FORMATION OF BULK WC_{1-X}-BASED COATINGS ON METAL SUBSTRATES AT HIGH-SPEED SPUTTERING OF ELECTRIC DISCHARGE PLASMA JET*

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Since R.B. Levy and M. Boudart [1] has theoretically proved that tungsten carbide has catalytic properties similar to those of the platinum group metals for some chemical reactions, scientists have actively begun attempting to use it as a catalyst for the hydrogen production. It is known that the widely used hexagonal phases WC and W_2C, as well as the metastable cubic high-temperature modification WC_{1-x} ($0<x<0.42$), can be formed in the W-C system [2]. The main obstacle in the way of studying this cubic phase is the difficulty of its obtaining compared to the hexagonal W_2C and WC phases (narrow synthesis temperature range from ~ 2790 K to ~ 3060 K; transition to a hexagonal structure at slow cooling). However, there are some reports about the possibility of existing WC_{1-x} at room temperature [3], as well as it is believed that it can be obtained from the melt [2] with a crystallization rate of at least 10^8 K/s [4]. In addition to an ambiguity in the issues of obtaining the cubic tungsten carbide phase (WC_{1-x}) in the form of powdered materials, there is a difficulty in obtaining a bulk sample, consisting in the phase transition from a cubic to a hexagonal lattice at a temperature above 700-800 °C [5]. This is one of the main obstacles and the reason why the bulk material has still not been synthesized and, accordingly, its structural, physico-mechanical, thermal and electro-physical characteristics have not been investigated.

Overcoming the above-mentioned obstacles of obtaining and studying WC_{1-x} powdered material is possible by implementing a synthesis process in a high-speed plasma flow containing carbon and tungsten atoms and generated by using a high-current (up to 10^5 A) pulsed (500 μs) coaxial magnetoplasma accelerator of an electric erosion type. The distinctive features of the considered system are a high crystallization rate (10^7-10^9 K/s) and the versatility that allows synthesizing various materials (carbides, nitrides, oxides) in ultrafine form. The preliminary exploratory studies have already shown the possibility to synthesize the nanoscale cubic phase of tungsten carbide by this method [6].

This work presents the studies on the implementation of plasma dynamic method to create bulk coatings, predominantly containing cubic tungsten carbide, on the surfaces of metal substrates. It is found that using the plasma dynamic method it is possible to reach the yield of the WC_{1-x} phase in the coating structure of 85 wt. %. Such sufficient concentration of the WC_{1-x} phase allows estimating its physico-mechanical properties and completing the information about materials in the "W-C" system.

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