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RESEARCHES ON ELABORATION OF COMPOSITE MICROPOWDERS WITH WOLFRAM MATRIX USING MECHANICAL ALLOYING TECHNIQUE

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ABSTRACT

The purpose of this paper is to present some researches regarding the composite micropowders with wolfram matrix in mixture with copper used in the production of electrical contacts. In order to alloy the two powder, the mechanical alloying is used. The SEM micrograph of the tungsten micropowder and copper and then the SEM micrograph of the mixture WC-Cu for the different mechanical alloying time are presented.

Keywords: micropowders, copper, mechanically alloyed, SEM images

1. INTRODUCTION

Copper alloys are one of the most commonly used materials for various engineering applications, although one of the factors limiting the wider application of copper and copper alloys is, on the one hand, the relatively low mechanical strength and, on the other hand, the large density. Silicon carbide (SiC) is recognized as one of the potential candidates for electronic packaging and thermal management applications. Metal matrix composite materials reinforced by Al_2O_3 were developed by various methods and also found wide application where high electrical conductivity, high thermal conductivity and high strength and low wear resistance are required.

WC/Cu Composite material is used for electrical contacts, resistance welding electrodes and electrodes for automatic welding.

One of the most frequent technique to alloy the WC powder and Cu powder is the mechanical alloying, a recent technique used for this materials, [1, 5].

Copper tungsten sintered materials are manufactured with different copper contents, from 20% up to 70%, depending on the use to which they are put [3]. The method of manufacture depends on the percentage of tungsten present. Materials with large percentages of tungsten (around 80%) are generally made by the impregnation process, where it is advantageous to use a coarse grain tungsten powder to decrease arc erosion.

For percentages of the order of 60%, liquid phase sintering is more appropriate, and for materials with less tungsten, powder mixtures without a liquid phase are sintered together.

Materials with a low copper content are used for high currents to improve contact life and breaking capacity. With a higher copper content, about 67%, the material erodes slightly less than pure copper, at low currents (around 20 amp), and the improvement in erosion resistance is enhanced at higher currents, but this is accompanied by considerable deformation of the contact surface. The contact resistance increases considerably on arcing, due to oxidation and depletion of copper in the interface.

The lack of solubility of W in Cu makes W-Cu a model system for liquid phase sintering because densification can be attributed to either particle rearrangement or solid-state sintering of the skeletal structure, [7].

The final shape and, also, the physical and mechanical characteristics of the micropowders are obtained through the microwave technique, known as a very useful technique for this type of refractory materials [2, 6].

2. POWDER CHARACTERISTICS

2.1. Copper powder

In order to elaborate the composites materials with tungsten micropowder matrix and copper for electrical contacts, the following powder type was used (tables 1 and 2 for copper powder and tables 3 and 4 for tungsten powder). The copper powder was characterized through SEM technique using an electronic microscope, FEI –INSPECT from INFLPR Bucharest, and images are presented in Figs. 1, 2, 3 and 4.

Due to the electrolytic process, the shape of copper powder can be characterized as dendrite.

