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EFFECT OF IRRADIATION WITH A PULSED ION BEAM ON THE MORPHOLOGY, STRUCTURE, AND CHEMICAL STATE OF SURFACE LAYERS OF TUNGSTEN-FREE HARD ALLOYS

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Titanium carbide-based tungsten-free hard alloys (TFHA) are an inexpensive alternative to traditional hard alloys. One of the promising methods for modifying the structure and properties of hard alloy materials is their irradiation with pulsed energy flows: ions and electrons of micro- and nanosecond duration. There are works [1,2] in which a significant positive effect of these types of impact on the performance properties of tools made of traditional hard alloys based on WC. However, the study of the influence of various modes of ion modification on the change in the composition and properties of TFHA has not been studied enough, but is of great scientific and practical interest. In this paper, we study the influence of the impact of a pulsed ion beam (PiB) of nanosecond duration on the change in the morphology, structure and chemical state of TFHA of the "TiC-TiNi" system. The samples were irradiated at the «Temp» accelerator with a proton-carbon beam (30% H^+ and 70% C^+). The particle energy E was ≈250 keV. The duration of the irradiation pulse is $\tau \approx 60$ ns., beam current density ≈ 150 A/cm^2.

On fig. 1 shows the Ti_2p XPS spectra of the TFHA composition of 50% TiC-50% TiNi in the initial state (a) and after irradiation to one PIB pulse (b).

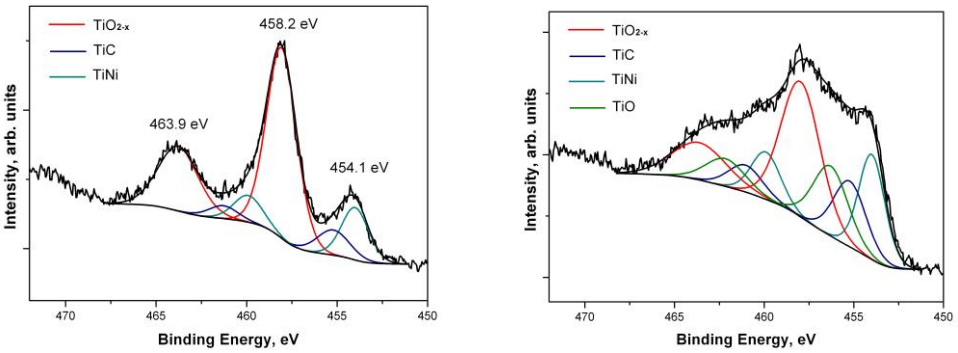

Fig.1. XPS Ti_2p spectra TFHA 50% TiC – 50% TiNi: (a) – initial, (b) – irradiated sample

In the initial state, the spectrum of titanium Ti_2p consists of three component, maximum which are located on the binding energies: 458.2 eV, 455.2 eV and 454.1 eV. They correspond to defective nonstoichiometric oxide TiO_{2-X}, titanium carbide TiC, and titanium in the metallic state Ti^0, respectively [3]. In the spectrum of the irradiated sample, the intensity of the components corresponding to metallic titanium in the composition of the TiNi binder and titanium carbide TiC increases significantly. Formation of Ti-C bonds can proceed with the participation of the reaction of adsorbed free carbon on the surface of the sample and metallic titanium, as part of the TiNi binder, as a result of high-temperature beam exposure.

The impact of PIB leads to a significant melting of the surface of the TFHA "TiC-TiNi". On the basis of experimental studies, it has been established that this type of irradiation leads to an increase in the microhardness of the studied TFHA by ~ 20% and the resistance of samples to gas corrosion at high temperatures. The results obtained in the work can be used in the development of technological processes for the surface modification of titanium-based hard alloys.

REFERENCES

[1] V.V. Uglov, A.K. Kuleshov, G.E. Remnev, M.S. Saltymakov, V.M. Astashinsky "Modification of T15K6 hard alloy by powerful pulsed ion beams and compression plasma flows," Izv. Vuz. Porosh. Metal. i Fun. coat. no. 3, pp. 63-68, 2011.

[2] S.N. Povoroznyuk, K.N. Poleshchenkov, G.A. Vershinin, P.V. Orlov "Variation of surface properties of hard alloys exposed to ion beams of various intensity," Surf. Inv.: X-Ray, Synch. and Neutr. Techn. Vol. 15, no. 5, pp. 791-796, 2000.

[3] A.M. Badamshin, S.N. Nesov, V.S. Kovivchak, S.N. Povoroznuyk, V.V. Akimov "The Influence of Ion Irradiation on the Morphology and Elemental and Chemical Composition of Surface Layers of Tungsten-Free Hard Alloys, " Tech. phys. let.. Vol. 47, no. 3, pp. 757-760, 2021.