

## **Bactericidal effects of non-thermal plasmas on causative agents of nosocomial infections**

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Non-thermal plasma was proven to possess unspecific bactericidal activity. Effectiveness of bacterial eradication is dependent on both plasma and bacterium features. We compared the effectiveness of three non-thermal plasma sources in eradication of causative agents of nosocomial infections, i.e. infections acquired by patients in the course of staying in a hospital. Clinically isolated bacterial strains characterized by multiple antibiotic resistance were used. The sources of microwave argon plasma, ferroelectric discharge in argon or ambient air and pin-to-plane positive and negative DC coronas in air were applied to treat bacteria placed on the agar surface and in biofilms. Chlamydia trachomatis was used to evaluate effectiveness of non-thermal plasmas against intracellularly persisting bacteria.

Bacterial eradication with microwave argon plasma produced by the MicroPlaSter  $\beta$  device was dependent on a bacterial species and strain. In general, Gram-negative bacteria were more sensitive than Gram-positives. Bactericidal effects on bacteria in biofilms were dependent on biofilm thickness. Microwave plasma was effective against pathogenic bacteria infecting slash wounds in rats. Moreover, it was effective against intracellular bacteria. Microwave argon plasma included UV radiation, charged argon particles, free radicals and chemically active molecules from the ambient air, argon metastables and microwave radiation and its bactericidal effect was a superimposition of all types of antibacterial agents as no one of them did not cause a bactericidal effect as significant as the effect of whole plasma. The afterglow of the ferroelectric discharge included neutral active species only. Ferroelectric discharge in air produced air-borne active particles including O<sub>3</sub> and NO radicals in concentrations comparable with described above MicroPlaSter  $\beta$ . Still its effect on bacteria was 2 to 3 log<sub>10</sub> lower that confirmed the importance of a synergetic effect of microwave plasma components. The afterglow of the ferroelectric discharge in argon was not bactericidal. The pin-to-plane positive and negative DC coronas in ambient air generate predominantly the charged particles and neutral active species and UV radiation. Fission of charged particles and neutral species reduced a bactericidal effect.

Taken together, obtained results demonstrated that both charged and neutral active particles contribute essentially to the whole plasma bactericidal effect on causative agents of nosocomial infections, including those in biofilms, on the wound surface and within mammalian cells, and underscored the importance of synergetic effects of plasma active components [1, 2].

[1] Boudam M.K., Moisan M.J., Phys D Appl Phys (2010) 43, 295202

[2] Ponomarev A., Maksimov A., Vasilets V., Menagarishvily V., High Energy Chem (1989), 23, 231–232.