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ENERGY FLUX TO THE SUBSTRATE IN THE PROCESS OF PULSED DUAL MAGNETRON DEPOSITION OF TIALN FILMS*

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Functional TiAlN coatings are now widely used in industry. Compared to TiN, they are more resistant to oxidation and have increased hardness and heat resistance. To obtain TiAlN coatings, various deposition methods are used, in particular chemical vapor deposition, vacuum arc deposition, ion plating and so on [1]. The paper presents the results of using a dual magnetron sputtering system with metal targets (Al and Ti) to obtain TiAlN films in a mixture of Ar and N_2. The power supply of the sputtering system has a wide range of regulation of frequency, pulse duration, as well as high values of pulsed current and voltage. The schematic diagram of the vacuum installation is shown in Fig. 1. The results of studying the influence of the frequency and duty cycle of pulses on the ion current density on the substrate, the coating deposition rate and the energy flux density on the substrate under a floating potential or at a bias potential of -100 V are presented. It is known that when thin films are deposited, their stoichiometry, structure, and morphology strongly depend on the energy flux to the substrate [2, 3]. During the experiments, the total energy flux density on the substrate was measured, which depends on duty cycle and pulsing frequency. Figure 2 shows the dependences of total energy flux density on the frequency of voltage pulses for a substrate at floating potential and at a -100 V bias potential. The substrate was located at a distance of 10 cm from the magnetron targets. The total discharge power was 1.75 kW (1 kW for Ti targets, 0.75 kW for Al targets). It is shown that as the voltage pulse frequency decreases from 30 kHz to 3 kHz while maintaining their duration (20 µs), the part of energy delivered to the substrate due to ion bombardment increases from 40 to 65%. Also, the pulse frequency effects on mechanical properties (hardness H, plasticity index H/E and resistance to plastic deformation H^3/E^2) of TiAlN coatings due to changes in the elemental and phase composition. The optimal value of the pulse repetition frequency is found, at which high values of these parameters are achieved.

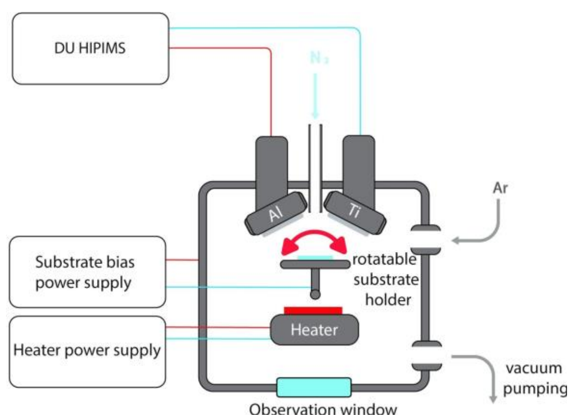

Fig. 1. The schematic diagram of the vacuum installation

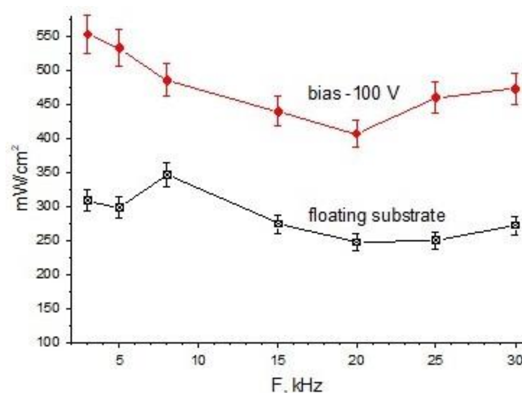

Fig. 2. The energy flux density on floating substrate and substrate at a -100 V bias potential

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