STUDY OF THE TITANIUM-BASED COATINGS STRUCTURE OBTAINED BY THE COLD SPRAY DEPOSITION METHOD

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The work presents the results of study of the titanium-based coatings structure obtained by the cold spray deposition method.

Keywords: cold spray deposition, powder metallurgy, coating, titanium alloys, powders

Introduction. Titanium alloys are being used in an increasing number of applications in various industries due to their unique physical and mechanical properties. There is a need for materials with enhanced damping properties in many industries (aerospace, engineering, military, and others). The creation of porous products based on titanium, characterized by the finest specific strength, is one of the encouraging directions in developing damping and energy-absorbing materials. Currently, titanium alloys are characterized by relatively low values of these required characteristics, and products made from them, obtained by traditional casting and hot deformation technologies, are quite expensive, which limits their use. Therefore, developing economic technologies for obtaining titanium materials with improved damping and energy-absorbing characteristics is an important area of research. Titanium is also valued for its unique combination of high specific strength, lightness, and corrosion resistance.

Experiment. In this work, the method of low-pressure Cold Gas Dynamic Spraying (CGDS) of titanium powders was used to create a surface layer with controlled porosity on a massive (non-porous) substrate. Experiments were carried out to create and study bulk coatings obtained from a composition of powder materials based on titanium (Table 1). To avoid oxidation of powder particles, argon was used as a working carrier gas. The pressure and temperature settings of the gas flow were 8 kgf/cm^2 and 300 - 400 °C.

As starting materials for the preparation of composite mixtures, industrial aluminum powder with a size of less than 63 μm and electro corundum F 240 powder (size near 50 μm), as well as laboratory-made titanium and titanium hydride powders (titanium sponge) were used. Titanium hydride was sifted through a 63 μm sieve and annealed in a vacuum furnace at a temperature of 600°C for 30 minutes.

Results and discussion. Titanium powder was obtained as a result of annealing, which further was mixed with aluminum powder and electro corundum in the proportion from Table 1 and was used for sputtering.

Based on the results of applying composite powders, a quantitative calculation of the material deposition was made (Table 1).

Table 1. Composition of powder.

Sample	Ti, %	Al, %	TiH_2	Al_2O_3, %	Deposition, %	Average hardness, HV
1	70	–	–	30	7.6	166.2
2	62	15	–	23	9.6	108.3
3	52	22	–	26	10.1	105.9
4	–	22	52	26	4.1	–

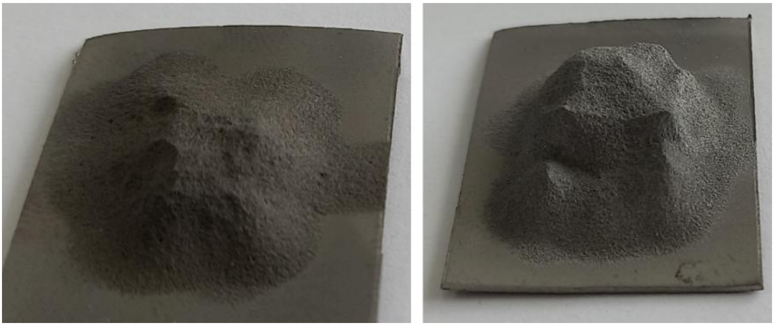

Fig. 1. Photo of samples obtained by the low-pressure CGDS method.

The resulting bulk coatings were annealed in a vacuum furnace at 1000 °C for 60 minutes.

The experiment showed that the powder composition based on titanium hydride has a poor deposition rate on the surface and that the resulting coating is characterized by a significant number of pores after spraying, therefore this mixture was not studied in further work. The study of the coating structure showed that the number and size of pores decreased with an increase in aluminum content in the powder composition.

Figures 2 and 3 show the distribution of chemical elements from which it can be concluded that the coatings have a quite uniform distribution of chemical elements with a significant change in the aluminum content in the transition from the substrate to the coating (Fig. 2). And also founded the presence of electro corundum particles in the coating.

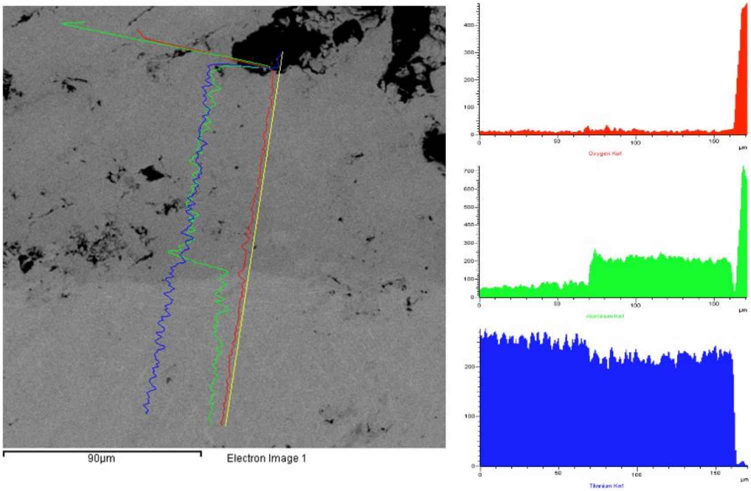

Fig. 2. Distribution of chemical elements during the transition from the substrate to the coating (red – oxygen; green – aluminum; blue – titanium).

Fig. 2 shows an obvious transition from the substrate to the coating, which is accompanied by a significant change in the aluminum content. There is almost no obvious transition between the substrate and the coating in the case of the deposition of a mixture of titanium without aluminum.

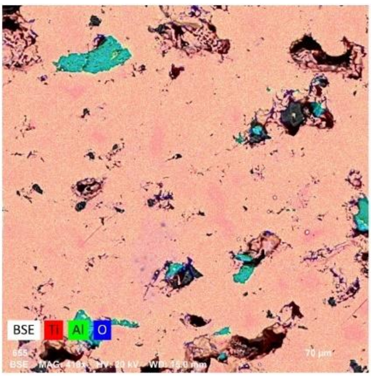

Fig. 3. Chemical analysis of the coating.

Conclusions. In work established that the low-pressure Cold Gas Dynamic Spraying method can be used to create titanium-based coatings with specified parameters of porosity and other mechanical properties.