IPP AS
CZECH REPUBLIC
23rd SPPT 2008

CZECH TECHNICAL UNIVERSITY
23rd SPPT
2008

23rd SYMPOSIUM ON PLASMA PHYSICS AND TECHNOLOGY

June 16-19, 2008
Prague, Czech Republic

PROGRAMME & ABSTRACTS

EPJ The European Physical Journal

EPS

S6 Sterilization by DC discharges at atmospheric pressure

Z. Machala[1], I. Jedlovský[2], D. Giertl[2], L. Chládeková[2], B. Pongrác[1], M. Zvarík[2], and L. Šikurová[2]

[1] *Division of Environmental Physics, Department of Astronomy, Earth Physics and Meteorology,*
[2] *Division of Biophysics, Department of Nuclear Physics and Biophysics,*
Comenius University, Mlynská Dolina, 842 48 Bratislava, Slovakia

Three types of DC discharges in atmospheric pressure air in point-to-plane or point-to-water level gaps are presented. A *streamer corona* with small current pulses (~10 mA) of streamers with a 10-30 kHz repetitive frequency generates very cold non-equilibrium plasma (300-350 K). With increasing applied voltage, the streamer transits to a *transient spark*: a spark with very short (~100 ns) current pulses (~1 A) of 0.5-5 kHz repetitive frequency and very limited energy. Thanks to the very short spark pulse duration given by the small internal capacity of the discharge system and the limiting series resistor, the plasma cannot reach LTE conditions (500-1000 K). With an appropriate ballast resistor, this transient regime evolves into a pulse-less discharge, with the cathode fall and positive column and other properties of a typical *glow discharge*. It has descending current-voltage characteristics and provides relatively hot (1500-2000 K), yet non-thermal plasma.

The emission spectra and the measured temperatures indicate that these discharges generate non-equilibrium plasmas with various excited species, molecular and atomic radicals. Such plasmas induce chemical and biological effects important for applications, such as VOC abatement or sterilization.

Sterilization of selected bacteria (*S. typhimurium, B. cereus*) or spores (*B. cereus*) by these DC discharges in both polarities was tested. Bacteria in water or physiological solution were treated both in a static and a flowing regime. Satisfactory results were obtained in the static regime, with the highest efficiency in the transient spark with ultra short high current pulses. Glow discharge was efficient but too energetic. In the flowing regime treatment by 5 parallel transient sparks, higher decontamination efficiencies were achieved in shorter treatment times. Streamer corona that was weak in the static regime was found efficient in the flowing regime with the treated medium flowing directly through the high voltage needle electrode and thus through the active corona zone. The spores were treated by streamer corona on various surfaces (paper, plastic or aluminum foil).

Electrical discharge and emission spectroscopic investigations indicated important bio-inactivation mechanisms, mainly the major role of radicals and active species, generated especially in TS with high short pulses. In addition, we are investigating an application of TBARS (thiobarbituric acid reactive substances) method (spectrometric detection of the products of lipid peroxidation) to examine the effect of radicals on bacteria. Comparing the effects of a direct vs. remote plasma exposure is envisaged in near future. The bacteria were handled and their population evaluated by standard microbiology cultivation procedures. In parallel, we are developing a rapid fluorescence spectroscopic method for bacterial live/dead population evaluation using SYTO 9 and Propidium iodide fluorescent stains.

This research was supported by VEGA 1/0293/08, NATO EAP.RIG 981194, and EOARD FA8655-08-1-3061 grants.

* * *