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Influence of air and water vapor on EEDF and some active species in atmospheric pressure low temperature helium plasmas: investigation by global model

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A numerical 0D global model is developed with an aim to study the influence of air and water vapour impurities on electron energy distribution function and chemical composition of atmospheric pressure helium plasma, focusing on the main reactive oxygen and nitrogen species. Model includes 1488 reactions among 74 species, taken from the literature [1,2]. Rate coefficients for electron impact processes are calculated using two-term Boltzmann solver BOLSIG+ [3], with cross section data mainly taken from Quantemol-DB database [4]. The main channels for production and consumption of reactive species are examined for a constant electron concentration 10^{10}cm^{-3} and electron temperature 2eV. We have performed parametric study where mole fraction of air and water vapour were varied in the wide range, using data from the literature [5]. The calculations are done for 100ppm, 1000ppm and 10000ppm of air in plasma, and for each of these values the content of water vapour was 100ppm, 1000ppm, 2000ppm and 10000ppm. Through the influence of these contents on EEDF and appropriate rate coefficients, the variations of the most important production and consumption processes for O, OH, N and NO are analysed in detail. Results show that increasing of air and water vapour contents require higher E/N values to achieve given mean electron energy, rising the energy tail of EEDF and the values of rate coefficients for the electron impact processes with higher energy thresholds, such as dissociation of O_2 , N_2 and H_2O , important for initial production of O, OH, N and NO. Thus, for the same amount of water vapour, increasing of air content in plasma leads to higher concentration of OH radical and consequently higher level of H_2O_2 . For the same amount of air, higher content of water vapour generally leads to decrease of O and N concentrations through chemical reaction with OH radicals.

References

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