Topic number: 17

Surface-wave-sustained plasma for model biological systems treatment

E. Benova[1], Y. Topalova[2], P. Marinova[3], Y. Todorova[2], M. Atanasova[4], T. Bogdanov[5], I. Yotinov[2]

[1] *DLTIS, Sofia University, Sofia, Bulgaria*
[2] *Faculty of Biology, Sofia University, Sofia, Bulgaria*
[3] *Faculty of Physics, Sofia University, Sofia, Bulgaria*
[4] *Faculty of Mathematics and Informatics, Sofia University, Sofia, Bulgaria*
[5] *Department of Medical Physics and Biophysics, Faculty of Medicine, Medical University – Sofia, Bulgaria*

Surface-wave-sustained Argon plasma torch operating at 2.45 GHz was used for treatment of Gram negative and Gram positive bacteria as model biological systems to study the plasma bactericide effect. In special discharge conditions we are able to produce microwave plasma torch with gas temperature close to the room temperature eliminating in this way the heating of the treated object by the plasma. Such plasma can be used for direct treatment of living tissues and thermo-sensitive materials. The obtained results show good deactivation effect at direct plasma treatment of bacteria in agar and in bacterial suspension. This means that at such discharge conditions the microwave plasma torch can be used for direct *in vivo* treatment and disinfection.

1. General

Argon plasma torch is sustained by travelling electromagnetic wave excited by surfatron type wave launcher at 2.45 GHz. A solid-state microwave generator is used at low wave power (from 12 to 40 W) with 0 W reflected power. Argon gas flow does not exceed 3.2 l/min. At appropriate discharge conditions a stable plasma torch with low gas temperature can be produced (Fig. 1).

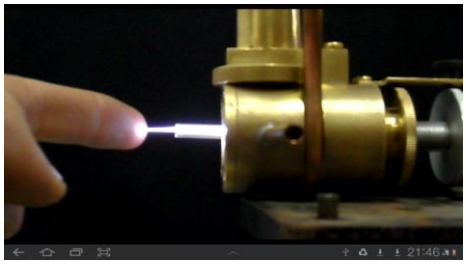

Fig. 1. Microwave Argon plasma torch with low gas temperature

The plasma torch is applied for direct treatment of microorganisms in agar and in bacterial suspension. Two model bacterial strains were used: *Pseudomonas sp. AP-9* as a suitable model of pathogenic Gram negative bacteria and *Brevibacillus laterosporus BT-271* as a suitable model of pathogenic Gram positive, spore-forming bacteria. In all experiments the treatment time is very short – less than 1 min.

2. Results and discussion

Thick layers of *Pseudomonas* with density from 2×10^7 to 6×10^9 cells/ml in agar plate were treated directly by the plasma torch at different wave power (14–22 W) and different treatment time (3–20 s). In Fig. 2 one can see well-presented completely sterilized zones with diameter depending on the wave power and treatment time. The later dependence is presented in Fig. 3.

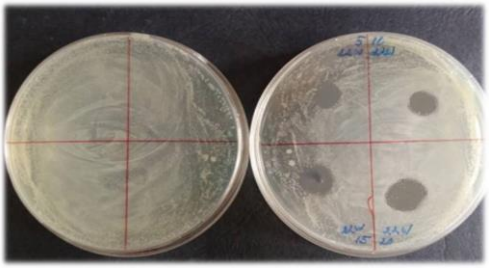

Fig. 2. Control (left) and plasma treated agar plates (right) with *Pseudomonas sp. AP-9*

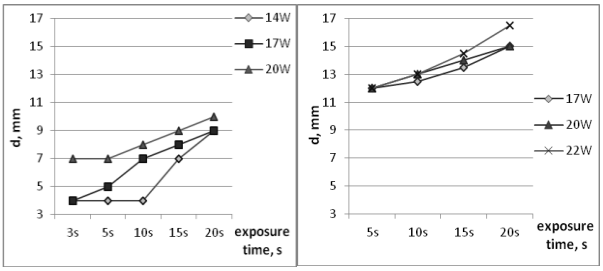

Fig. 3. Diameter of sterilization area at various wave power and treatment time at *Pseudomonas* concentration 6×10^9 cells/ml (left) and 2×10^7 cells/ml (right)

The diameter of the plasma torch is about 2 mm and that of sterilized zones can be more than 1 cm with no movement in radial direction during the treatment. The sterilization was complete, without any survived colonies and stable (confirmed by more than 168 hours monitoring).

Acknowledgements

This work was supported by Bulgarian Science Fund under Grant DH08/8 of 2016.