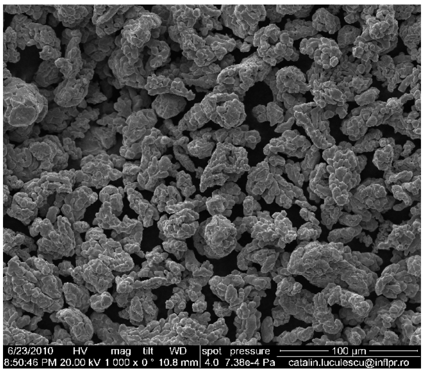

Fig. 1. SEM micrograph for 1000x

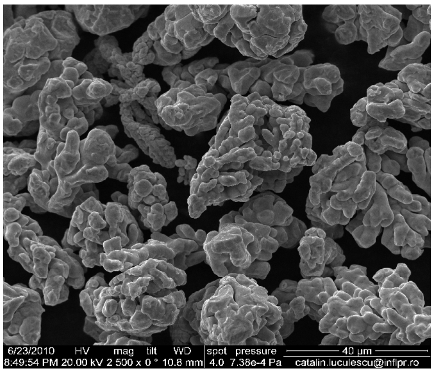

Fig. 2. SEM micrograph for 2500x

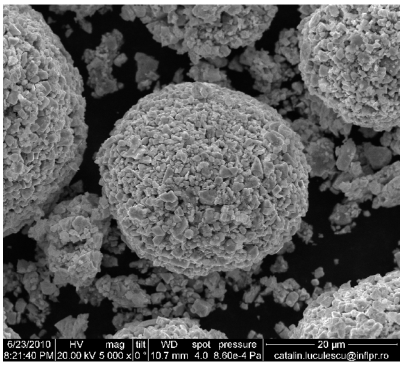

Fig. 3. SEM micrograph for 5000x

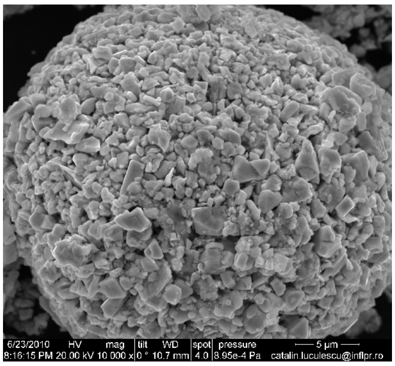

Fig. 4. SEM micrograph for 10000x

2.2. Tungsten Powder

In this paper, K30 powder type was used with the chemical composition presented in table 3, and SEM micrograph for different magnifications in Figs. 5 to 8.

Table 1. The main characteristics of copper powder

Powder	Density at 20 °C [g/cm³]	Atomic volume [cm³/atg]	Thermal conductivity [cal/cm°CS]	Fusion point [°C]	Brinell Hardness [daN/mm²]
Cu	8.92	10.28	1	960	35

Table 2. Physical and chemical characteristics of Pcu99 copper powder type

Powder	Type	Purity [%]	Apparent density [g/cm^2]	Grain maximum dimension [μm]
Cu	Pcu99	99.50	1.0 – 1.2	5

3. MECHANICAL ALLOYING

In order to elaborate the tungsten nanopowders, a mechanical alloying technique and Pulverisette 6 vario-planetary ball mill were used.

The working process parameter was:

- bowl volume: 250 ml;
- bowl material: stainless steel;
- ball diameter: Φ=10 mm; balls number: 50 pieces; balls material: stainless steel;
- material/ball ratio: ½ (100gs powder K30+Cu and 200 gs, balls);
- alloying environment: air;
- alloying times: 5, 10, 15 hours.

Table 4. The concentration of copper and tungsten powders for mechanical alloying

Samples	Cu [%]	K30 [%]
1.	35	65
2.	30	70
3.	25	75

Table 4 shows the concentration of copper and tungsten powders for mechanical alloying.

Fig. 5. SEM micrograph for 1000x

Fig. 6. SEM micrograph for 2500x

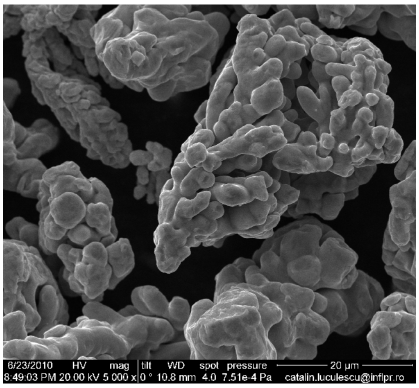

Fig. 7. SEM micrograph for 5000x

Fig. 8. SEM micrograph for 10000x

For the mechanical alloying, nine samples were prepared:

- **3 samples K30 (65%)-Cu(35%),** using three time for mechanical alloying: 5, 10 and 15 hours**;**
- **3 samples K30 (70%)-Cu(30%),** using three time for mechanical alloying: 5, 10 and 15 hours;
- **3 samples K30 (75%)-Cu (25%),** using three times for mechanical alloying: 5, 10 and 15 hours.

The ratio of mixture was done using a precision analytical balance WPS 510. The weigh of each sample is 100 g.

Table 3. Chemical composition of the K30 powder type

Group ISO	WC [%]	TiC [%]	TaC [%]	CO [%]	C total [%]
K30	90.3	0.2	0.5	8.7-9.3	5.62-5.7-5.78

4. CHARACTERISATION OF POWDER MIXTURES

The mixture K30/Cu with the ratio 65/35 is presented in Figs. 9 to 11. The mixture K30/Cu with the ratio 70/30 is presented in Figs. 12 to 13.c. The mixture K30/Cu with the ratio 75/25 is presented in figs 15 to 16.

