Self-consistent Electron Energy Distribution Functions in Reacting CO$_2$ discharge and post-discharges conditions

L.D. Pietanza, G. Colonna, A. Laricchiuta, M. Capitelli

PLASMI Lab CNR, Bari, Italy

Large attention is nowadays devoted to the understanding of the activation of CO$_2$ by cold plasmas in different conditions (MW, DBD, nano-pulsed discharges). Theoretical efforts are being developed to better understand the electrical conditions necessary for maximizing the CO$_2$ dissociation process [1-2]. In particular, Bogaerts et al. [1] concentrated their efforts on the vibrational plasma kinetics, while Pietanza et al. [2] devoted particular attention to the development of the electron energy distribution function (eedf) in pure CO$_2$ and CO plasmas. In this contribution, we present new results for MW CO$_2$ reacting mixture, emphasizing the role of CO$_2$ and CO species in affecting the eedf through their non-equilibrium vibrational distributions, as well as their concentration of electronic states. Vibrational and electronic states play an important role in superposing structures in eedf especially in the post-discharge regime due to the action of superelastic collisions. A sample of results is reported in the following figure for discharge (a) and post-discharge (b) conditions characterized by the following values: $P$=20 torr, $T_g$=300 K, power density $W$=80 W/cm$^3$, discharge time $t_d$=50 ms, post-discharge time $t_{pd}$=800 ms). The role of excited states in affecting eedf is well evident in the post-discharge regime where the plateau created by the CO$_2$ metastable at 10.5 eV and a multitude of peaks mainly due to the electronic states of CO clearly appear, these structures being hidden under discharge conditions by the applied field.