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Relaxation of a radiofrequency discharge, disturbed by a high-voltage nanosecond pulse

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Short (tens of ns) high-voltage (kV to tens of kV) are proposed as a manipulation tool for the microparticles, levitating in steady-state dc [1] and rf [2] plasmas. Although, the significant dynamical effect on the microparticles is evident, the particular plasma processes, underlying it, are not clear. Therefore, here we investigate the influence of a high-voltage nanosecond pulse on a steady-state capacitively-coupled radiofrequency discharge.

The experiments are performed in a modified GEC reference cell. Two disc-shaped electrodes of 15 cm diameter are separated by a 5 cm gap. Top electrode is grounded. To the bottom electrode sinusoidal RF signal (13.56 MHz, 50-100 V peak-to-peak), sustaining a steady-state discharge, is applied. In addition, to the same electrode single pulses of 20 ns duration and 1-16 kV amplitude are coupled. Both RF and nanopulse generators are connected to the electrode via the protecting filter. Experiments are performed in argon in the pressure range 0.07-1.2 Pa.

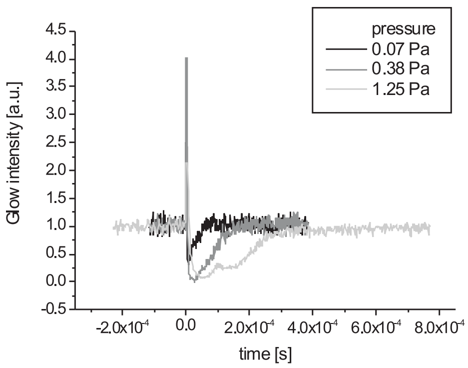

Fig. 1: Time evolution of the intensity of the glow of a radiofrequency discharge, disturbed by a high-voltage nanopulse (7 kV amplitude) at different argon pressures.

The integral glow of the discharge is detected by a PMT-module with the amplifier bandwidth of 200 kHz. The application of the pulse leads first to a dramatic and very sharp increase of the glow, after which the discharge enters the so-called dark phase: the intensity of the glow drops to the values, significantly below the steady-state level. The duration and depth of the dark phase increase with pressure and amplitude of the pulse. Typically after several hundreds μs after the pulse the intensity of the glow returns to the steady-state value.

The possible mechanisms, underlying the formation of the dark phase are discussed. The results are compared with the known effect of a dark phase in a dc discharge [3, 4].

Reference

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