Numerical modeling of ns discharge development in strong magnetic field

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The numerical characterization of nanosecond pulsed discharges has been conducted in a strong magnetic field environment. Streamer discharge development and plasma generation in pure CO_2 was analyzed when magnetic field was directed along the axis of the discharge cell. Numerical simulations were based of a two-dimensional fluid model. It is shown that strong magnetic field affect dramatically on the plasma formation. The ns streamer diameter decreases significantly, plasma density increases. Calculations were carried out for different magnetic field values for fixed CO_2 pressure $P = 50$ Torr and fixed ns pulse voltage $U = 20$ kV. Streamer initiation and propagation was simulated on the basis of an axially symmetric two-dimensional fluid model. The system of equations under study consisted of transport equations for the densities of charged particles (electrons and positive and negative ions) and the Poisson equation for the electric field. It can be concluded that the streamer discharge sharply changes its characteristics with increasing magnetic field from $B = 0$ to 4 T for gas pressure 50 Torr. With a further increase in the magnetic field, the discharge parameters change much more smoothly. Thus, the reduced gyrofrequency $\omega/N = 4 \times 10^{-13}$ [rad m^3/s] (Hall parameter ~ 1) is an important threshold above which the transverse expansion of a pulsed nanosecond discharge in CO_2 can be practically neglected. This remark is very important when designing the electrodes of the supersonic magnetohydrodynamic channel, since an increase in the magnetic field above a certain value for each gas pressure allows one to avoid the development of a discharge in the boundary layers.