Online LTP Seminar
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Investigating the Role of Vibrational States, Electronic States and Surfaces in CO2 Plasma Kinetics

Dr. Olivier Guaitella

Laboratory of Plasma Physics, Ecole Polytechnique, Palaiseau, France

The interest in CO2 plasma has been revived by environmental concerns but CO2 plasma are also of interest for some surface treatment processes or spacecraft planetary atmosphere entry, as well as in situ resources utilization (ISRU) on Mars. Beyond applications, CO2 plasmas are a valuable test case for molecular plasma kinetics. Being a triatomic molecule, CO2 in a plasma leads both to intra- and inter-molecular vibrational energy transfers. It can also dissociate in relatively large proportion producing very reactive radicals (O, O(1D)) or metastable states (CO(a3Pi)) which carries large amount of energy. All these contributions make CO2 plasma kinetics very rich and complex. At the same time both CO2 and CO have also very strong line strengths in the mid-infrared allowing for relatively easy experimental measurements even with low densities. Therefore, when studying the mechanisms controlling pure CO2 and CO2 containing plasma kinetics, many types of important processes taking place in any molecular non thermal plasma are investigated. Despite the numerous works performed since the early studies of CO2 lasers, many fundamental data are either missing of suffer from large uncertainties. This makes accurate and predictive models of CO2 plasmas very challenging. We have therefore performed a series of experiments in pulsed DC glow and RF discharges to investigate separately different aspects of CO2 containing plasmas by comparing time resolved infrared absorption measurements with 0D kinetics models developed at IST Lisbon. In pure CO2, the direct electron impact dissociation, the e-V, V-V and V-T energy transfers as well as the key role of CO(a3Pi) and negative ions have been investigated. In CO2/CH4 plasma (relevant for gas reforming applications), the relative quenching efficiency of CO and CO2 by H, H2, CH4 and H2O has been studied. The role of large specific surface materials as well as catalyst has also been investigated. In particular, infrared absorption spectroscopy is performed through catalyst pellets under the same CO2/CH4 plasma exposure in order to compare the data of species detected both in the plasma and the adsorbed phase for gaining better understanding of plasma/catalyst interaction.

References

[1] H. Gota et al., Nucl. Fusion 59, 112009 (2019)

[2] M. Binderbauer et al., Phys Plasmas 22, 056110 (2015)

Short Bio

Dr. Olivier Guaitella is a researcher of the Non-Thermal Plasma group from Laboratory of Plasma Physics in Ecole Polytechnique near Paris. He has received is PhD degree in Physics in 2006 at Ecole Polytechnique. His main research interests are focus on plasma surface interactions and their influence on non-equilibrium plasma kinetics at elevated pressure. This work finds applications for indoor air treatment, Plasma/catalyst coupling, plasma in liquids, plasma jets interaction with targets. After being an invited researcher at Eindhoven University of Technology in 2014, he started focusing on plasma CO2 recycling. He has also a strong interest in the development of new diagnostics techniques and has especially an expertise in infrared absorption techniques. He was member of the steering committee of the French non thermal plasma network from 2013 until 2019. He is among the teachers of the Bad Honnef plasma school since 2014 and he is currently scientific coordinator of the H2020 ITN-EJD PIONEER project on CO2 conversion.