NEW MODELS AND DISTRIBUTIONS OF THE ELECTRICAL BREAKDOWN TIME DELAY IN NEON

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Abstract. The measurements of the electrical breakdown time delay t_d in DC neon glow discharge for a wide range of working voltages and at different preionization levels are presented. The statistical breakdown time delay t_s and the discharge formative time t_f are experimentally separated and theoretical models of their dependencies on the overvoltage and number densities of residual charges during relaxation are suggested. Several empirical and semiempirical models are used to describe the formative time delay dependence on working voltages $t_f(U)$. The empirical and theoretical models from the literature are also applied to the experimental data, without and with empirical corrections. Good agreements with experimental data are found primarily at low overvoltages and with empirical corrections even at high overvoltages. Several new distributions are experimentally obtained: Gauss-exponential, Gaussian and double Gaussian ones for the statistical time delay, as well as Gaussian and double Gaussian distributions for the formative time.

The measurements of the breakdown time delay at different preionization levels (afterglow periods) $t_d(\tau)$ obtained with a galvanic layer of gold and a sub-layer of nickel on the copper cathode are compared to the measurements with a vacuum deposited gold layer on the cathode surface. It was found that the surface charges retaining on a galvanic layer of gold influence the breakdown time delay. The surface charges mask the exponential Ne_2^+ decay in afterglow, as well as, the conversion maximum due to molecular nitrogen ions production in Ne_2^+ collisions with nitrogen impurities $Ne_2^+ + N_2 \rightarrow N_2^+ + 2Ne$. The formative and statistical time distributions are double Gaussians due to combined effects of surface and gas-phase charges from the preceding glow. Presence of surface regions with reduced conductivity on a galvanic layer of gold retaining the surface charges is confirmed by scanning electron microscopy (SEM) images and energy dispersive X-ray (EDX) spectrum.