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CONTRACTION OF PULSED NANOSECOND DISCHARGES IN NITROGEN AND AIR AT ATMOSPHERIC PRESSURE *)

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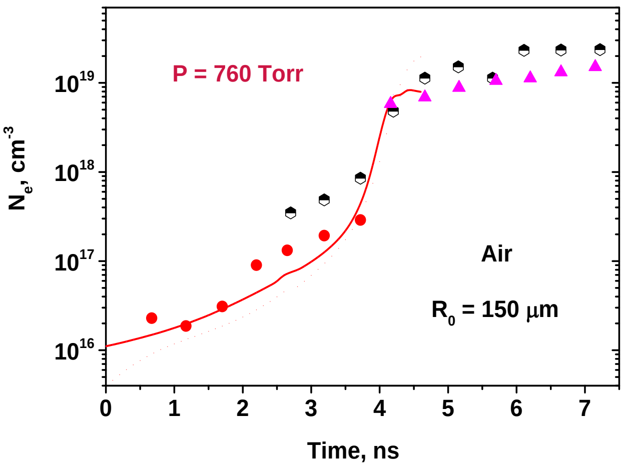
Recently, a number of experimental works on the study of contraction of pulsed nanosecond discharges in air [1–3] and nitrogen [4] at atmospheric pressure are appeared. The discharge current pulse duration, as a rule, was t_{imp} = 10–20 ns, I_{max} = 40–60 A, interelectrode gap $d \leq 3$ mm. A distinctive feature of all the discharges studied was their contraction, that is, a sharp decrease in the radius of the plasma channel in nanosecond time scale. The consequence of contraction was a rapid increase in the electron density, which increased from $N_e = 10^{15}–10^{16}$ cm^{-3} to $N_e > 10^{19}$ cm^{-3} in 3–4 ns (see Fig. 1). The electron density was measured by the Stark broadening of the lines of atomic hydrogen, oxygen or nitrogen.



This work presents a 1-D model with a given temporal dynamics of the discharge current, which describes the mechanism of contraction of nanosecond discharges for experimental conditions of [3, 4]. A distinctive feature of the developed model is that it takes into account the dissociation of excited molecules N_2(A,B,C) by electron impact, as well as the stepwise ionization of the excited atoms N(^{2}D), N(^{2}P) [5].

Figure 1 shows the results of calculations of the temporal evolution of electron density in air for the experimental conditions [3]. Calculations were carried out within the current approximation using an experimentally measured current pulse [3]. At times t = 1–3 ns, an effective production of atomic nitrogen occurs, the concentration of which reaches 10^{19} cm^{-3}. The sharp increase in electron density at t > 3.5 ns is associated with the effective ionization of nitrogen atoms by electron impact and the formation of atomic N^+ ions with a relatively low coefficient of electron–ion recombination [5].

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