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Decontamination of teeth and plastic surfaces from biofilms and spores with DC and pulsed corona in air

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Biofilms or bacterial spores can cause a variety of infections and exhibit increased tolerance towards commonly used antimicrobial agents. Cold air plasmas at atmospheric pressure provide an alternative to conventional sterilization methods, because they are efficient even for biofilms and spores and do not cause degradation of thermo-sensitive materials or human tissues. We investigated bactericidal effects of the atmospheric pressure air corona discharges combined with electrostatic spraying of water applied on plastic and *ex-vivo* human teeth surfaces contaminated by *Streptococci* biofilms and *Bacillus cereus* spores.

Teeth and plastic foils were contaminated by oral biofilm cultivated on *Streptococci* selective agar or directly by *Bacillus cereus* spores. We applied positive and negative corona discharge generated by either DC or pulsed power supplies. With DC power, positive corona formed streamers with frequency 5-16 kHz and maximum amplitude 30 mA and negative corona formed Trichel pulses with frequency 20-100 kHz and current amplitudes up to 7 mA. The pulsed discharge with frequencies up to 300 Hz was generated by rotary spark gap system. Exposure times were 5 min for teeth and 2-10 min for plastic foils.

The discharge set-up contains hypodermic injection needle as a high voltage electrode opposite to a grounded stainless steel mesh or plate [1]. Polypropylene plastic squares (1.5×1.5 cm) and extracted human teeth with *Streptococci* biofilms or *B. cereus* spores were placed on the grounded mesh (plate). The gap between the needle electrode and a sample (teeth or plastic) was 0.5 cm.

The use of pulsed power showed that negative corona was more efficient in decontamination of spores than positive one. With 5-10 min treatment, the efficiency of 96-97% was reached, which was slightly more than with DC power (80-90%).

In some experiments with biofilms treated by DC corona, tap water was electro-sprayed on samples from the HV electrode through the discharge. This significantly improved the decontamination effect both on teeth and plastics: from about 1 log reduction without spray to 3-4 logs with the spray. At water flow rate 0.01 mL/min, negative pulses were the most efficient (~4 logs). Decontamination of biofilms on plastic foils exposed for 2 min was slightly stronger with negative Trichel pulses than with positive streamers but not statistically significantly different.

DC positive and negative, as well as pulsed corona was proved as efficient methods of biofilm and bacterial spore decontamination from teeth and plastic surfaces. Electro-spraying of water on the treated surfaces at low flow rates significantly improved the effect.

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[1] Z. Šipoldová and Z. Machala: *Bio-decontamination of plastic and dental surfaces with atmospheric pressure air DC discharges*, IEEE Trans. Plasma Sci. 39 (2011) 2970-2971.