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STRUCTURAL AND FUNCTIONAL PROPERTIES OF CHROMIUM COATINGS DEPOSITED BY HIGH-RATE MAGNETRON SPUTTERING EHNAHCED BY RF-ICP SOURCE*

A.A. BONDAR[1], V.A. GRUDININ[1], G.A. BLEYKHER[1], D.V. SIDELEV[1]

[1]Tomsk Polytechnic University, Tomsk, Russia

Nowadays, magnetron sputtering techniques are of great interest for deposition of coatings with a wide range of structural and functional properties. A one pf the main disadvantages of magnetron sputtering is relatively low deposition rate (it is about 10-20 nm/s even for metal coatings). The deposition rate of coatings can be increased using an additional mechanism of target erosion (sublimation or evaporation) [1]. However, it becomes more difficult to tailor and control the properties of coatings due to the fact that the flux of evaporated (sublimated) particles has an extremely low kinetic energy (0.1-0.3 eV). To increase the averaged kinetic energy of particles, high-power pulsed power sources can be used. Moreover, an additional discharge plasma source can be applied to increase the ionization degree of the erosion particle flux. The present study is devoted to investigate the role of an external plasma source on the structural and functional properties of chromium coatings obtained by high-rate magnetron sputtering.

The chromium coatings were obtained using different discharge power density and with coating thickness (1, 3 and 5 μm). For this purpose, a high-power pulsed power supply in oscillating mode (DOMS) was used. In addition to it, a radio-frequency (13.56 MHz) plasma generator (RPG-128) was used as the external plasma source. X-ray diffraction (XRD, Shimadzu XRD-7000S with a CuKα accelerating tube) was used to study the crystal structure of the Cr coatings. Coating thickness was determined using a Calotest instrument (CSEM, Switzerland) and a scanning electron microscope (Quanta 200 3D). The hardness of the Cr coatings was measured using the Oliver-Farr method (Nanohardness Tester 2, CSM). The corrosion resistance of the Cr coatings on AISI 321 substrate was studied in a 3.5 wt.% NaCl solution using a P-45X potentiostat-galvanostat (Electrochemical Instruments, Russia).

It was found that the use of the external (additional) plasma source (RPG-128) allow to tailor the functional characteristics of the obtained Cr films. The hardness of 1 μm-thick Cr coatings are varied from 4 to 18 GPa depending on the power density. Typical hardness of Cr coatings obtained by magnetron sputtering is usually in a range of 7-11 GPa [2]. The hardness at the maximum power density (44 W/cm2) is 4 GPa, when the erosion particle flux is mainly formed by sublimation. It is typical for chromium films produced by a resistive evaporation [3]. So, the functional properties of the Cr films can have the parameters close to the films obtained by magnetron sputtering at low power density and to conventional magnetron sputtering at high power density.

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