness measurements. We used optical and electronic microscopy and the diffraction of X-rays for microstructural study. Density is calculated by the Arthur process [9]. On a durometer of the GALILEO type, the Rockwell ball steel hardness of 1.5mm diameter was carried out with an initial load of P0 = 10N followed by a load of P1 = 140N for 10 seconds. Optical microscopy and electronic scan microscopy are the observing methods used. Detailed attention is needed in the preparation of the porous samples. To extract the oxide coating formed on the surface, the samples are initially ground with abrasive paper 900. For in electronic microscopy, we used an electronic scan microscope of the type Joel JSM - 6100 equipped with a detector of secondary electrons, a detector of retro diffused electrons and a system of qualitative analysis of elements. .

IV. Results and discussion

The variance of the density according to the temperature under a pressure of 40MPa and for different time times is shown in Figure 1. It is noted that in the specified temperature region, the density increases in a quasi-linear manner. Since the melting point of the tin is around 300 ° C, the combined effect of temperature and pressure seems to us to lead to the liquid phase sintering.. Therefore, as the temperature rises, tin wets the copper grains well and plays the role of a binder, promoting the thickening of the alloy. Furthermore the rise in temperature stimulates the copper-tin diffusion pair. The curves give the density variance with pressure for a 300 ° C sintering temperature. This rise can be explained by the rearrangement of the powder after settling at low pressure values.For high values of pressure, the contact surfaces expand, powder grains, being ductile, plastically deform to density the compact and thus reduce the rate of porosity.

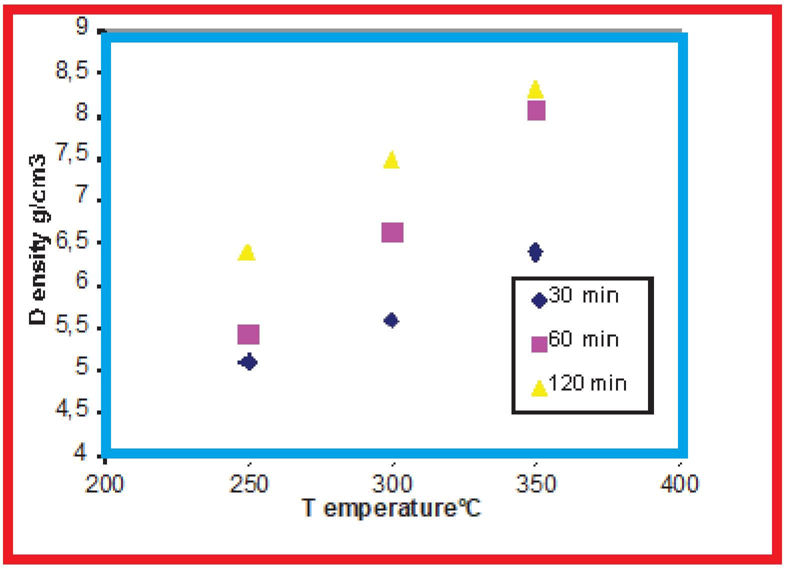

Fig. 1: Density variation according to sintering temperature under a pressure of 40 MPa and several durations of maintain

4.1. Study of hardness

Figure 2 shows the variance of Rockwell ball hardness by temperature (with a pressure of P=40MPa) and pressure (with a temperature of T=200°C). Generally, as the temperature or/and the pressure increases, the hardness of the samples increases. It is very clear that the rise in temperature and pressure inevitably raises the material density; the latter shows a certain resistance to the ball's penetration. However we cannot correlate this increase to a clear relation. Corresponding to the electrolytic copper particles, a very fine grayish zone corresponding to the tin particles obtained by atomization

