On the coupling of vibrational and electronic excited state kinetics with the electron energy distribution function in CO_2 cold plasmas

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The activation of CO_2 by cold (non-equilibrium) plasma has caught the attention of many research groups for the importance of converting carbon dioxide into fuels or value-added chemicals to handle the problem of increased emissions of greenhouse gases and the decreasing reserves of traditional energy sources. Non-equilibrium plasma could be used to achieve high-conversion efficiency thanks to the activation of molecular vibrational excitation in CO_2 dissociation. Recently, a topical review [1] has discussed different crucial theoretical and experimental aspects regarding the use of non-equilibrium plasmas for the dissociation of CO_2. The present contribution will focus on the importance of excited states, vibrational and electronic, in enhancing reactive channels and in influencing the free electron kinetics in CO_2 plasma discharges [2]. In particular, the results of an advanced self-consistent model [3, 4] describing the vibrational and electronic excited state kinetics, the plasma composition and the free electron kinetics will be presented in different possible types of discharges (microwave, glow, etc) and in an extended experimental range of gas temperatures, pressures, electron density and reduced electric field and/or power density values. An improvement of the electronic excited state kinetics for CO_2 and CO systems is provided by taking into account radiative and quenching processes involving such states. Another important aspect investigated is the role of gas temperature in influencing the plasma properties, using also available experimental time dependent profile as input data of kinetic modeling. Finally, an attempt to validate the model results through comparison with other model results [5] and recent measurements [6] is provided finding a good agreement.

References

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