Numerical Modeling of gas mixtures submitted to electrical discharges

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This work aims at the analysis of the temporal evolution of species and heating a gas mixture subjected to electrical discharge. The simulation domain, a radially symmetric two-dimensional region, is divided into two parts, with and without free electrons [1]. Transport effects, i.e. heat and mass transfer, are considered in both parts [2], while electronic collisions with molecular species in the mixture are accounted only in the discharge region. Reaction rate and transport coefficients that depend on the electron energy distribution function are calculated from collision cross-section data by solving the electron Boltzmann equation (BE). The BE solver BOLSIG+ [3] required for solved electron energy distribution function. A discrete sub-model for the electron-species and species-species collisions [4] [5] is used in the frame of ZDPlasKin, a zero dimensional plasma analysis tool [6]. Idealized dry air, composed by molecular nitrogen and oxygen (8:2) is the initial mixture in the simulation. Due to the high computational cost, a domain decomposition with Message Passing Interface (MPI) is used for parallelization of the calculations [7]. Spatio-temporal profiles for the gas temperature and species density are here calculated and reported.

References