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PhD Thesis Abstract

Energy storage and transfer in non-equilibrium CO_2 plasmas

Due to the steady growth of greenhouse gases (mainly CO_2 and CH_4) in the atmosphere, the reduction of fossil fuel consumption and of CO_2 emission is one of the key challenges for the next decades. The greenhouse gas emissions could be decreased by an energy-efficient capture and decomposition technology, which would be very significant from the environmental, economical and societal points of view. Together with the use of renewable energy sources, this could also reduce the dependence on fossil fuels. The limiting step to achieve an efficient storage in high energy density hydrocarbon–based fuels produced from industrial CO_2 emissions is CO_2 dissociation. Non-equilibrium plasma technologies are recognized as a possible solution to this problem, giving the possibility to enhance specific reaction channels and suppress others by controlling the electron density, electron temperature and gas temperature. Therefore, the main objective of this research is to develop and validate a self-consistent model of CO_2 plasmas, in order to understand the energy storage and energy transfer pathways in CO_2 plasmas and to optimize the conditions enabling the required energy efficiency for industrial applications. The proposed work consists on a thorough theoretical, simulation and experimental investigation of all the steps involved in plasma decomposition of CO_2, including: electron kinetics and control of the electron energy distribution; input of energy in the low v-levels by low-energy electrons; up-pumping of vibrational quanta up to high v-levels; experimental characterization of microwave discharges; and fully coupled kinetics of CO_2 plasmas.