Think Inside the (Black)Box - Insights into the influence of water on the plasma conversion of CO_2 by in situ investigations

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ABSTRACT

A critical inspection of CO_2 plasma conversion research nowadays reveals that too often the community is sitting on the fence. On the one hand, many studies focus on pure CO_2 thereby neglecting the presence of impurities. On the other hand, the plasma is regularly treated like a black box that turns an input of CO_2 into products like CO and that is solely controlled by outer parameters like power as if the industrial stage was already reached. However, sophisticated process optimization is only possible from the groundwork of fundamental understanding obtained from experimental or modelling in situ investigation. To shrink this gap, in situ laser-spectroscopic investigations of the influence of water, an omnipresent impurity, on the conversion of CO_2 are presented. Particularly, OH laser-induced fluorescence (LIF) spectroscopy measurements in a pulsed DC CO_2-H_2O glow discharge at 6.67mbar are conducted. The hydroxyl radical influences the chemistry in the plasma due to its high reactivity but can also serve as probe molecule of the conversion process. With a new suggested calibration method absolute OH number densities in the order of $10^{18}m^{-3}$ are presented in this environment, for the first time to the best of our knowledge, together with the CO_2 conversion fraction [1]. Furthermore, a potential difficulty, namely the spectral overlap with excited CO, is uncovered and resolved through proposition of a new excitation scheme [2]. These results will prove valuable in plasma kinetic modelling.

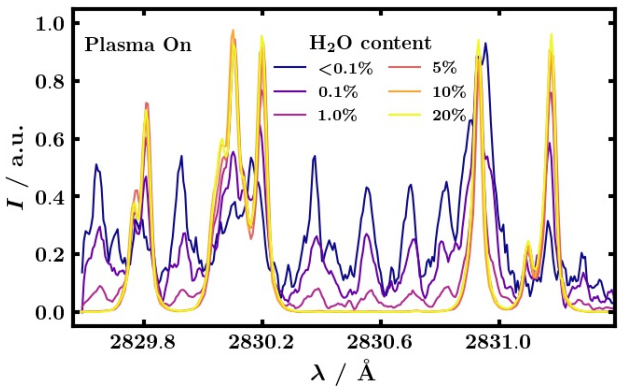

Figure 1. Distortion of an OH excitation spectrum for decreasing admixture of H_2O to the CO_2 glow discharge caused by the third positive system of CO [2].

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