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NANOSECOND PULSE BREAKDOWN IN NOBLE GASES[1]

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The breakdown phenomenon underlies the operation of the gas-discharge switching devices. In devices with a cold cathode in most cases the breakdown is due to the Townsend or streamer mechanisms, which are based on the development of electron avalanches from the initial/background electrons concentration. There is form of gas discharge in which such a geometry of the discharge gap is realized that processes outside the discharge gap behind the anode affect the mechanisms of emission and current development. In this so called "open" discharge in the discharge gap of ~ 0.1-10 mm the electrons are emitted under the influence of resonance radiation having the Doppler shift and generated by atoms which appears in the process of recharging of ions moving toward the cathode. A specific feature of such a discharge is insignificant multiplication of electrons in the discharge gap, so the discharge current is provided only by emission of electrons from the cathode and the external electric circuit. The breakdown characteristics in discharges of this type in form of dependences of current and delay of the discharge development on the voltage were investigated. The experiments were carried out in planar discharge cells consisting of circular *SiC* cathodes and two molybdenum grids used as anode and separated by 11 mm drift space. The length of the discharge gap was 7 mm. Such construction allowed studying the characteristics in two modes depending on the connection way: (i) - classical "open discharge" (OD), (ii) - "open discharge" with counter-propagating electron beams (ODCPEB). In the first case, the grid and cathode of one of the gaps were grounded through current shunts and acted as a collector. In the second case, the grids were grounded and the cathodes were supplied with the equal electric potential. Load resistance R_L = 33 Ω and discharge capacitance C = 100 pF. The Fig. 1 shows the dependences of *I(U)* in *He* (p_{He} = 20-100 Torr), *Ne* (p_{Ne}=1.5-25 Torr), and *Ar* (p_{Ar} = 0.5-4 Torr) in the ODCPEB mode as increasing curves, with *I(U)* weakly depending on *He* pressure.

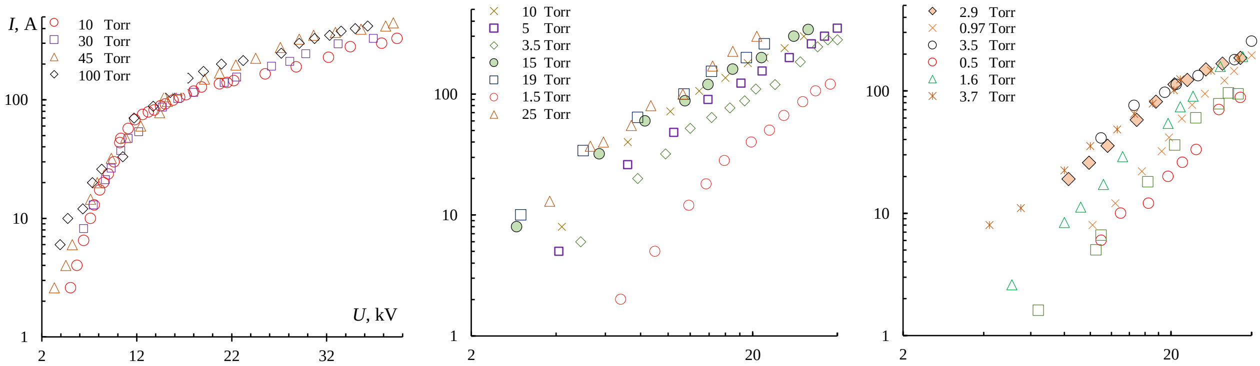

Fig.1. Dependences *I*(*U*): (*a*) - *He* (p_{He} = 20–100 Torr), (*b*) - *Ne* (p_{Ne}=1.5–25 Torr), (c) - *Ar* (p_{Ar}=0.5–4 Torr)

The dependences of the parameter $p\times\tau$ on *E/p* for different gases (τ is the delay time of the discharge development) shows that the discharge development in both types of studied discharges is characterized by higher *E/N* values than in case of the avalanche breakdown [1]. As pressure increases for each gas, the dependences converge, and in the *He-Ne-Ar* series, the heavier gas is characterized by higher values of τ. ODCEB in comparison with OD is characterized by significantly lower τ, associated with intensive generation of VUV radiation during the oscillations of electrons in the discharge gaps in the former, and the absence of them in the later. At increased values of the gas pressure (p_{He}=60 Torr) in case of *He*, when the decelerating length of beam electrons is less than drift space length and, electron oscillations are absent, current development rates in ODCPEB and OD are equalized and reach in *He* (p_{He}=100 Torr and *U*=36 kV τ≈0.3 ns).

REFERENCES

[1] P. Felsenthal, J.M. Proud "Nanosecond-pulse breakdown in gases", Physical Review, vol. 139 n. 6A, pp. A1796, 1965.

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