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Understanding the start of pulsed discharges in atmospheric air with 3D particle simulations

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Abstract

Pulsed discharges are widely used for many applications, such as plasma assisted ignition/combustion, water/gas cleaning and ozone generation.

We study the properties of "inception clouds" and "streamers". Streamers are thin ionized channels that can propagate into non-ionized regions, due to the electric field enhancement at their tips. They typically form at higher pressures (e.g., atmospheric pressure). Streamers are strongly non-linear, as they propagate due to space charge. Streamer discharge is a precursor to lightning, also is an important initial stage of long-gap discharge between high-voltage transmission lines. We present a 3D particle model that has been developed recently to simulate streamer discharges. Advanced numerical techniques that are used in the code will be shown in detail. These techniques might be of general interest for researchers doing particle simulations, especially those who have to consider space charge effects. Selected results will be represented, i.e., streamers incepted from a needle electrode (Fig. 1), overlapping avalanches in an overvolted gap (Fig. 2), splitting of positive streamers induced by external background ionization or magnetic field. Our results help to answer fundamental questions about pulsed discharges.

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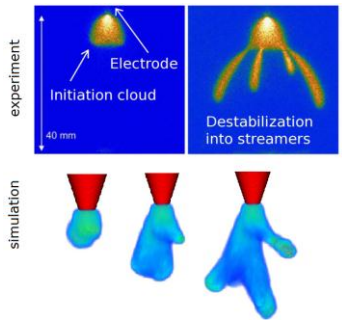

Fig. 1 Comparison of streamers incepted from a positive needle electrode

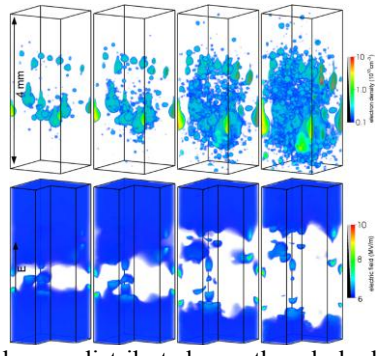

Fig. 2 Discharges distributed over the whole domain with 3D particle simulations, if the background electric fields above breakdown in atmospheric air