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ELECTRICAL BREAKDOWN IN NITROGEN AT LOW PRESSURE - PHYSICAL PROCESSES AND STATISTICS

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Abstract. The results of investigation of the electrical breakdown in nitrogen, obtained in combined approach based on measuring of the current-voltage characteristic, modeling of basic physical processes and statistical analysis of the breakdown time delay are presented in this report.

Measurement of the current-voltage characteristics with additional monitoring of spatial and temporal distribution of the emission from discharge provides information concerned on development of different regime of low-pressure gas discharge and on processes of the electrical breakdown and discharge maintenance.

The presented model of the gas discharge includes the kinetics of mains constituents of the nitrogen plasma, charged particles, vibrationally manifold of molecular ground state, molecular singlet and triplet states and nitrogen atoms. The model is applied in case of a homogenous electric field, at electric field to gas density ratio E/N of 1000 Td (1Td = 10^{-17} Vcm^2). The obtained results show that the main mechanism of a nitrogen atoms production in this case is the molecular dissociation in a direct electron impact, while influence of highly excited vibrationall states can be neglected.

Also, two new distributions of the statistical time delay of electrical breakdown in nitrogen, the Gaussian and Gauss-exponential ones, are presented. Distributions are theoretically founded on binomial distribution for the occurrence of initiating electrons and described by using analytical and numerical models. Moreover, the correlation coefficient between the statistical and formative time delay of electrical breakdown in nitrogen is determined. Starting from bivariate normal (Gaussian) distribution of two random variables, the analytical distribution of the electrical breakdown time delay is theoretically founded on correlation of the dependent statistical and formative time delay. Gaussian density distribution of the electrical breakdown time delay goes to Gaussian of the formative time or to Gaussian of the statistical time delay depending on electron yields, while the correlation coefficient is determined in the transition region from the formative time to statistical time dominated statistics .