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ELECTRIC FIELD MEASUREMENTS IN SURFACE NANOSECOND DIELECTRIC BARRIER DISCHARGE

E.I.Mintoussov[(1)], P.N.Sagulenko[(2)], S.M.Starikovskaia [(1,*)]

[(1)] Laboratoire de Physique des Plasmas, Ecole Polytechnique Palaiseau FRANCE

[(2)] Moscow Institute of Physics and Technology, Institutskii lane 9, Dolgoprudny RUSSIA

[(*)] **svetlana.starikovskaya@lpp.polytechnique.fr**

The dielectric barrier discharge (DBD) has been extensively investigated for nearly 50 years since it is widely used for different applications such as ozone production [1-3], intensive UV-light generation [4], plasma gas and surface treatment and so on. Surface DBDs have been studied recently for air flow control [5]. Nevertheless, experimental information on electric field value in DBD microdischarges is rather limited [6, 7, 8]. Spatially and temporally resolved nitrogen emission measurements were made in volume single-streamer DBD [6]. The electric field in surface DBD discharge in atmospheric air along the surface of dielectric with ε=16 (BGO crystal) was studied in [7]. Our last experiments at LPP demonstrate presence of a high electric field in 50 Hz DBD surface discharge [8]. The surface barrier discharge in coplanar geometry in synthetic air at atmospheric pressure was studied with the help of cross-correlation spectroscopy [9]. High values of electric field were obtained in [10], where measurements of E/N were performed in a nanosecond surface discharge (25 ns and 20 kV pulse) in air at different pressures, from 200 Torr to 1 atm. Still the question about E/N value at surface DBDs remains open.

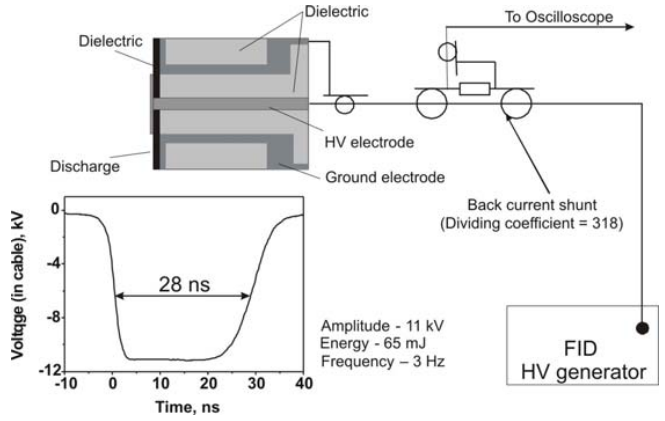

Fig. 1 Scheme of the experimental setup.

Coaxial geometry electrode system with 0.4 mm PVC film as a dielectric has been used to measure the electric field (see Fig. 1) in dry air. 4 concentric diaphragms of different diameters were used to select the radiation. The difference in external and internal diameter of each diaphragm was 2 mm, and the diaphragms were installed at the distances 0, 3, 6, and 9 mm from 20 mm diameter high-voltage electrode. The molecular nitrogen emission at 337.1 nm and 391.4 nm was used to calculate the electric field. The light was collected with a 60-mm focal distance quartz lenz and was focused onto the entrance slit of Triax 320 monochromator (2400 mm^{-1} grating, 1.3 nm/mm dispersion) connected to RTC XP2020 photomultiplier. The signal was

registered by LeCroy oscilloscope. The energy input into the discharge was measured using back current shunt installed 12.5 m apart from the discharge gap in 50-Ohm cable connecting the high-voltage generator and the discharge cell. The signal from the current shunt was also used to trigger the oscilloscope, so, signals at 337.1 nm and 391.4 nm were synchronized in time with the accuracy of at least 0.5 ns. Review emission spectra were taken in the wavelength range 334-338 nm and 388-392 nm. With that we determined the widths of the entrance slits of the monochromator, which were equal to 2.540 mm and 1.308 nm respectively. The output slit was significantly smaller. The relative calibration of the intensity at two wavelengths of interest was made using deuterium lamp (ORIEL 63163).

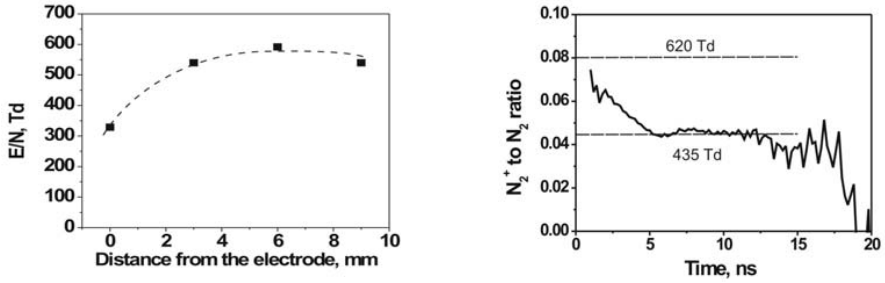

Fig. 2 (a): E/N at 1 atm for different distances from high-voltage electrode for a fixed time moment; (b) emission ratio for P=3 atm and 3 mm distance from the HV electrode.

Fig. 2 (a) represents spatial distribution of peak of the emission ratio 391.4/337.1 for 1 atm pressure. It is obvious that minimal peak emission ratio is observed at the edge of the electrode (about 0.02), while for the other distances the ratio remains practically constant (0.063-0.073, which corresponds to 540-590 Td, compare to [11]). With pressure decrease, the ratio 391.4/337.1 drops significantly. It should be noted that for the first diaphragm (corresponding to the edge of the high-voltage electrode) we did not see any change of the emission ratio with pressure increase. Fig. 2 (b) illustrates time-resolved behaviour of the electric field for 3 atm pressure. The data were taken at 3 mm from the high-voltage electrode and at the edge of the electrode. It is seen that the electric field decreases from a high value (first 1-2 nanosecond are inaccessible for time-resolved measurements because of low signal-to-noise ratio) during approximately 5 ns and then remains relatively high up to 15-20 ns.

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