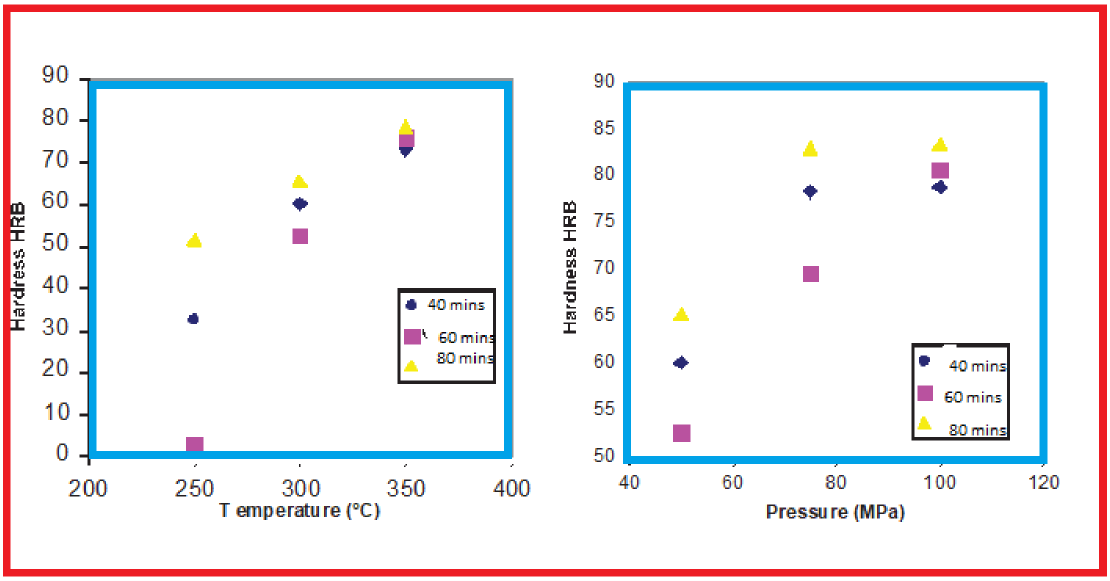

Fig. 2: the hardness variation according to (a) the temperature and (b) pressure.

4.2 .SEM IMAGE

Electronic micrography (fIg 3.) confirms a heterogeneous structure similar to that given by optical micrographs consisting of: dendritic-rich zones Structure tin when the sintering temperature is low, tin-rich zones of different shapes depending on the temperature and the sintering pressure, intermediate zones between Sn-rich and tin-rich zones corresponding to the tin-rich zones and corresponding to the tin-rich zones where damping is weak.

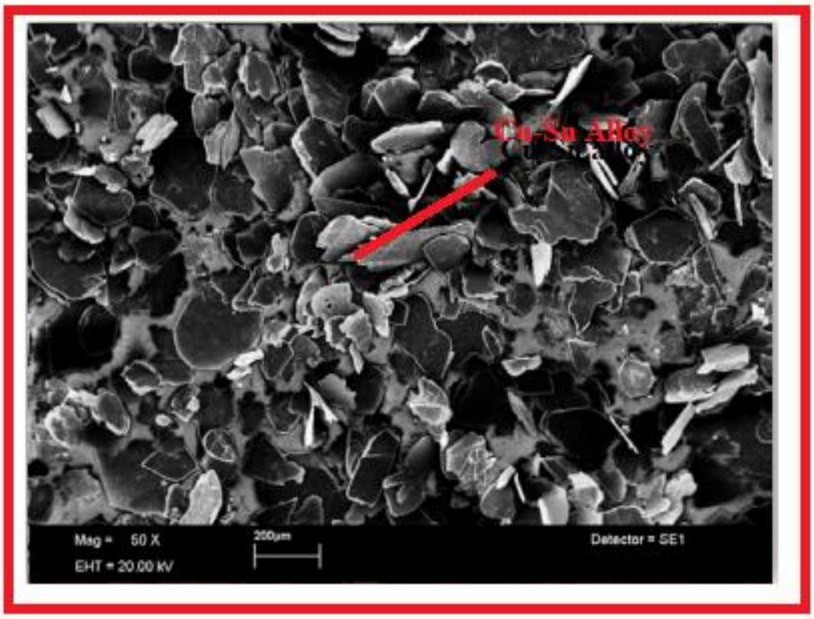

Fig 3. SEM image of Cu-Sn alloy

4.3. Study of the spectrum of the X-ray diffraction

In order to analyze the influence of this parameter on the formation of the phase in question, we have presented the X-ray diffraction spectra according to the sintering temperature. Therefore, we note that no secondary phase takes form in a significant way at a low temperature of 250 ° C to high temperature 400 0 C. On the opposite, the intensity of the peaks corresponding to the secondary phases grows as the temperature rises (fig. 4). We are able to classify the following stages via the study of X-ray diffraction:: -the unalloyed copper, which did not react with the tin content of copper content significantly from that of tin, -phase Cu-Sn which is a stable phase and mainly formed for different parameters of development. It is orthorhombic structure resulting from the diffusion of tin in copper

