EFFECT OF UV IRRADIATION OR DIFFUSE PLASMA ON SURFACE PROPERTIES OF MICRO-ARC CALCIUM PHOSPHATE COATINGS*

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Nowadays functionalization and modification of medical implants are widely used to add new set of properties. Calcium phosphate (CaP) coatings are widely applied as a component of dental, orthopedic and osteosynthesis implants in clinical settings due to porous structure and osseointegration ability [1]. Posttreatment of the CaP coatings using ultraviolet (UV) irradiation or plasma of runaway electron preionized diffuse discharge (REP DD) can improves the hydrophilic properties and variates the surface electrical charge, which significantly affect to the protein and biomolecule adsorption, and cell adhesion [1,2]. However, the changes in activation mechanism, bioactivity stability and cell response of the UV and REP DD treatments of CaP coatings are still not clear. The work was focused on to study the influence of UV irradiation or REP DD posttreatment on the surface properties of the micro-arc CaP biocoatings.

The coating were deposited on commercial pure titanium by the MAO method in anodic potentiostatic mode under following parameters: the pulse duration of 100 μs, the frequency of 50 Hz, the process time of 10 min, and the pulsed voltage of 200 V [1]. The electrolyte contained the phosphoric acid, calcium carbonate and stoichiometric hydroxyapatite. To modify the surface properties of the coatings the different posttreatments by UV irradiation and REP DD in the ambient air were carried out. There were three groups of the CaP coatings: 1) non-treated CaP coating; 2) post treated by UV CaP coating (KrCl-excilamp, λ = 222 nm, exposure dose of 5.5 J/cm^2, treatment duration varied from 1 to 20 minutes [2]); 3) post treated by REP DD CaP coating (the pulsed voltage of 18 kV with negative polarity, pulse duration of 4 ns, number of pulses varied from 10000 to 80000 [3]).

Wettability studies of not-treated CaP coating showed that the contact angles with water (polar liquid) and glycerol (non-polar) did not exceed 16° and 30°, respectively. Both UV irradiation and REP DD posttreatments of CaP coating leads to decrease of contact angels in 1.5-2 times with both liquids. The free surface energy, which calculated by the Owens-Wendt method [1], of non-treated CaP coatings as well as post-treated by UV or REP DD the CaP coatings was not differed and had high value of ~ 73 mJ/m^2. It is well known, that the free surface energy consists of two components of dispersive and polar ones. In the case of non-treated and post-treated CaP coatings, the polar component is more in ~ 3 times than dispersive component. It indicates the presence of strong polar covalent bonds in the coatings, such as OH-groups, phosphates, and oxides. After UV or REP DD post-treatment the redistribution of the values of the polar and dispersive components of the free surface energy of the CaP coatings was observed.

Infrared spectroscopy showed that the intensity of adsorption bands of the OH- and PO_4- groups increased in the coatings after UV post-treatment and decreased in the coatings after REP DD post-treatment in compared with non-treated CaP coatings. These results can indicate the possibility of redistribution of the electrical charge on the surface depending on the type and condition of the post-treatments.

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