Characterization Of Microwave Gaseous Discharges For Dissociation Of CO_2

Tiago Silva[1], Nikolay Britun[1], Thomas Godfroid[2] and Rony Snyders[1,2]
[1] *Chimie des Interactions Plasma Surface (ChIPS), CIRMAP, Université de Mons, 23 Place du Parc, B-7000 Mons, Belgium*
[2] *Materia Nova Research Center, Parc Initialis, B-7000 Mons, Belgium*

Carbon dioxide (CO_2) is one of the main greenhouse gases emitted as a result of human activities, which makes the study of CO_2 dissociation a highly demanding issue, requiring attention and the corresponding solutions. Among the proposed strategies, one possible way to limit CO_2 emission is to use plasma for breaking the CO_2 molecule into oxygen (O) and carbon monoxide (CO), which can be later used for production of valuable chemicals, e.g. for the fuel synthesis (syngas). In particular, microwave plasmas under non-equilibrium conditions are well known to provide high dissociation degree in molecular gases [1]. Using this type of plasmas, where the molecules have different degrees of freedom, it should be possible to follow a "preferential" molecular dissociation channel(s).

In this study, the recent results on the plasma diagnostics performed in CO_2-containing microwave surfaguide discharges (MSGD) operating at 2.45 GHz and 0.9 GHz in pulsed and continuous regimes are presented. The plasma is sustained either in pure CO_2 or in CO_2-N_2 gas mixtures inside a quartz tube with the inner diameter of 14 mm and length of 24 cm surrounded by another (polycarbonate) tube for cooling purpose.

The microwave discharges are characterized in terms of the plasma parameters using different optical emission spectroscopy (OES) approaches. In particular, the characteristic plasma temperatures, such as the gas temperature (via CO rotational spectra), and vibrational temperature (via N_2 vibrational bands) are determined as a function of time at different axial positions along the gas flow in the discharge tube. The CO_2 conversion rate in the discharge volume, along with the measurements of plasma energetic efficiency of such conversion is performed by means of optical emission actinometry. The results of the time- and space-resolved OES measurements demonstrate a non-uniform dissociation rate of CO_2 along the gas propagation direction in the discharge [2]. It is shown that, the dissociation degree can be substantially modified by varying the power balance, pressure and the composition of the gas mixture.

[1] T. Godfroid, et. al., *Surf. Coating Technol* **174-175** 1276-1281 (2003)
[2] T. Silva, et. al., *Plasma Sources Sci. Technol* **23** 025009 (2014)