A parametric Boltzmann equation analysis of CO_2 dissociation in cold plasmas and afterglows

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Large attention is presently devoted to the activation (dissociation) of CO_2 by using cold (non equilibrium) plasmas. The basic idea is to introduce vibrational quanta into the vibrational ladder of CO_2 by electron molecule resonant interaction followed by V-V (vibration-vibration) energy climbing up to the dissociation limit. This idea is at the basis of the so-called pure vibrational mechanisms (PVM), which can enter in competition with the electron impact mechanisms (DEM) especially when the electron average temperature is of the order of 1eV. The main advantage of PVM mechanisms against DEM ones is in its lower power necessary for the process.
To understand the situation one must construct ab initio models based on completely new data bases for electron-molecule and molecule-molecule cross sections allowing their dependence on the vibrational quantum number(s). The relevant information must be inserted in the Boltzmann equation for the electron energy distribution function (eedf), which must be solved in the presence of vibrational and electronic states. eedf, in turn, is strongly dependent on the concentration of excited states, characterized by different vibrational temperatures, and on different ionization degrees and on electronic excited states molar fractions. The different rates coming from the solution of Boltzmann equation are then used for characterizing the global PVM and DEM rates, showing, in particular, the range of prevalence of PVM on the DEM. Moreover, the rate dependence on the insertion in the Boltzmann equation of a complete set of electron-molecule transitions along the asymmetric vibrational mode of CO_2 is discussed, emphasizing the importance of new atomic and molecular data bases in describing the activation process.
To end this presentation we underline that the different slides are self-explanatory taking also into account the recent paper published by the present authors[1].

[1]L.D.Pietanza, G.Colonna, G.D'Ammando, A.Laricchiuta and M.Capitelli, "Vibrational excitation and dissociation mechanisms of CO_2 under non-equilibrium discharge and post-discharge conditions", Plasma Sources Science and Technology 24, 042002 (2015)

Prof. Mario Capitelli's research fields:

- dynamics of elementary processes
- plasma physics and chemistry
- non-equilibrium vibrational kinetics
- laser-plasma interaction
- aerothermodynamics