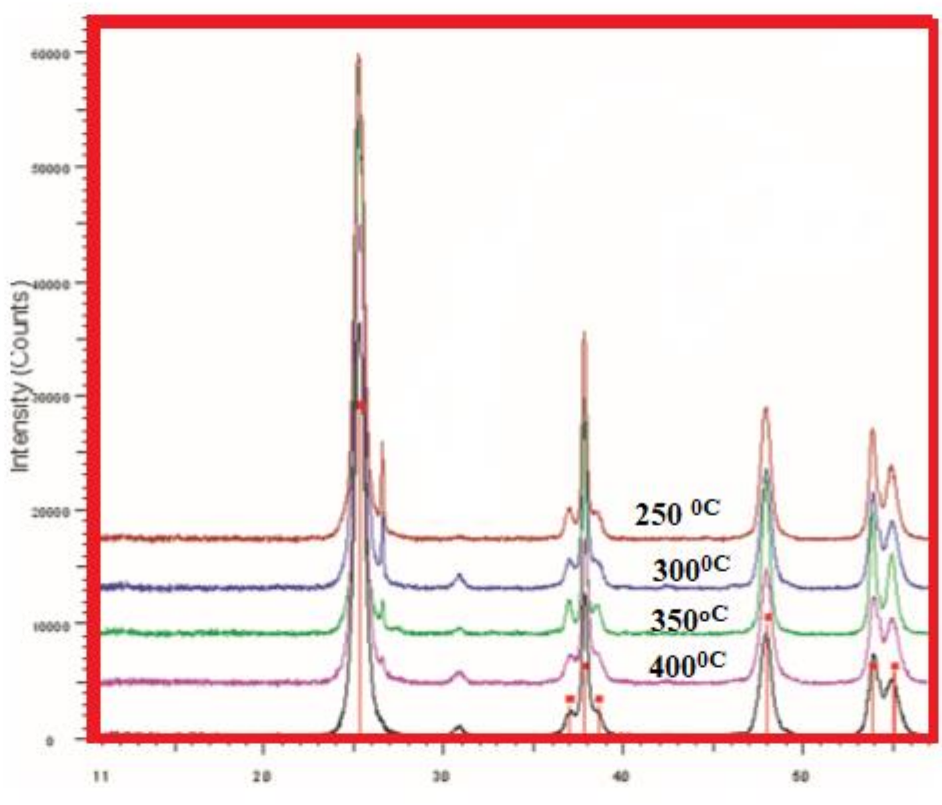

Fig 4. XRD image of Cu-Sn alloy

V.CONCLUSION

Increase in the processing parameters density function (temperature, pressure) and is almost linear in the fields scanned, hardness generally increases according to the development parameters but we cannot find a clear relationship taking into account the dispersions met particularly in microhardness measurements, determination of a secondary phase majority Cu-Sn alloy with the possibility of of alloy with a generalized porosity

REFERENCES

[1] A. P. Savitskii , N. N. Burtsev, and M. A. Emel'yanova, Dilatometric investigation of the processes of liquid phase sintring of materials of the Cu-Sn system, Poroshkovaya Metallurgiya, No. 9 (261)1984, pp.27-31

[2] N. N. Acharya, Effect of probe pressure during dilatometric studies on sintering of copper-tin bronzes, Journal of Materials Science Letters 18 (1999) pp681-683

[3] C. Alves, V. Hajek, C.A. dos Santos, Thermal behavior of supersolidus bronze powder compacts during heating by hollow cathode discharge, Materials Science and

Engineering A348 (2003) pp84-89

[4] V. Kumar, Porous metal bearing – a critical review, Wear, 63 (1980) pp271-287

[5] D. Bouvard, G. Cizeron, métallurgie des poudres, Article de la Revue de Métallurgie C.I.T/Science et Génie des matériaux, (1994) 684p

[6] G. Parallis, G. Mader, Precis de Métallurgie, Edition dépôt égale, Paris (1990) 186 P.

[7] R. Cazaud, R. Leroux, Métallurgie mise en forme et traitements, Edition Dunod Paris (1951) 573p.

[8] S. Klpakgian, Manufacturing process for ingeneering materials, Edition Addison Wesley Massachusett (1984) 839p.

[9] F. Keraghel, Elaboration et caractérisation des bronzes frittés sous pression, mémoire de Magister, Institut de Mécanique, Université B. M. Annaba – Algérie (1999) 98p

[10] N.N. Acharya, P.G. Mukunda, Sintring in the copper-tin system : Identification of phases and reactions, The International Journal of Powder Metallurgy, V31, 1(1995) pp.63-72