GENERATION OF X-RAY QUANTS IN PULSED DISCHARGES OF ULTRA-HIGH PRESSURE*

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Runaway electrons (RE) are known to be usually generated in a discharge gap at the breakdown stage of a discharge and provide pre-ionization of a gas medium. The volume pre-ionization leads to a decrease in the commutation time of a high-pressure diode [1] and the formation of a discharge in a volume form before the development of a spark channel [2,3]. In particular, in [4], a formation of a subnanosecond volume discharge was registered experimentally in nitrogen at a pressure of 6 atm. Wherein, the experimental conditions [1] were believed to be not sufficient for the development of the volume discharge stage observed. A simulation performed in [4,5] by means of the Monte-Carlo numerical model proved the possibility of the RE generation in the vicinity of cathode microprotrusions and the volume discharge initiation under the conditions described in [4,5]. Nevertheless, the simulation also showed that most of electrons initially accelerated near the cathode microprotrusions up to the energies of ~2-5 keV may impact a series of "catastrophic" collisions with scattering angles more than $\pi / 2$. These "catastrophic" collisions not only lead to thermalization of REs, but also have to provide generation of X-ray bremsstrahlung quants which may contribute significantly to the volume pre-ionization, as REs do. Moreover, for gas discharges of an ultra-high pressure (~10 atm and more), the X-ray pre-ionization might prevail over the electron impact ionization provided by REs because of a high collision frequency and a low runaway probability. Within the present paper, the Monte-Carlo approach was employed to calculate radiation energy losses of REs. Frequency of "catastrophic" collisions was determined. Limits of scattering angles and impact parameters within which the X-ray quant generation is possible were estimated. A bremsstrahlung quant spectrum was calculated.

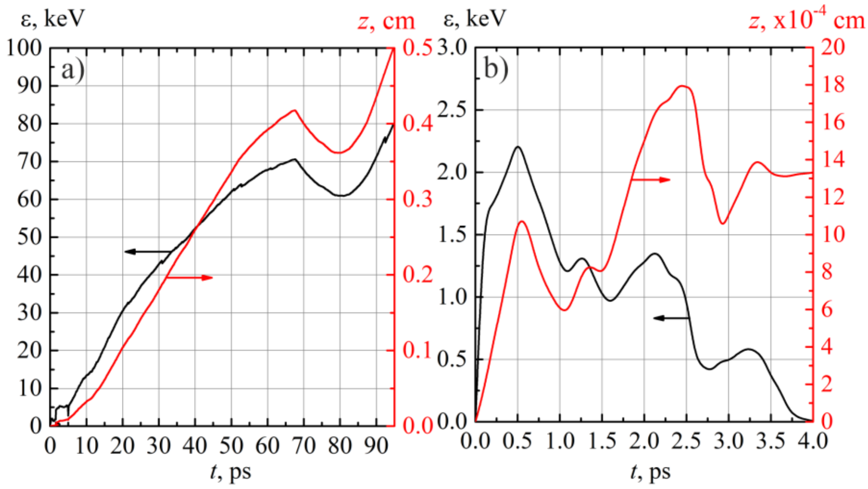

Fig.1. Two types electron motion through a discharge gap: a) – continuous accelerating, b) – deceleration and thermalization. Sharp changes in the electron motion direction along the z-axis correspond to "catastrophic" collisions. The discharge system considered is the same as in [4,5]: nitrogen at a pressure of 6 atm, the cathode-anode distance is 0.5 cm, average electric field strength is ~200 kV/cm.

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