ANALYSIS OF ELECTRICAL CHARACTERISTICS OF CERAMICS ON THE BASIS OF ZnO-Bi_2O_3, OBTAINED BY SPARK PLASMA SINTERING*

A.A. SIVKOV[1], A.S. IVASHUTENKO[1], I.A. RAKHMATULLIN[1], YU.L. SHANENKOVA[1], A.I. TSIMMERMAN[1]

[1]National research Tomsk Polytechnic University Lenin Avenue 30, Tomsk, 634050, Russia, alextsimmer@yandex.ru, +7(952) 893-87-32

Ceramic zinc oxide varistors are the most promising fast-acting means of protecting electrical circuits from impulse overvoltages. They have high non-linearity of electrical characteristics. Due to the recent need to protect semiconductor control circuits of power equipment, the limiting voltage of which only slightly exceeds the operating one, it is important to increase the nonlinearity of varistors in the field of switching currents, limiting overvoltage to a safe level [1].

Obtaining ceramic samples from nanopowders is a challenge. Currently, effective methods of pressing powdered materials include the following methods: hot pressing, hot isostatic pressing and spark plasma sintering (SPS). The main advantage of the SPS is the speed of the process of consolidation of powders [2]. The paper considers the possibility of sintering powdered materials of the ZnO-Bi_2O_3 system, obtained by the method of plasma dynamic synthesis (PDS) [2, 3] and under commercial conditions. The PDS method does not require preliminary preparation of the main precursors - zinc and oxygen. Zinc enters the plasma due to the electroerosive wear of the zinc barrel and is carried into the reactor chamber, which is pre-filled with oxygen. In addition, the channel of formation of the plasma structure can be filled with additional precursors (for example, bismuth), which also enter the plasma structure when initiating the arc discharge. Metallic bismuth Bi (purity 99%) in the form of a powder with an average particle size of about 100 microns was inserted into the channel of formation of the plasma structure of a high-current discharge at the beginning of the accelerating channel (AC) of the zinc barrel of a coaxial magnetoplasma accelerator (CMPA). During the course of the arc according to the AC, the production of the base material, zinc, which enters the plasma structure, in which bismuth is already present, occurs. After that, the plasma structure is carried into the chamber, where it enters into a plasma-chemical reaction with oxygen. The collection of the highly dispersed fraction of the product was carried out after its complete precipitation from the suspension on the walls of the reactor chamber. The sample was sintered using the IPA method in vacuum in a graphite mold under a pressure of 60 MPa and at a sintering temperature T = 1200 ºC.

The paper shows the possibility of obtaining ultrafine composite materials of the ZnO-Bi_2O_3 system with the core-shell structure using a high-current high-voltage coaxial magnetoplasma accelerator. In addition, studies have been conducted on the consolidation of materials by the method of spark plasma sintering. Sintered ceramics based on the PDS product is characterized by the fine-grained structure of zinc oxide ZnO (average grain size 1.3 μm) with a uniformly filled intergranular space bismuth oxide Bi_2O_3. Analysis of the current-voltage characteristics of ceramics of different composition showed a significant advantage (nonlinearity coefficient, breakdown voltage, leakage current) of using the PDS ZnO-Bi_2O_3 product with the core-shell structure compared to commercial materials.

REFERENCES

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