# MORPHOLOGY OF COATINGS OBTAINED BY COLD GAS-DYNAMIC SPRAYING METHOD

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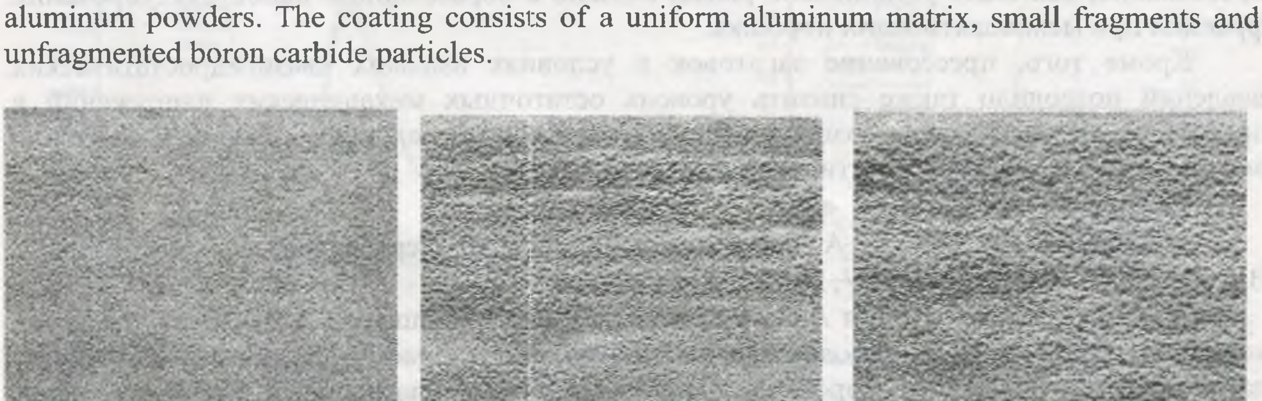
The intensive development of nuclear power and industry, the wide implementation of nuclear energy facilities in practically every sector of human activity pose a problem for the implementation of radiation protection requirements for ensuring radiation safety. Today organic and inorganic radiation shielding materials and mixtures are widely used in the field of nuclear. Having excellent mechanical properties pure metals and alloys in the rate of high radiation are subject to considerable swelling as well as because of changes in structure. These structural changes can be prevented by using materials that are subjected to weak swelling and by modification of ceramic fillers. Due to the introduction of various fillers in a matrix, selection of composition, changes of component ratio the radiation protection and other properties of a composite can be controlled [1].

Modern radiation-protective metal-composite materials are artificial composite materials combining plastic metallic matrix (aluminum, lead, copper, tin, etc.) and solid metallic and nonmetallic reinforcing components both of natural and artificial origin (granite, basalt, limestone, dolomite, expanded clay, iron oxide systems, etc.) [2].

The use of nanosized powder particles of radiation absorbing materials (BN, $B_4C$, Pb, and W) increases the neutron absorption rate at 1.5 times and the dispersion coefficient of gamma ray emission at 30÷40% [4]. For obtaining composite coatings containing boron carbide using cold gas- dynamic spraying method a mixture of powders prepared by different methods has been used [5, 6]. This is a mechanical mixture, for example, Al-12Si matrix and 20 wt.% of boron carbide particles [5], $B_4C$ powders plated with nickel [6]. The initial powder for deposition was a powder mixture of aluminum, aluminum oxide and boron carbide of 30÷50 μm particle size and had the following composition: Al - 5 wt.% $B_4C$, Al - 5 wt.% $B_4C$ - 5 wt.% $Al_2O_3$, Al - 5 wt.% $B_4C$ - 10 wt.% $Al_2O_3$.The coatings were deposited on the aluminum substrate at a temperature of 420°C by gas-dynamic spraying method with temperature stabilization of the carrier gas within 5°C. The obtained composite powder coatings were investigated by optical and scanning electron microscopy.

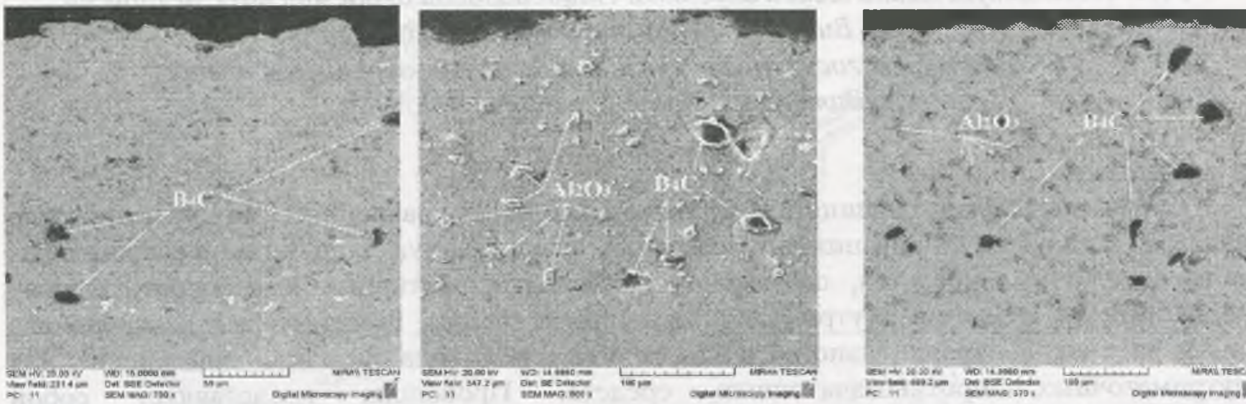
Fig. 1 shows the obtained protective coatings based on dispersed boron carbide and aluminum powders. The coating consists of a uniform aluminum matrix, small fragments and unfragmented boron carbide particles.




a) b) c)

Fig. 1.- Coating surfaces based on Al-B4C with the initial powder mixture obtained by gas-dynamic spraying method: a)Al- 5 wt.% $B_4C$; b) Al - 5 wt.% $B_4C$ - 5 wt.% $Al_2O_3$ ; c) Al - 5 wt.% $B_4C$ - 10 wt.% $Al_2O_3$

The deposition aluminum oxide coating causes the uneven distribution of $B_4C$ particles and uniform $Al_2O_3$ in aluminum matrix. Introduction of aluminum oxide into the initial mixture (5 or 10 wt.%) increases the proportion of powder mixture from 1.9% (without aluminum oxide) to 3.1% or 4.0% that leads to increasing the thickness of the deposited coating from 180 μm to 420 μm. The obtained coatings are homogeneous, free of voids or cracks, no delamination of the coating from the substrate (Fig. 2).




a) b) c)

Fig.2.- SEM image of the coating on aluminum substrate and $B_4C$ particle and $Al_2O_3$ in aluminum matrix. The initial mixtures: a) Al- 5 wt.% $B_4C$; b) Al - 5 wt.% $B_4C$ - 5 wt.% $Al_2O_3$ ;c) Al - 5 wt.% $B_4C$ - 10 wt.% $Al_2O_3$

Thus, coatings based on boron carbide can be used as a multipurpose radiation protection material for manufacturing of shipping containers for transport of spent nuclear fuel, protective shield doors of nuclear reactor, etc. The technology can be used for protection of electronic components and armaments systems, military and medical defenses, protection of power systems, communications and transport systems, especially in emergency situations.

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