Preferred main topic: Modeling and Diagnostics

Abstract title: N_2 influence on the vibrational distribution of the asymmetric level of CO_2 in non-thermal plasmas

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Abstract:

DC pulsed discharges in CO_2–N_2 plasmas ignited at room temperature, pressures between 1 and 5 Torr and currents between 20 and 50 mA, show an increase of CO_2 dissociation when molecular nitrogen is present [1]. In this case, dissociation is assumed to be obtained partly from highly vibrating molecule collisions, as well as from direct electronic impact. The former process is enhanced by strong non-Boltzmann distributions of the vibration levels, typical from cold plasmas. The CO_2 molecule possess 3 vibrational modes, namely the symmetric v_1, the bending v_2^{l2} and the asymmetric v_3, represented following Herzberg's notation as $CO_2(v_1,v_2^{l2},v_3)$. Molecular nitrogen is known for having its lower vibration energy levels almost equal to those of $CO_2(00^0v_3)$, allowing N_2 to easily exchange vibration quanta with the asymmetric mode of CO_2. Hence the possibility that previously excited molecular nitrogen injected in a CO_2 cold plasma can favor CO_2 dissociation. In order to investigate the kinetics of such plasmas, a self-consistent model is developed, able to reproduce time-resolved experimental results for the populations of several CO_2 vibrational levels and to quantify the relative importance of all the processes involved in CO_2 dissociation. The model accounts for about 70 vibration levels for CO_2 and 10 levels for N_2, where all the species are at the ground electronic state. It includes reaction datasets for the vibration-translation energy exchanges (V-T), vibration-vibration exchanges (V-V) and excitation by direct electron impact (e-V) in mixtures of CO_2–N_2, extending the work in pure CO2 from [2]. The e-V processes are derived from the LisbOn KInetics Boltzmann code (LoKI-B). The overall good agreement between the model predictions and the experimental results provides a validation of the current kinetic scheme. Some discrepancies remain, which can however be justified by the influence in the kinetics of some species not considered in the current model, namely CO, O and O_2. The present simulations strongly suggest the possibility of using previously excited N_2 to assist CO_2 dissociation.

References:

[1] M. Grofulović, B. L. M. Klarenaar, O. Guaitella, V. Guerra and R. Engeln, *Submitted to PSST*, 2019

[2] T. Silva, M. Grofulović, L. Terraz, C. D. Pintassilgo, and V. Guerra, *Journal of Physics D: Applied Physics*, 2018

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