Topic number: W1

RF PLASMA STERILIZATION OF MATERIALS FOR BIOMEDICAL APPLICATIONS

I. I. Filatova [1,*], V. V. Azharonok [1], O. E. Shedikova [2]

[1] B. I. Stepanov Institute of Physics of the National Academy of Sciences of Belarus, Nezavisimosty Ave., 68, 220072, Minsk, Belarus
[2] The Republican Scientific-Practical Centre of Hygiene, 13, P. Brovki str., 220013 Minsk, Belarus
[*]**filatova@imaph.bas-net.by**

Cold plasma has the potential as a good tool for sterilization of thermolabile medical equipment such as polymer- based instruments or textile that cannot be treated with chemicals, steam or dry heat [1–3]. Simultaneously it is important to know the survival of bacteria on various surfaces after plasma treatment. In this study we investigated a bactericidal effect of low pressure rf plasma on surface of medical supplies contaminated with microorganisms of different taxonomic and physiological groups.

The reference strains *E. coli* ATCC 8739, S. *aureus* ATCC 6538, *B. subtilis* ATCC 6633, clinical isolates of bacteria of the family *Staphylococcus* – $37C_1$ lec (+) and bacteria species of *Enterobacteriaceae*– EB 158 as well as spore of *B.subtilis* ATCC 6633 were chosen as tested species. Fat-free sterile samples (parts of medical instruments maid of metals, polymers and capillary-porous materials) were contaminated in a glass tube containing microorganisms with the initial concentration of 10^9 CFU/ml and then were exposed to 5.28 MHz air plasma at pressure P = 0.6 Torr during 5, 10, 15 and 20 min. The discharge chamber is formed by two parallel round copper electrodes with diameter Ø=120 mm. The distance between electrodes was 20 mm. The investigated samples were placed on the grounded electrode. The supplied full specific rf power was W≈ 0.9 W/cm^3.

The concentration of the survived cells on metallic and polymeric samples almost linearly decreased with increase of the plasma irradiation duration. The complete sterility of both samples has been achieved for duration of 20 minutes (reduction of cultivable cells more than 6 decimal logarithmic units) (fig. 1).

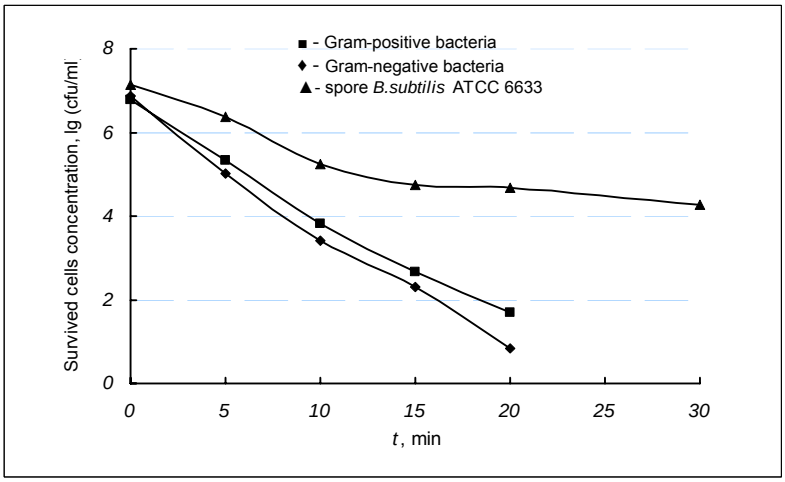

Fig.1: Concentration of bacteria survived cells on metals in dependence on duration of plasma exposure

In the case of porous materials decontamination the dependence of lg(CFU/ml) on plasma time exposure *t* was not a linear as it has been observed for metallic and polymeric samples (fig. 2). A rate of microorganisms survivor plotted on porous material decreased only by four

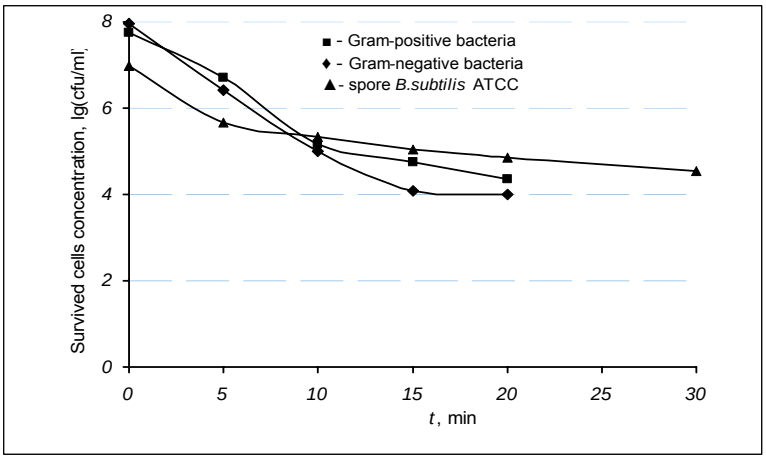

Fig.2: Concentration of bacteria survived cells on porous materials in dependence on duration of plasma exposure

orders of magnitude for treatment duration of 20 min. It is connected apparently with peculiarities of plasma interaction with porous materials. To ensure the effect of homogeneous sterilization of investigated suture throughout their volume, chemically active species must be able to penetrate through the material without losing their modifying ability.

It was established that for all treated samples Gram-positive bacteria strains (*Staphylococcus,* vegetative sells of *B.subtilis* ATCC 6633) demonstrated a greater resistance to the plasma treatment than Gram-negative ones (bacteria species of *Enterobacteriaceae*) because of peculiarities of their cell wall structure (fig. 1, 2). The most resistant to the treatment was bacterial spores: the sterilizing effect in air plasma was not achieved even for 30 min of exposure both for metallic and porous samples.

We have assumed from optical emission spectra, recorded during microorganisms inactivation that the sterilization effect of air plasma is determined along with the UV radiation by oxygen atoms formed in the discharge due to dissociation of oxygen contained molecules that belong to atmospheric air.

It was established that low pressure rf air plasma is an effective tool for bacterial cells inactivation on a surface of various materials for biomedical applications, without any destructive impact on their bulk structure.

Acknowledgments. This work was supported by the Belarusian Republican Foundation for Fundamental Research (Grant No T08МЛД-021).

Reference

[1] N. Philip, B. Saoudi, M.-C. Crevier, M. Moisan et al., 2002, *IEEE* Tr*ansactions on Plasma Science*, **30**, 1429
[2] K. S. Lassen, J. E. Johansen, R. Grün, 2005, *J. Biomed. Mater. Research* B: Applied Biomaterials **78** (1) 189
[3] O.Kylian, T.Sasaki, F.Rossi, 2006, *European Physical J.:* Applied Physics, **34**, 139