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SYNTHESIS AND SINTERING OF THE W / CU PSEUDOALLOY*

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Over the past decade, the development and synthesis of bimetallic nanomaterials has attracted much attention due to their functionality, mechanical properties, catalytic activity, and other characteristics compared to monometallic nanomaterials [1]. Alloys W - Cu are widely used for the manufacture of heavy-duty electrical contacts and electrodes [2]. Copper provides high conductivity, while tungsten provides mechanical strength, tribological resistance and hardness.

Recently, there has been increased interest in W-Cu pseudoalloys due to their excellent temperature control properties and high microwave absorption capacity. Due to the mutual insolubility of the elements, it is difficult to form microscale composites of this system by solid-phase and liquid-phase sintering, or the formed composites have anisotropy of properties. Obtaining a nanopowder in the process of explosion, and not from mixtures of powders, makes it possible to obtain a structure with a uniform distribution of elements over the volume, which leads to isotropy of properties at the microlevel [3].

In the present study, bimetallic nanoparticles were obtained by electric explosion of two wires, one of which is W and the other is Cu. Wires of a certain diameter were chosen, so that the Cu content did not exceed 30%. The synthesized powders were passivated in the atmosphere to reduce their pyrophoricity.

The powder is represented by both micro- and nanoparticles. In this case, the maximum size of microparticles is 10 μm, and the nanostructure as a whole is preserved. The study of the elemental composition shows the presence of tungsten and copper, the W:Cu ratio is 70:30 by weight. Oxygen is present in an amount of not more than 10 at.% on the surface of the particles. Its presence is associated with the passivation of the powder in air. The phase composition shows the presence of small amounts of tungsten oxide (identical to β-W), in addition to pure α-W and Cu.

The pressed W-Cu powders were sintered at different temperatures. Initially, the samples have high porosity, which is associated with poor compressibility of the powders. The porosity of raw samples is at the level of 16% and begins to decrease with an increase in the sintering temperature. Above 900°C, a sharp shrinkage of the sample occurs, associated with the approach to the melting point of copper (T_{melt} = 1085°C, T = 900°C = 0.83 T_{melt}). When Tm is reached, the density reaches 98% and further growth stops. The established sintering modes indicate the need for sintering at a temperature not lower than 950 °C to increase the density of the samples. The experimentally obtained behavior of W-Cu powder shrinkage during sintering as a function of temperature is confirmed by literature data on this system [4].

The microhardness (HV 0.5/10) of the samples after sintering at 1000°C is 2.2 ± 0.2 GPa. The hardness of the composite is 1.95 GPa calculated according to the rule of mixtures:

$$H = n_W H_W + n_{Cu} H_{Cu}$$

where H_W and H_{Cu} are the theoretical hardness of W and Cu, respectively, n_W and n_{Cu} are the proportional contents of W and Cu, respectively, $n_W + n_{Cu} = 1$). The hardness of the obtained samples is higher than expected due to the presence of dispersed particles W in the material. The particle size W does not change after sintering due to the relatively low temperature of the process.

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