Topic number: no. 10.

MICRODISCHARGES IN STEADY-STATE DBD: AVALANCHE GAS BREAKDOWN OR PLASMA CONSTRICTION?

Yu. Akishev(*), G.Aponin, A.Balakirev, M.Grushin, V.Karalnik, A.Petryakov, N.Trushkin

SRC RF TRINITI, Pushkovykh St-12, Troitsk, Moscow region, 142190, Russia

(*) **akishev@triniti.ru**

As it is known, plane-to-plane DBD fed with sinusoidal voltage can exist in different current modes – in transverse uniform mode without microdischarges (MD) [1-2] and with MDs which are regularly patterned [3] or exhibit spatial-time chaotic behavior [4]. The latter regime is widely used in practice (in ozone generation, surface treatment, etc), and such DBD is popular subject of numerous investigations. In this regime, steady-state DBD at each half-period (HP) consists of great many short-lived MDs which are distributed, according to a wide-spread opinion, randomly in time and space of the gap, i.e. MDs have no spatial "memory" and they appear at each HP always at different (or new) places having no relation to former places occupied by them in previous HP. Another wide-spread idea is that each MD is formed due to local electron avalanche breakdown of the gas gap once total electric field in the gap gets up to the critical value.

We have done a detailed search on spatial-time behavior of MDs in DBD with transparent plane electrodes (36x36 mm^2) activated with sinusoidal voltage of variable frequency (from 50 Hz to 100 kHz) and amplitude (up to 20 kV). Inter-electrode gas gap is 1.2 mm, plasma forming gas is ambient air and nitrogen of high purity at atmospheric pressure. Discharge current and voltage waveforms covering many periods were recorded simultaneously with taking of a sequences of four DBD pictures at short exposition time (up to 50 ns) and step-by-step video film of DBD with duration up to 2 s. Video film was taken by fast camera. Additionally optical signal corresponding to the light collected by optical fiber from discharge area of 80 μm in a diameter were recorded by photomultiplier. This signal exhibits time behavior of individual MD at the fixed local position. Analysis of extended experimental information showed the following.

After initial breakdown, the number of MDs at each HP in steady-state DBD is constant determined by voltage amplitude. This number increases from several (5-7) up to maximum about 900 with an increase in voltage amplitude. Maximum number is determined by discharge surface and correlates with full filling this surface by MDs separated with a distance close to the length of inter-electrode gap. As a rule each MD appears at every HP but only once at the same place. Because of slow recombination decay of the MD plasma channel, there is short-term spatial "memory" (about of 10 periods) for MDs. It means each MD in succeeding HP occurs practically at the same place as it was in the preceding HP. However there is scattering in time over HP for appearance of the MDs. An existence of short-term spatial "memory" cancels the necessity in local avalanche breakdowns at HP. So, steady-state DBD supports due to regular alternation in constriction and decay of plasma columns corresponding to MDs but not avalanche breakdowns.

Acknowledge. This work was supported in part by RFBR (grant No. 08-02-00601).

References

[1] Yu. Akishev, A. Demyanov, V. Karalnik, M. Pankin, N. Trushkin 2001 *Plasma Phys. Rep.* **27** 164
[2] N. Gherardi, N. Naude, J.-P. Cambronne and F. Massines 2005 *J. Phys. D: Appl. Phys.* **38** 530
[3] M. Klein, N. Miller and M. Walhout 2001 *Phys. Rev. E* **64** 026402
[4] B. Eliasson and U. Kogelshatz 1991 *IEEE Trans. Plasma Sci.* **19** 309