STUDY OF DIFFERENT MATERIAL FOR CO_2 RECYLCING BY PLASMAS

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Summary

Climate change is one of the most challenging issue of our time and is mainly caused by the increase of CO2 content in the atmosphere due to anthropogenic emissions. It is therefore necessary to find ways either to reduce these emissions or to capture and recycle CO2. In this regard, one promising option is the use of low temperature plasmas to convert CO2, for example from industrial sources, into "syngas", synthetic fuel that could be reused [1]. The first step in that process is the CO2 dissociation to create CO and an oxygen atom. However, the probability of recombination between these products through the so-called "back reaction" is non-negligible at the gas temperature in the discharge. One way to control this reaction is by using catalytic surfaces, that could for example increase the recombination between two O atoms to produce O2 instead of between CO and O, thus preventing the back reaction. In this work, different catalytic surfaces are investigated in order to study surface processes affecting the final dissociation fraction

Experimental setup

CO2 plasma was ignited in a glow discharge reactor made of Pyrex, and powered by a DC power supply to produce discharge currents between 10 and 40 mA. The pressure range of the experiments was between 0.4 an 5 Torr and the gas flow was varied between 0.3 and 7.4 sccm, changing the residence time of the gas in the reactor between 0.5 and 20 seconds. A layer of Silica-based micro-structured fibers is attached to the internal wall of the reactor. Three types of fibers were investigated: raw SiO2 fibers, SiO2 fibers coated with Al2O3 and with Al2O3+ 5 % CeO2. Additional measurements with graphite coating on the reactor wall were also performed.

Fourier Transform Infra-Red Spectroscopy (FTIR) was the main diagnostic technique. It provides absorption and emission spectra that can be fitted with a MATLB script explained in detail in [2] providing valuable information, such as CO2 and CO molecular densities, vibrational temperatures of CO2 and CO and the rotational temperature of CO2, in equilibrium with the gas temperature in our experimental conditions.

Discussion

Previous in-situ measurements with raw SiO2 fibers showed an increase in the CO2 vibrational temperature due to the recombination in the fibers of O atoms which were found to be the quencher of the vibrations of CO2. However, no effect on the dissociation was detected. In this work, the use of different coatings show interesting effects of the surface material on the dissociation fraction. SiO2 fibers coated with Al2O3 show a relevant decrease in the CO2 dissociation while SiO2 fibers coated with Al2O3 and a small amount of CeO2 show the opposite behaviour (see figure 1a). The possible pressure-dependent recombination of O into CO with the carbon from the graphite is also investigated (see 1b).

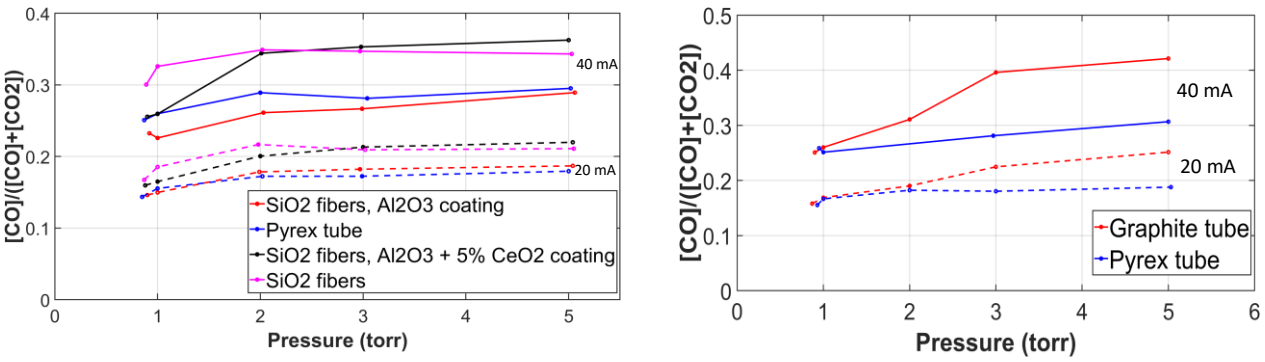

Figure 1: Comparison of the dissociation fraction of CO_2 in a CO_2 plasma a) with the addition of different fibers on the reactor wall (left) b) with graphite in the reactor (right)

Références

[1] Fridman A 2008 Plasma Chemistry (Cambridge University Press)

[2] B L M Klarenaar et al. 2017 Plasma Sources Science and Technology 26 11500