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FEATURES OF HIGH-RATE DEPOSITION OF CRN_X COATINGS USING MAGNETRON SPUTTERING OF A HOT CROMIUM TARGET*

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Our previous studies have shown that the use of a hot chromium target undergoing sublimation can significantly increase the deposition rate of chromium coatings during the operation of magnetron sputtering systems [1, 2]. This circumstance was used for the synthesis of coatings based on chromium-nitrogen compounds, which are of great interest for various industries. It seems that in this case it will be possible to significantly increase the productivity of applying such coatings to the surface of products.

A new scheme for the synthesis of CrN_x films in an atmosphere of argon and nitrogen during the operation of a magnetron sputtering system has been developed and implemented in experiments. Its specifics are as follows. The inlet of argon and nitrogen is carried out separately in the space of the vacuum chamber. A magnetron with a hot chromium target operates in a metallic mode and creates a flow of atomic chromium particles on the substrate. To increase the reactivity of nitrogen, an assisting radio-frequency inductively coupled plasma (RF-ICP) source is used. The regions of the RF-ICP discharge and the nitrogen flow into the chamber are combined and are significantly distant from the region of the magnetron discharge localization. Experiments have shown that this technique reduces the flow of nitrogen particles to the surface of the magnetron target (i.e., prevents its "poisoning") and provides conditions for intensive dissociation and ionization of nitrogen, which are necessary for the synthesis of chromium nitride on the substrate surface.

The effect of target heating on the functioning of the magnetron discharge is investigated. It is shown that under these conditions there is practically no hysteresis in the behavior of current and voltage depending on the rate of nitrogen flow into the chamber. Analysis of the target substance after a series of experiments showed the absence of chromium and nitrogen compounds in it. The contribution of the sublimation of the chromium target to the increase in the deposition rate of the chromium and CrN_x coating with the increase in the magnetron power is revealed experimentally and by calculations. It has been shown that the dependence of the deposition rate on the magnetron power density is a nonlinearly increasing function of over 18 W/cm^2, and in the range from 18 to 28 W/cm^2 the target sublimation enables an increase in the deposition productivity by a factor from 2 to 12 compared with the cooled target sputtering under the same experimental conditions.

The elemental and structural-phase composition of the coatings deposited using the planetary rotation of substrates has been studied depending on a magnetron power density. It has been found that with an intense sublimation on the chromium target surface, the coatings have an inhomogeneous elemental and structural-phase composition. In addition, an alternation of chromium layers with a low content of chromium nitride and layers that mainly consist of chromium nitride has been determined.

The working parameters that most significantly affect the mechanical properties of the formed coatings are revealed. The important role of the type of power supply, the configuration of the magnetic field and the power of the RF-ICP source in providing high hardness and wear resistance characteristics is shown.

REFERENCES

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