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STUDIES ON STREAMER DISCHARGES IN ULTRA-LOW GWP GASES

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Abstract. In this work, we use a Particle-in-cell/Monte Carlo collision (PIC/MCC) model to investigate the inception and propagation of both positive and negative streamers in ultra-low GWP gases, including $C_3H_2F_4$ and C_3HF_5. The modelling results can be used as a basis for assessing the performance of these gases in high-voltage insulation as eco-friendly alternatives to SF_6.

The PIC/MCC model uses Velocity Verlet scheme to track individual electrons in 3D and a Monte Carlo null-collision technique to sample the electron-neutral collision parameters. The electric field is assumed to be axially symmetric and is computed on a 2D numerical grid coupled with a Poisson equation solver. The electric field solver is implemented using the iterative multigrid method provided by the AMReX software framework. AMReX is an open-source C++ library for massively parallel block structured adaptive mesh refinement applications. In addition to its in-built geometric multigrid solver, we use the programming abstractions that it provides to implement adaptive mesh refinement and to support MPI and OpenMP parallelization on multicore CPUs. We also employ a particle management technique in order to optimize the number of particles in a simulation and shorten the computation time. To study the propagation of positive streamers, we include a photoionization model and a stochastic background ionization as sources of free electrons.

Results of PIC/MCC simulations are presented as an evolution of electron and ion densities, electric field distribution, streamer radius and velocity, and are obtained as a function of the applied electric field strength. In addition to ultra-low GWP gases, calculations are also performed for artificial dry air so as to validate and compare our results with those from open source Afivo-pic code.

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