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Line intensities in nitrogen low-pressure microwave discharges

L.L. ALVES, V. GUERRA, IPFN/IST, Lisbon, Portugal, C. LOPEZ, J. COTRINO, ICMSE/CSIC, Sevilla, Spain — This paper analyzes the intensity of radiative transitions in nitrogen low-pressure (0.3-0.5 Torr) microwave (2.45GHz) discharges, using both optical emission spectroscopy (OES) measurements and a 0D non-equilibriun kinetic model. The latter solves the homogeneous and stationary electron Boltzmann equation, coupled to the rate balance equations for the N_2(X, v=1-45) vibrationally excited states, the $N_2(A^3\Sigma_u^+,\ B^3\Pi_g,\ C^3\Pi_u,\ a^1\Sigma_u,\ a^1\Pi_g,\ w^1\Delta_u,\ a^1\Sigma_g^+)$ electronic states, the N(^{4}S, ^{2}D, ^{2}P) atomic states, and the N_2^+(X,B) and N_4^+ molecular ions. The plasma is produced by a surface-wave discharge, within an 8mm diameter quartz tube, at ∼55W power and ∼100mm axial length. The rotational (gas) temperature of the nitrogen plasma (∼ 300-600 K) is experimentally determined from measurements of the band transition with the first positive system [FPS, N_2(B)–N_2(A)]. Comparison between simulations and measurements for the line intensity ratio R of the first negative system [FNS-00, N_2^+(B,v=0)–N_2^+(X,v=0) at 391.4 nm] to the second positive system [SPS-25,N2(C,v=2)–N2(B,v=5) at 394.3 nm] are used to estimated the electron density (∼ 10^{11} cm^{-3}) and temperature (∼ 3eV). We discuss the calculation of R using different model approximations, analyzing its evolution with variations in the working parameters: electron density, gas pressure, and gas temperature.

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