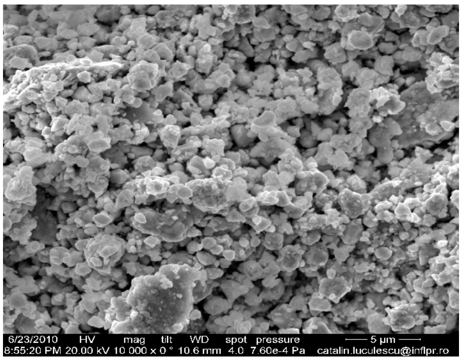

Fig. 9. SEM micrograph of the mixture K30 (65)–Cu(35) alloying time: 5 hours

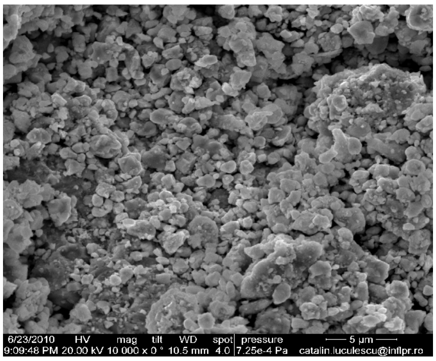

Fig. 10. SEM micrograph of the mixture, **K30 (65)–Cu (35)** alloying time: 10 hours

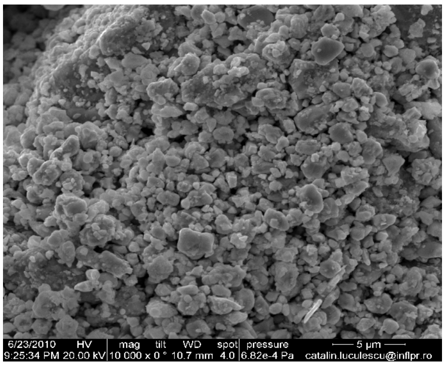

Fig. 11. SEM micrograph of the mixture **K30 (65)–Cu (35)** alloying time: 15 hours

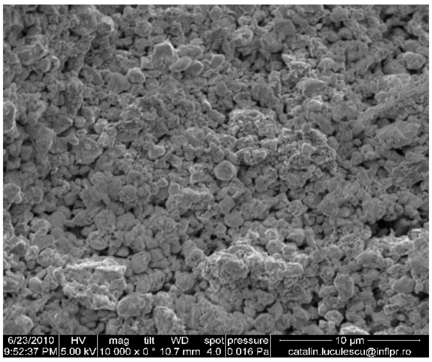

Fig. 12. SEM micrograph of the mixture **K30 (70) – Cu (30)** alloying time: 5 hours

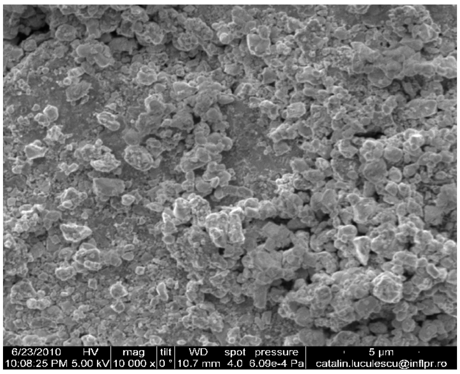

Fig. 13. SEM micrograph of the mixture **K30 (70)–Cu(30)** alloying time: 10 hours

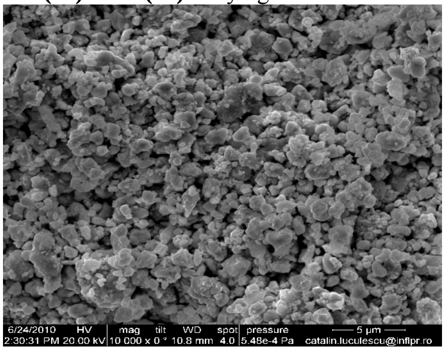

Fig. 15. SEM micrograph of the mixture **K30 (75)–Cu (25)** alloying time: 5 hours

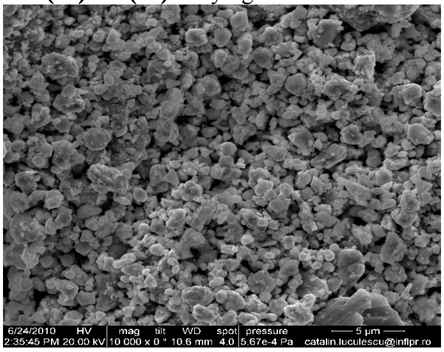

Fig. 16. SEM micrograph of the mixture **K30 (75)–Cu (25)** alloying time: 10 hours

5. CONCLUSIONS

In order to elaborate the W-Cu nanostructured powders, the mechanical alloying technique was used.

From SEM analysis it is observed that the particles are agglomerated specially at higher times of mechanical alloying. There is difference between copper particles and tungsten particles.

The shape for all the three samples obtained after 8 hours of mechanical alloying by friction mode, respectively shock mode, is irregular.

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