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Surface-wave capillary plasmas in helium: modeling and experiment[1] M. SANTOS, L.L. ALVES, IPFN/IST-UTL, Portugal, C. NOEL, T. BELMONTE, LSGS/CNRS, France — In this paper we use both simulations and experiments to study helium discharges (99.999% purity) sustained by surface-waves (2.45 GHz frequency), in capillary tubes (3 mm radius) at atmospheric pressure. Simulations use a self-consistent homogeneous and stationary collisional-radiative model that solves the rate balance equations for the different species present in the plasma (electrons, the He^+ and He_2^+ ions, the He(n<7) excited states and the He_2* excimers) and the gas thermal balance equation, coupled to the two-term electron Boltzmann equation (including direct and stepwise collisions as well as electron-electron collisions). Experiments use optical emission spectroscopy diagnostics to measure the electron density (H_β Stark broadening), the gas temperature (ro-vibrational transitions of OH, present at trace concentrations), and the populations of different excited states. Model predictions at 1.7x10^{13} cm^{-3} electron density (within the range estimated experimentally) are in good agreement with measurements (deviations < 10%) of (i) the excitation spectrum and the excitation temperatures (2795 $\pm$ 115 K, obtained from the Boltzmann-plot of the excited state populations, with energies lying between 22.7 and 24.2 eV), (ii) the power coupled to the plasma ($\sim$ 180 $\pm$ 10 W), and (iii) the gas temperature ($\sim$ 1700 $\pm$ 100 K). We discuss the extreme dependence of model results (particularly the gas temperature) on the power coupled to the plasma.

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