Numerical Solution of 2D Streamer Propagation by Finite Volume Method on Unstructured Grid.

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Abstract

The paper deals with numerical solution of a simple 2D model of streamer fluid. It consists of a drift-diffusion equation for electrons and a simplified equation for ions coupled with a Poisson's equation for electric field potential:

$$\frac{\partial n_e}{\partial t} = -\text{div}[n_e \boldsymbol{v_e} - D_e \,\text{grad} n_e] + S_e \,, \quad \frac{\partial n_i}{\partial t} = S^+ \tag{1}$$

$$\Delta V = k(n_e - n_i) \,, \quad \boldsymbol{E} = -\text{grad} V \,, \tag{2}$$

where n_e and n_i denotes the number densities of electrons and positive ions, V is a potential of electric field E. The drift velocity of electrons is denoted by $v_e = v_e(E)$, $D_e = D_e(E)$ is the diffusion coefficient. The difficulty of described problem is connected with coupling of electric field and electron motion, stiff source terms and very steep gradients of unknowns in region of moving front of streamer. The system of equations is solved by finite volume method on unstructured triangular adaptive grid. The upwind type higher order scheme for convective term and diamond scheme for diffusion term are used for discretization of convection - diffusion equation (1). The diamond scheme is used also for discretization of Poisson's equation (2) together with umfpack solver of the sparse linear equation system. Numerical results of the model problem of streamer motion in electric field generated by planar electrodes are presented and discussed.

References

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