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Arc-discharge and magnetron sputtering combined equipment for nanocomposite coating deposition

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It is known that characteristics of nanocomposite coatings produced by reactive magnetron sputtering undergo an essential influence on the following parameters such as original component composition of targets being sputtered, as well as abundance ratio of such components in the coatings deposited, relative content of inert and reactionary gases in a gas mixture used and a value of operating pressure in a chamber, substrate temperature, and a value of substrate bias potential, determining energy of ionized atoms, ionized atoms flow density, i.e. ion current density on a substrate. The multifactor character of production process of nanocomposite coatings with certain physical and mechanical properties demands a purposeful and complex control on all above-mentioned parameters.

To solve such a problem, an arc-discharge and magnetron sputtering combined equipment including a vacuum chamber of approximately $\sim 0.5\ m^3$ with a built–in low–pressure plasma generator made on the basis of non–self–sustained discharge with a thermal cathode and a planar magnetron combined with two sputtered targets has been created. Construction of such a complex set-up provides both an autonomous mode of operation and simultaneous operation of an arc plasma generator and magnetron sputtering system. Magnetron sputtering of either one or two targets simultaneously is provided as well.

An arc plasma generator enables ions current density control on a substrate in a wide range due to discharge current varying from 1 to 100 A. Energy of ions is also being controlled in a wide range by a negative bias potential from 0 to 1000 V applied to a substrate.

The wide control range of gas plasma density of a arc discharge of approximately $10^9 \div 10^{11}\ cm^{-3}$ and high uniformity of its distribution over the total volume of an operating chamber (about 15% error with regard to the mean value) provides a purposeful and simultaneous control either of magnetron discharge characteristics (operating pressure of its initiation and discharge current) or chemical phase composition and properties of coatings.

By now, on the basis of arc discharge plasma assistance, nanocomposite coatings of doped titanium nitride with microhardness of 50 GPa (0.2 N load at 1 μm coating thickness). It has been also established that further application of arc gas discharge plasma at magnetron sputtering provides:

- Actual control on operating pressure parameters and magnetron discharge current value, i.e. sputtering rate of coating material;
- Cleaning and surface activation of a material prior to coating deposition, providing its good adhesion even at low temperature values (~200°C);
- Control on chemical phase composition of deposited coatings and, correspondingly, their physical properties, in particular, increasing microhardness of coatings over 10 GPa.