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APPLICATION OF BACTERICIDAL COATINGS ON MEDICAL INSTRUMENTS USING LOW-TEMPERATURE PLASMA *)

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The use of titanium-hafnium nitride coatings when installing joint implants to reduce the number of complications is promising [1]. The coating has bactericidal properties and is compatible with the tissues of a living organism.

The coating process is based on the condensation of compounds from the metal plasma of an electric arc discharge in a reaction gas. Condensed coatings and their surfaces contain metal clusters and a nanodroplet phase of joint titanium and hafnium nitride $TiHfN_2$. The mechanism of the coating's effect on bacteria may be associated with the migration of nitride nanoparticles from the surface of the coating and their toxic effect on microflora [2].

To increase the yield of nanoparticles from the coating, the surface was treated with a flow of low-energy ions from a low-pressure high-frequency capacitive discharge at a pressure of 15–30 Pa. In this case, the ion current density was 0.6–0.8 A/m^2 and with an ion energy of 50–70 eV in the range of power input into the discharge of 750–1000 W [3]. The ions acquire this energy in a layer of positive charge near the surface of the sample with a thickness of 1.0–3.0 mm. When colliding with a surface, the kinetic energy of the ion is transformed into vibrational energy of surface atoms.

To determine the mechanism of action of the RF discharge, it is necessary to develop a mathematical model of the interaction of the ion flow with the titanium-hafnium nitride coating. The model is described by a system of classical molecular dynamics equations based on the all atom model with the Lennard-Jones (LJ) potential for the bombarding ion and the charge-optimized many-body (COMB) potential for the co-condensed system of TiN and HfN.

An initial assessment of the impact of low-energy ions on the surface showed a decrease in the amount of droplet condensates adsorbed on the surface of the coating and a decrease in the size of nanoparticles migrating from the surface of the coating from 200–1500 to 8–10 nm according to the NanoBrook 90Plus ZetaParticleSizeAnalyzer.

The results allow us to put forward a hypothesis about the decisive role of the impact of titanium-hafnium nitride coating-condensate nanoparticles on contact inhibition of the vital activity of pathogenic microflora through the ion-cluster mechanism.

References

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