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METHODS TO CONTROL THE GENERATION OF ACTIVE RADICALS BY COLD PLASMA JET FOR BIOMEDICAL APPLICATIONS*

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Cold plasma jet (CPJ) is an actively used and investigated tool for treating biological objects of different origins. CPJ is a type of gas discharge in which the streamers generated by applying a voltage propagate along the gas flow outside the discharge volume to the target. Insignificant heating of biological object surface caused by interaction with CPJ enables predominantly influence by active particles induced during propagation and interaction of gas-discharge plasma with aqueous or gaseous medium surrounding the object. Nitrogen and oxygen-containing active radicals produced in this way actively interact with cells of biological tissues, affecting the processes of vitality, including the shown selective effect on healthy and cancer cells [e.g., 1, 2]. It is assumed that OH, H_2O_2 и O_2 are the main active particles that set the increased level of active oxygen species in CPJ-treated cells [3]. The aim of this work was to investigate methods to intensify the generation of active radicals during CPJ propagation. Electrical and spectral parameters of CPJ in the area of interaction with a biological object were investigated and methods to control the generation of active radicals were determined:

1. The frequency of current touching the object of influence f_I can be equal to the frequency of applied sinusoidal voltage f_U ($f_I = f_U$) or multiple of 2 ($f_I = f_U/2$) or 4 ($f_I = f_U/4$) [4]. With the increase of applied sinusoidal voltage frequency in modes with equal current frequency in the interaction area with the object ($f_I = f_{U1} = f_{U2}/2 = f_{U3}/4$) the current amplitude increases that leads to the increase of pulse power injected into gas discharge and accelerates ionization processes, in particular, intensification of hydroxyl radical OH generation (from H_2O molecules with the following occurrence of H_2O_2 peroxide synthesis reaction).

2. When initiating CPJ by pulsed voltage with adjustable pulse duration it was found that in the operating voltage range with decreasing voltage pulse duration the current amplitude increases, and streamers forming CPJ become more intense with a regular character of propagation, respectively, the generation of active radicals, including OH hydroxide, in the interaction area of CPJ with the object increases.

3. Increasing humidity in the area of CPJ impact on a biological object changes the plasma characteristics and increases the rate of generation of hydroxyl radicals. Accordingly, the additional introduction of water vapor into the area of interaction of CPJ with the object intensifies the generation of hydroxyl OH.

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