Synthesis of tungsten carbides submicron powder with high-frequency electroerosion method

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Introduction

The main application of tungsten carbides (WC, W2C) is the manufacture of tools with high wear resistance (for example, cutting tools), in which ultra-high hardness is required in combination with maximum viscosity, which are provided by the nanodispersed structure of the material. However, the existing methods of obtaining tungsten carbides, based on the direct reaction of metal powder or metal oxide with carbon when heated to 1800 °C for several hours, make it impossible to obtain nano-sized powder due to the consolidation of the nano-sized fraction. Instead, electroerosive treatment of metals is based on the flow of large pulsed currents (duration from 100 ns to 10 ms and amplitude from 10 to 10,000 A) through the contact between granules of metal (or different metals), which are placed in a carbon-containing liquid. At the same time, the amount of materials (metal and working fluid) that evaporates, and the dispersion and number of reaction products can be regulated by changing the duration or magnitude of the current flowing through the metal granules, that is, by regulating the energy of the spark discharge and changing the frequency. Energy costs for the production of tungsten nanocarbides by this method will be relatively low, since the energy required for both metal vaporization and hydrocarbon liquid destruction is injected directly into the contact point by pulses, so there are almost no costs for unnecessary heating of the environment. When reducing the amount of energy in the pulse, the minimum amount of tungsten granule metal will evaporate and the formed carbide particles will be smaller in size. But minimizing this energy will lead to a significant decrease in productivity. Therefore, along with reducing the energy in the pulse, it is necessary to increase the frequency of their tracking to increase the productivity of the method.

Therefore, the development of a method for obtaining powder of nanosized tungsten carbides using high-frequency electrospark treatment of pure metal in carbon-containing liquids is an urgent scientific task.

The research goal: to develop a method of high-frequency electroerosion synthesis of submicron powders of tungsten carbides

A high-frequency electroerosion method for the synthesis of submicron tungsten carbide powder from tungsten granules in a carbon-containing organic liquid has been developed. The developed pulsed power supply (Fig.1) provides the specified characteristics of discharge current in the range from 10 to 100 A and voltage in the range from 100 to 600 V. Electroerosion treatment of tungsten according to the developed method in a carbon-containing liquid allows obtaining nanosized tungsten particles. Electroerosion treatment of tungsten in water allows obtaining nanosized tungsten particles. The specified performance of up to 3 g/hour of tungsten carbides is achieved by the high frequency up to 10 kHz of discharge pulses passage. The specific energy consumption of the synthesis of tungsten carbides reaches 20 g/kW*hour.

The image of the surface morphology of the particles of the obtained powder obtained with JSM-6700F scanning electron microscope confirms that the particles have the linear size from 40 to 200 nm (Fig.2, Fig.3). Nanosized particles form submicron globules, which are easily divided into nanosized components.

X-ray structural analysis of the obtained powder from tungsten granules in a carbon-containing organic liquid, which was carried out on DRON-4-07 diffractometer with the copper tube, showed fractions of tungsten and tungsten carbides (Fig.4).

Conclusion. The developed method of high-frequency electroerosion treatment of pure metal in carbon-containing liquids and the equipment created for its implementation make it possible to obtain a powder of nanosized tungsten carbides.

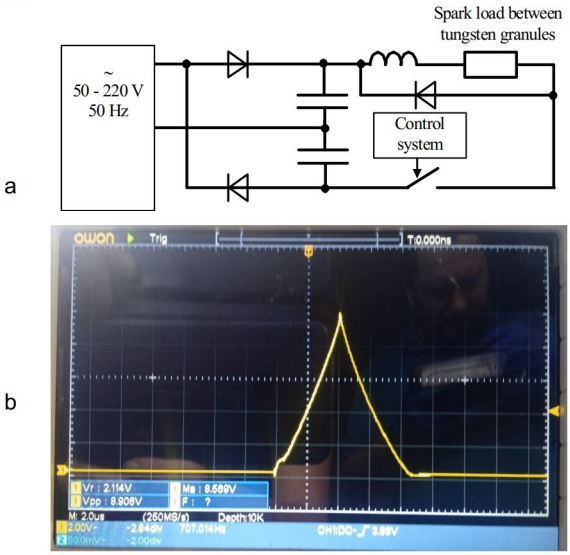

Fig.1. Power circuit of pulsed power supply for high-frequency electroerosion method for the synthesis of submicron tungsten carbide powder from tungsten granules in a carbon-containing organic liquid (a) and spark current pulse shape (b)

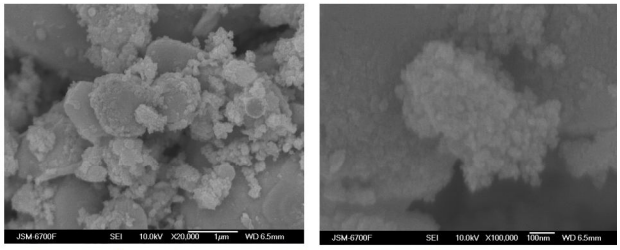

Fig. 2 The surface morphology of the obtained powder particles from tungsten granules in a carbon-containing organic liquid

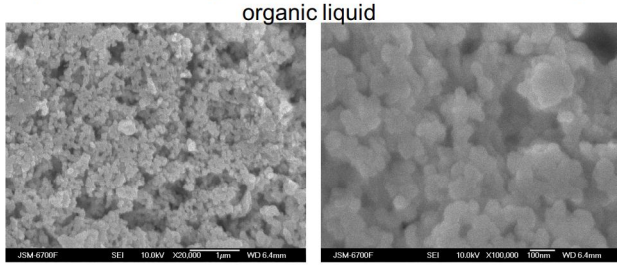

Fig. 3. The surface morphology of the obtained powder particles from tungsten granules in a water

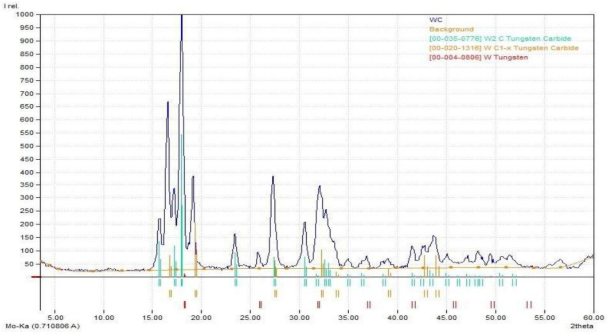

Fig. 4. X-ray structural analysis of the obtained powder from tungsten granules in a carbon-containing organic liquid