ARC DISCHARGE PLASMA SYNTHESIS AND PROPERTIES OF HIGH-ENTROPY CARBIDE TIVNBHFTAC$_5$*

A.I. KOKORINA[1], *A.A. SVINUKHOVA*[1]

[1]*Tomsk Polytechnic University, Tomsk, Russia*

High-entropy carbides are an equimolar solid solution of 4-6 transition metals with a cubic crystal lattice of the NaCl type [1]. The most stable are high-entropy carbides of five metals. These materials are characterized by high melting point, high strength and high hardness [2]. In this work, powders of high-entropy carbide TiVNbHfTaC$_5$ were obtained in arc discharge plasma in an open-air environment. After synthesis, the obtained powder was treated with spark plasma sintering.

Before the synthesis, an equimolar mixture of the starting reagents (powders of Ti, V, Nb, Hf, Ta and C) was homogenized in a ball mill for 12 hours at a frequency of 30 Hz. All experiments were carried out on a laboratory DC electric arc reactor in the 200 A, 45 s mode. The main elements of the reactor were the graphite anode and cathode. The anode was made in the form of a rod, the cathode - in the form of a crucible. The mixture of starting reagents was placed into the crucible.

The electric discharge was initiated by briefly bringing the anode to the cathode. According to X-ray phase analysis (Fig. 1), it was found that the synthesis product contains high-entropy carbide TiVNbHfTaC$_5$.

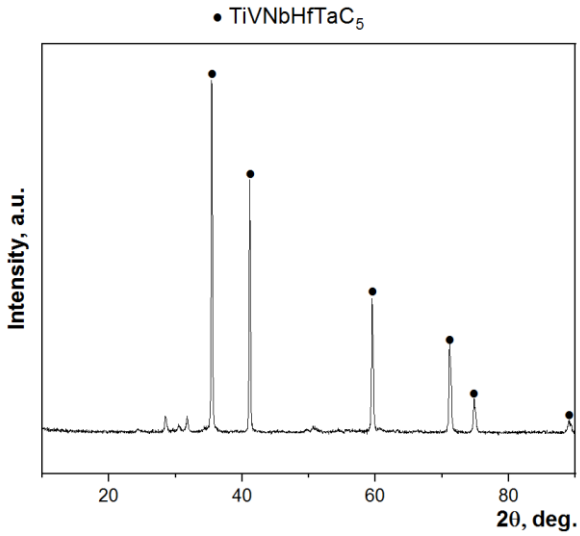

Fig.1. X-ray diffraction pattern of synthesized high-entropy carbide powder.

. Then the resulting powder was sintered using spark plasma sintering at pressure 35 MPa, temperature 2000 ºC for 8 minutes.

Morphology of the obtained powder was investigated using scanning electron microscopy, thermophysical properties (heat capacity, thermal conductivity and thermal diffusivity) were measured using the laser flash method and also Vickers hardness measurement was carried out.

REFERENCES

[1] A. Ya. Pak, V. Sotskov, A. A. Gumovskaya, Yu. Z. Vassilyeva, Zh. S. Bolatova, Yu. A. Kvashnina, G. Ya. Mamontov, A. V. Shapeev, and A. G. Kvashnin, “Machine learning-driven synthesis of TiZrNbHfTaC$_5$ high-entropy carbide, npj Computational Materials,” npj Computational Materials, vol. 9, no. 7, pp. 1-11, Jan. 2023, doi: 10.1038/s41524-022-00955-9.

[2] S. Zhang, F. Qin, M. Gong, Z. Wu, M. Liu, Y. Chen, and W. Hai, “Microstructure, Mechanical and Tribological Properties of High-Entropy Carbide (MoNbTaTiV)C$_5$,” vol. 16, no. 11, pp. 4115, May 2023, doi: 10.3390/ma16114115.

* The work was supported by Russian Science Foundation (project No. 21-79-10030).