Session [D]
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Секції [D]
Фізика радіаційних та іонно-плазмових технологій

SYNTHESIS, STRUCTURE AND PROTECTIVE PROPERTIES OF PVD MAX PHASE-BASED COATINGS

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Surface modification technologies have attracted the attention of many researchers as an effective way to improve the complex properties of materials. In recent years, protective ceramic coatings made of MAX phases have gained popularity among many other composite coatings. MAX phases are nanolaminated hexagonal carbides and nitrides with the general formula $M_{(n+1)}AX_n$ (M: early transition metal, A: Group IIIA or IVA element, X: carbon or nitrogen, n = 1-3 or higher). They contain successive layers of octahedral $M_{n+1}X_n$ and pure A elements with covalent ionic bonds MX and metallic MA. The special nanometer layer structure and combined bonding type give MAX ceramic phases the advantages of both metallic and ceramic materials. As a result, they have a high Young's modulus, damage resistance and self-healing ability, resistance to high-temperature oxidation and radiation, corrosion resistance and wear resistance, combined with electrical conductivity and good thermal properties [1]. Therefore, the synthesis of MAX phases in the form of coatings is of increasing interest for many applications [2].

Successful development of MAX phase coatings requires an understanding of how the production method and deposition parameters affect the composition, crystallographic structure and morphology [3, 4]. In turn, it is important to know how they determine the physical, mechanical and technological properties of the resulting material.

The purpose of this review is to summarize the progress made in the field of protective coatings based on MAX phases in Ukraine. The first part of this review discusses the advantages and characteristics of the synthesis of such coatings using ion-plasma physical vapor deposition (PVD) methods [3-5]. The purpose of the second part is to consider the properties of MAX phases that make them useful for creating multifunctional coatings to protect the surface of materials operating under difficult conditions of high temperature [4, 5] and wear [6]. Special attention is paid to the influence of PVD deposition parameters on the structure and properties of coatings. Cathodes in the form of 60 mm diameter and 5 mm thick discs based on the MAX phase Ti_2AlC, were produced using a single-stage technology. The process involved hot pressing of TiH_2, TiC, and Al powders at 1350 °C and 30 MPa pressure for 30 minutes. The coatings from the cathodes based on the MAX phases were deposited by three PVD methods: ion-plasma sputtering with gas plasma, magnetron sputtering, and cathodic arc evaporation.

The possibilities of obtaining coatings with high protective properties and prospects of their application in various industries are considered.

The work was supported by the III-7-22 (0785) Project of the National Academy of Sciences of Ukraine "Development of wear-resistant electrically conductive composite materials and coatings based on MAX phases for the needs of electrical engineering, aviation, and hydrogen energy" and by the NATO project SPS G6292 "Direct liquid fuelled molten carbonate fuel cell for energy security (DIFFERENT)".

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