HIGH VOLTAGE CONSOLIDATION OF TUNGSTEN CARBIDE – COBALT ALLOY AND HAFNIUM CARBIDE

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The method of high-voltage electric pulse consolidation (HVC) of high-temperature ceramic powder materials based on refractory metal carbides allows you to localize the high energy density of the electromagnetic pulse in the areas of interparticle contacts. Due to intense heating, the material in the zones of interparticle contacts becomes more plastic. This contributes to intense plastic deformation of the material under the influence of external pressure. The combination of a short (duration $\tau \sim 10^{-3} \div 10^{-4}$ s) high-voltage electric pulse (with a current density amplitude $j \sim 10^9$ A/m^2) and simultaneous exposure to mechanical pressure (P ~ 10^8 Pa) causes a high-speed deformation of the powder material localized in the contact region, which leads to the formation of a dense structure of the consolidated material. There is a limitation on the amplitude of the current density in the zone of interparticle contact, the excess of which leads to the effect of "electric explosions contact". A theoretical analysis of the processes occurring in the contact region [1] made it possible to establish the critical value of the current density j_*, for $j \geq j_*$ there occurs an “electric explosion of the contact”:

$$j_* = \sqrt{\frac{2\xi\sigma}{\rho h}} T_b^2 \qquad (1)$$

where: σ is the Stefan – Boltzmann constant; $\xi \leq 1$; T_b is the boiling point (loss of conductivity) of the material, ρ is resistivity, h is the size of the contact region with temperature T_b.

The method of high-voltage electropulse consolidation and the experimental setup are given in [2]. The values of the main technological parameters of electropulse consolidation (applied pressure and amplitude of a high-voltage current pulse) were experimentally determined to obtain dense consolidated samples of tungsten-cobalt carbide and hafnium carbide.

The results of a study of the microstructure of the samples consolidated powder materials by HVC: tungsten carbide–cobalt alloy and hafnium carbide are presented on Fig. 1 and Fig. 2 respectively.

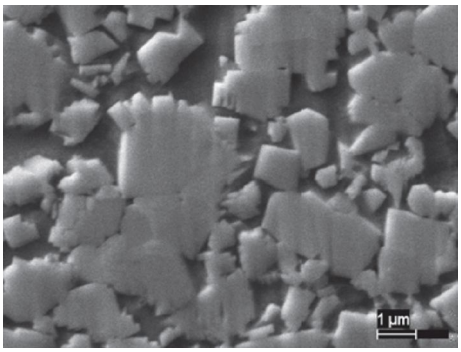

Fig. 1. Microstructure of WC–20%Co obtained by HVC

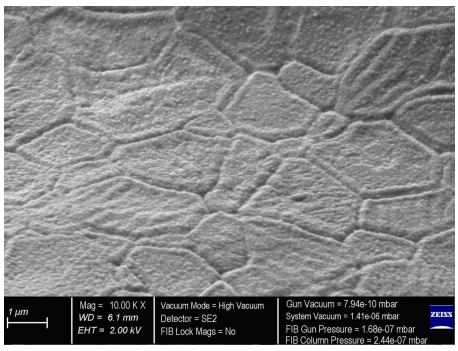

Fig. 2. Microstructure of HfC obtained by HVC.

High-voltage consolidation ensures the preservation of the initial fine-grained structure of the consolidated materials, a uniform distribution of the cobalt binder in the tungsten carbide–cobalt alloy, and an almost complete the absence of porosity in consolidated samples of WC–20%Co and HfC.

The presented work is a generalization of the results of work on the RFBR project No. 12-08-90400-Ukr_a.

REFERENCES

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