Energy transfer pathways in CO_2-containing DC discharges

V. Guerra[1], T. Silva[1], P. Ogloblina[1], M. Grofulović[1], L. Terraz[1], H. Rodrigues[1], C. Rodrigues[1], A. Silva[1], N. Pinhão[1], A. Tejero-del-Caz[1], L. L. Alves[1], A. S. Morillo-Candas[2] and O. Guaitella[2]

[1] *IPFN, Instituto Superior Técnico, Universidade de Lisboa, Portugal*

[2] *LPP, Ecole Polytechnique, UPMC, Université Paris Sud-11, CNRS, Palaiseau, France*

CO_2-containing plasmas constitute a hot topic nowadays, due to their importance in CO_2 reforming and the production of solar fuels [1,2] and in Mars-related studies [3,4]. A key step seems to reside in the selective excitation of the CO_2 asymmetric stretching vibrational mode, while limiting the losses by gas heating. The subsequent vibration-vibration (V-V) up-pumping may enhance dissociation and favour CO_2 conversion at a low energy cost [1,2]. This work presents a thorough theoretical, modelling and experimental investigation of discharges in pure CO_2 and in CO_2 mixtures with N_2, CH_4 and Ar and their afterglows, operating at pressures around 1 Torr, discharge currents of 10s of mA, either in a continuous or a pulsed regime. The basis of the model was presented in [5]. It comprises a detailed state-to-state kinetics of CO_2 vibrationally excited levels, coupled to the gas phase chemistry and to the homogeneous electron Boltzmann equation describing the electron kinetics. The model is validated from the comparison with the measurements of the populations of several heavy species, *e.g.* O, CO, $CO_2(v)$ and C_2H_x. Several phenomena are presented and discussed, such as the transfer of vibrational energy from N_2 to the CO_2 asymmetric stretching mode, the efficiency of dry reforming of methane, the influence of shifting the electron energy distribution function to higher energies due to Ar addition, or the main routes towards enhanced reactivity.

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