Modelling 1D Dielectric Barrier Discharge in Nitrogen Mixtures

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This work aims at analyzing the temporal evolution of species (Fig. 1), heating and other physical quantities in a gaseous mixture subjected to electric discharges. The mathematical model includes the application of high voltage in a gaseous mixture between electrodes. The simulation domain is a cartesian one-dimensional region. In the macroscopic perspective, the effects of transport, i.e. heat transfer and mass, are considered [1], microcopies, effects of heat generation due to electronic collisions and chemical reactions are also considered [2]. Reaction rate and transport coefficients depending upon the electron energy distribution function are calculated from collision cross-section data by solving the electron Boltzmann equation (BE). The application of a technique of separation of operators in the mathematical model provides to two sub-models, a global for macroscopic effects and another one containing microscopic effects of the plasma. A discrete sub-model for the electron-species and species-species collisions [3] is solved in ZDPlasKin [4], a zero-dimensional plasma analysis tool, while BE solver BOLSIG+ [5] required for solved electron energy distribution function. Nitrogen is used as an initial gaseous mixture in the simulation. Due to the high computational cost, a domain decomposition with Message Passing Interface (MPI) while OpenMP is used to solving a set of partial differential equations of each component in the gas mixture [6].

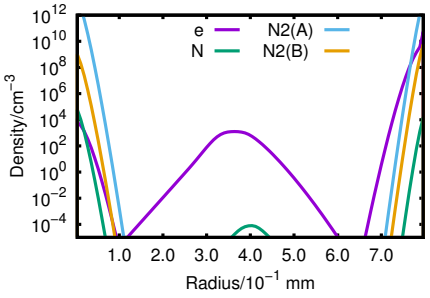

Figure 1: Species density at $1.0\times10^{-6}s$

References

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