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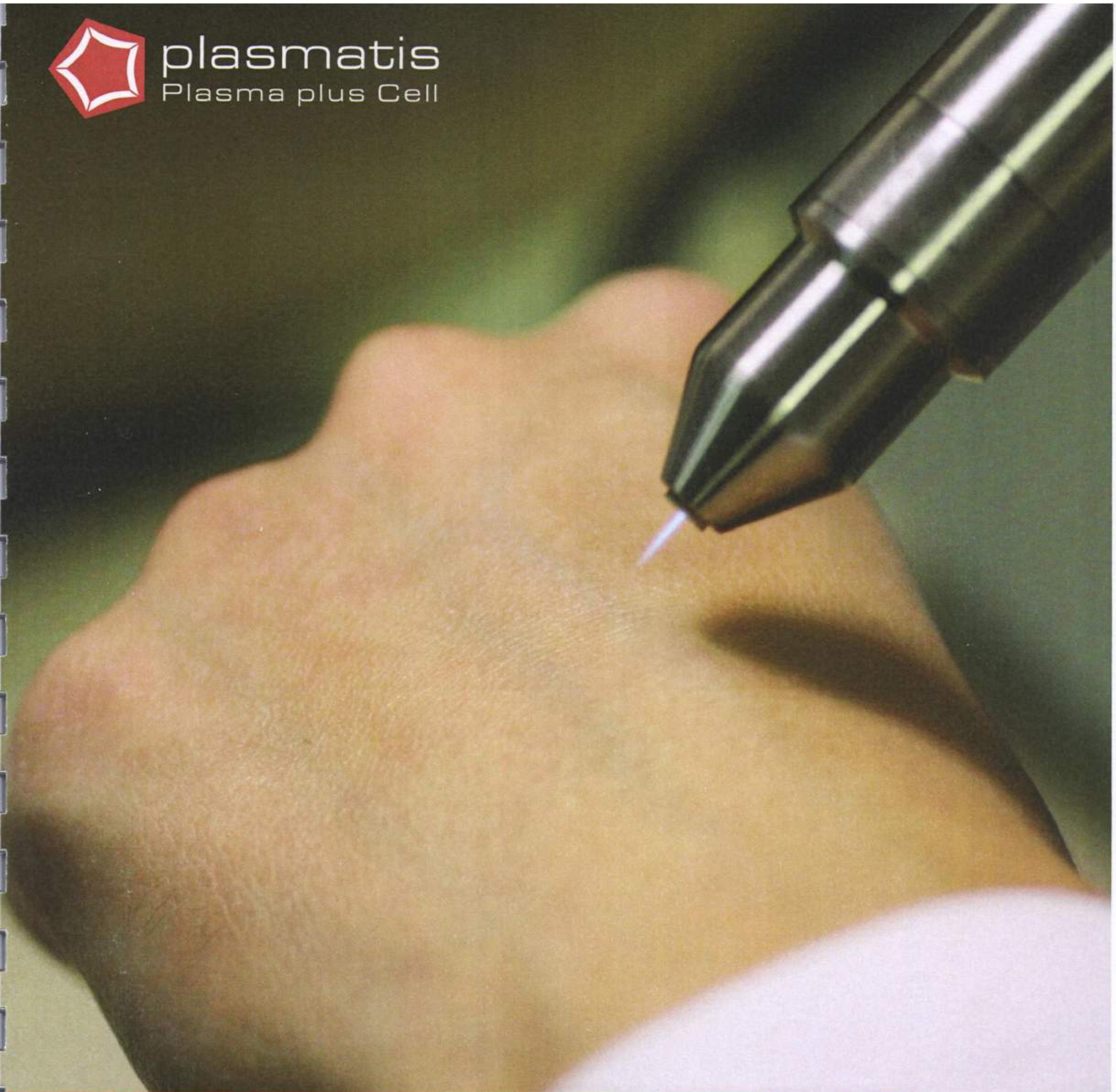

