Characterization of CO_2 splitting in atmospheric nanosecond pulsed microwave plasma with a highly time resolved OES

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CO_2 conversion to carbon monoxide and oxygen is considered more efficient in non-equilibrium plasmas as compared with thermal ones [1]. To achieve a non-equilibrium state in CO_2 plasma, the microwave pulsing is one of promising approaches. It is based on the interruption the energy supply before the VT relaxation starts to deteriorate the population of vibrational states. At atmospheric pressure, however, the VT relaxation time reduces significantly as compared with vacuum conditions [2] and to sustain a non-equilibrium, the nanosecond pulse times are necessary. Systematically investigations on the conversion rate and efficiency in atmospheric plasmas sustained with nanosecond microwave pulses are performed in KIT since 2018 [3]. To understand the phenomena taking place at a pulse time scale, we examined the atmospheric plasma by ultrafast optical emission spectroscopy (OES). It is enabled with the synchronizing the ICCD camera gate and microwave pulse by means of microwave detector and delay generator. The sketch of experiment and example of spectra recorded within pulse time of 2500 ns in atmospheric microwave plasma are presented in Figure 1. To interpret molecular emission bands in terms of temperature, the recorded spectra are fitted with synthetic spectra by utilizing the software MassiveOES [4]. It enables to resolve the rotational and vibrational temperatures of CO and C_2 species within a period of microwave power modulation.

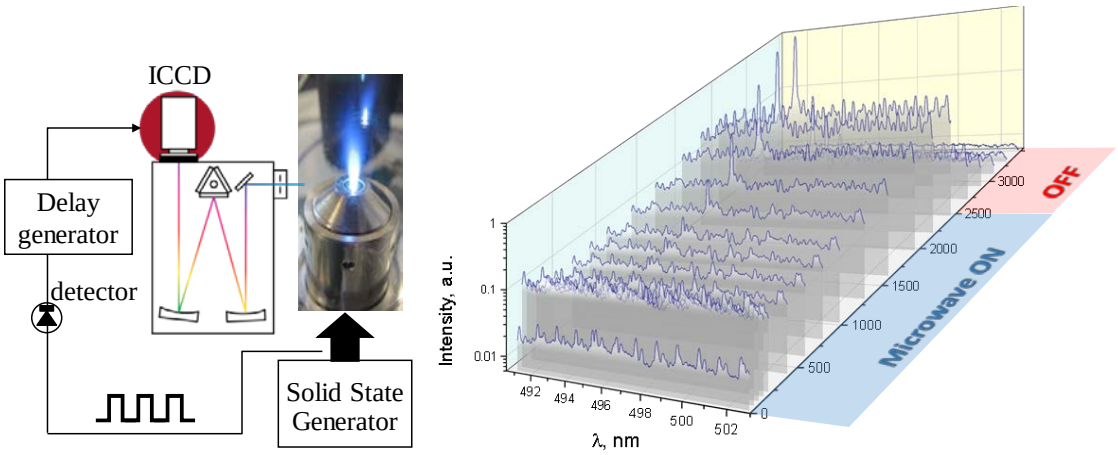

Figure 1: Sketch of time resolved OES system (left). Example of spectral characterization of CO_2 plasma emission for 2500 ns pulse time and 1 bar pressure (right).

References:

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