Effect of runaway electron preionization on discharge breakdown in air at atmospheric pressure: simulation study

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The runaway electron mechanism is of great importance for the understanding of the generation of X- and gamma rays in atmospheric discharges. Thermal runaway and the runaway electron avalanche discharge mechanisms are suggested to participate in the generation of Terrestrial Gamma ray Flashes. Thanks to development of both power supplies and diagnostic techniques, a number of experiments have been performed to study the discharges obtained using high voltage pulses with subnanosecond rise fronts. These discharges are also characterized by the presence of X-rays and runaway electrons. We use a 2D axisymmetric beam-bulk hybrid model, to study discharge breakdown appearing in a negative point-to-plane gap submitted to very high voltage pulse of 50 kV.

1. Introduction

The runaway electron mechanism is of great importance for the understanding of the generation of x- and gamma rays in atmospheric discharges [1]. Runaway electrons play also an important role for breakdown and discharge development in laboratory conditions [3, 2]. Both nanosecond discharges in an inhomogeneous electric field and atmospheric discharges are characterized by the presence of X-rays and runaway electrons [4].

2. Model and discussion

Negative streamer is simulated in a point-to-plane electrode configuration using a 2D axisymmetric hybrid beam-bulk approach [5]. Simulations are performed without pre-ionization or photoionization in order to emphasize the role of high-energy electrons. The discharge is initiated with a neutral gaussian plasma cloud composed of electrons and ions at rest in the vicinity of the pointed electrode. The results show the effect of high energy electrons on discharge development. While overtaking the discharge front, the high energy electrons pre-ionize the gas ahead and leave a trace of secondary seed electrons that in turn facilitate discharge propagation. As a result discharge with a support of fast electrons propagates significantly faster compared to discharge where the effect of fast electrons has not been considered, see figure 1.

3. Acknowledgements

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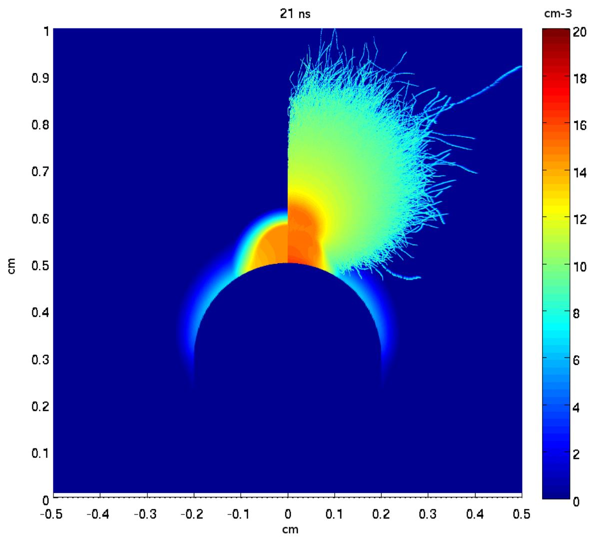

Figure 1: Negative streamer discharge onset close to the pointed electrode. Left: without runaways; Right: with runaways.

4. References

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