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Effect on *Escherichia coli* Induced by DC Transient Spark Discharge Generated in O_2/N_2 Gas Mixtures

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Abstract

Low temperature plasma has with no doubts a great potential in biomedical applications. However for deeper understanding it is important to explore plasma-chemical reactions with their surrounding. Especially, bio-decontamination and sterilization by low temperature plasma generated at gas-liquid interface shows to be promising [1-4]. The effects of positive DC transient spark discharge (TS) in the water solutions containing Gram-negative bacteria *Escherichia coli* were investigated. We employed the water electrode system, in which the water solution flowed down the grounded electrode repetitively through the discharge zone. The whole system was enclosed in a small chamber adapted for gas mixture variation. We observed the effect of gas mixtures O_2/N_2 (total gas flow ~ 2L/min) on plasma treated solutions. The main objective of the study was to put in correlation the chemical changes and bactericidal inactivation induced by plasma treatment generated in various gas mixtures in water solutions to get more information about which of the reactive agents are responsible for the biocidal effects. The chemical changes induced by TS discharge were investigated in a solution of 'water' = monosodium phosphate NaH_2PO_4 (pH 5, 600 μS/cm) and PB = phosphate buffer Na_2HPO_4/KH_2PO_4 (pH 7, 550 μS/cm). We analysed the concentration of hydrogen peroxide H_2O_2 and nitrites NO_2^- by absorption spectroscopy. The H_2O_2 analysis was performed via their reaction with titanium ions to form yellow coloured pertitanic acid with the absorbance maximum at 407 nm. The NO_2^- analysis was based on the reaction with Griess reagents to produce pink colored azo-product with the absorption maximum at 540 nm. We also evaluated the total oxidative potential by decolourization of the indigo dye. By colony counting method we determined the inactivation rate of bacterial population. We observed decrease of pH and increase of conductivity in 'water' solution, while in PB solution, the pH and conductivity did not change. After 15 min treatment of 'water' pH decreased from initial 5 to 3 and conductivity increased to 1400 μS/cm. The concentration of H_2O_2 and NO_2^- were dependent on the working gas mixture and subsequently the bacterial inactivation was related to them. The H_2O_2 concentration reached the highest values ~ 1 mM in O_2, but in this case we observed very little NO_2^-, no pH decrease and the lowest bacterial inactivation (Fig. 1). In N_2 /O_2 mixtures (10, 20, 50, 80% O_2), the NO_2^- concentration was higher ~ 0.4 mM, the H_2O_2 concentration was ~ 0.5 mM and pH decrease was more significant. As the Fig.1 shows, the bacterial inactivation was the most efficient in 20% O_2. However, in N_2 and O_2 we observed a decrease of vital bacterial population also, despite the chemical effects did not indicate it, that needs to be more explored. In general, however, the results demonstrated a potential of the TS discharge in water electrode system as an efficient tool for biomedical applications.

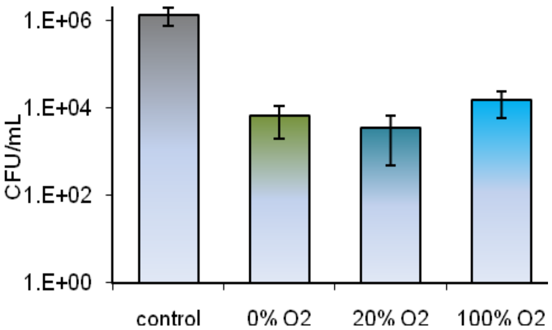

Figure 1: Bacterial concentration after 5 min treatment by TS generated in various gas mixtures in 'water; liquid flow rate 14 mL/min, working gas %O_2 in N_2, gas flow rate 2 L/min; applied voltage 12 kV, current pulses amplitude 8-18 A, frequency 1-3 kHz.

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