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EROSIONS MECHANISMS OF DIAMOND-LIKE CARBON COATINGS ON POLYIMIDE AND SILICON OXIDE SUBSTRATES BY INFLUENCE OF A PULSED GAS DISCHARGE

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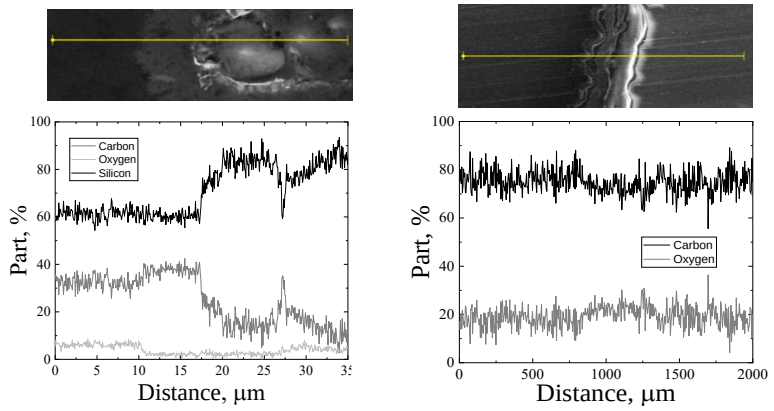
Progress in modern physics of elementary particles is largely due to the level of experimental capabilities of detectors. One of the main problems of gas-discharge detectors is the development of self-sustaining gas discharges. The purpose of this research is to determine the most probable mechanism of erosion of a diamond-like coating (DLC) of a flat anode by influence of a pulsed discharge in an $Ar_{90}(CO_2)_{10}$ gas.

The gas discharge was created by a pulsed voltage source with an output power of 0.8 MW at atmospheric pressure. Samples of two types were used: 1 – DLC_{pi} (polyimide substrate) with a thickness of 200 nm and 2 – DLC_{Si} (silicon substrate) with a thickness of 166 nm.

For DLC_{Si} samples was observed a through gas discharge with rounded damage of the coating (Fig.1a). For DLC_{pi} samples was observed a barrier gas discharge along the film-gas interface with oblong-shaped damage to the coating (Fig.1b).

Heating and subsequent erosion of the DLC film are caused by the radiation of the discharge plasma channel in the first case and ohmic heating due to an electron current in the second case. It has been established, that the main contribution to the erosion of the DLC film by influence of discharge is made by the peeling of the film from the substrate due to different expansion coefficients, however, such alternative mechanisms as a thermoelastic wave due to the heating of the plasma channel, sputtering of film atoms by gas ions, and sublimation of the coating were also considered.

The proposed mathematical model of erosion of a DLC coating under the influence of a barrier gas discharge is based on the non-stationary equations of deformation and thermal conductivity for a solid body was solved using the COMSOL Multiphysics package and predicts thermal stresses in the sample, induced by discharges of different power. Distribution of thermal stresses at different moments of time along the interface film and substrate is given on Fig.2.



a) b)

Fig.1. Scanning electron microscopy (SEM) images with distributions of chemical elements along the scan line in the erosion zone after exposure to the plasma channel on DLC coatings on Pi (a) and Si/SiO_2 (b) substrates

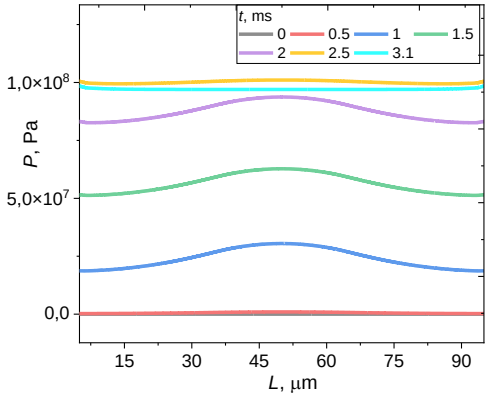


Fig.2. Distribution of thermal stresses at different moments of time along the interface between the film and the Pi substrate

Thus, it has been established that the main mechanism of erosion of a diamond-like coating by the influence of a pulsed barrier discharge is the peeling of the film from the substrate, and a numerical model has also been proposed that predicts the thermal stresses of the coating at specified discharge parameters.

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