PHASE AND STRUCTURAL TRANSFORMATIONS IN CHROMIUM NITRIDE UNDER THE ACTION OF A POWERFUL CARBON ION BEAM

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Methods of surface treatment of various materials based on the use of powerful pulse beams (MIP) of accelerated ions can effectively affect the structural-phase state and various physical and mechanical properties of the near-surface layers of these materials. The overwhelming number of experiments published to date on the treatment of structural materials with charged particle streams is related to the study of the interaction of powerful ion beams (MIP) with metals and alloys. Experiments on the effect of MIP on materials obtained by SHS-methods, practically not conducted. Therefore, this paper presents the results of studies of the impact of MIP carbon ions on the structural-phase state of the near-surface layer of chromium nitride obtained by SHS-method.

Samples for the studies were cut from chromium nitride produced by self-propagating high-temperature synthesis (SHS). Experiments on irradiation of chromium nitride samples with a powerful pulsed beam (MIP) of carbon ions were carried out on the Temp-4M gas pedal. The energy density affecting the surface of the samples was determined by the number of impulses N = 10. The detailed methodology of treatment of MIP materials with carbon ions is given in [1]. The phase composition and structure of the near-surface layers of the irradiated samples were investigated using a Shimadzu XRD 7000S diffractometer in Cu Ka - radiation in Bragg-Brentano geometry. Diffraction measurements were performed in sliding beam incidence geometry at angles of 3°, 10°, and 90°.

Figure 1 shows the diffractograms of SHS chromium nitride before and after its treatment with MIP of carbon ions. The diffractogram of unirradiated SHS chromium nitride shows diffraction reflections only from CrN and Cr_2N (Fig.1, a). Numerous studies show that only the near-surface regions of the materials treated by these beams are affected by high-power ion beams. Therefore, information about phase-structural changes occurring in the near-surface regions of materials during such treatment can be obtained from the analysis of X-ray data obtained in the sliding beam mode. Figure 1, b, c, d show the diffractograms of samples irradiated with a carbon ion beam (N = 10 impulses), when the X-ray beam is incident at angles of 3°, 10°, and 90°, respectively. On the diffractogram obtained at 3°, there is a decrease in the intensity of reflections belonging to chromium nitrides, on the one hand, and on the other hand, their broadening. On the diffractogram, taken at an angle of incidence of the X-ray beam 10°, the intensity of reflections of chromium nitrides increases, the broadening is preserved (Fig.1, c). In the diffractogram taken at an angle of incidence of the beam - 90° there are reflections only from chromium nitrides, as in the unirradiated The broadening of the reflections can be explained by partial amorphization of the near-surface regions, as well as the introduction of carbon into the lattice of chromium nitrides. In the diffractogram taken at an angle of incidence of the beam - 90° there are reflections only from chromium nitrides, as in the unirradiated sample (Fig.1, d).

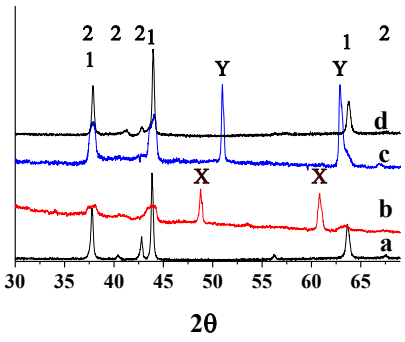

Fig.1 Diffractograms of SHS chromium nitride initial (a) and irradiated with carbon ion beam obtained at X-ray beam incidence at angles of 3° (b), 10° (c) and 90° (d), 1 – CrN, 2 – Cr_2N

REFERENCES

[1] G.V. Potemkin et al. Phase transformations in nitrided ferrovanadium under the action of a high power carbon ion beams. Physics and Chemistry of Materials Treatment, № 5, 2020.