DEVELOPMENT AND SPECTROSCOPIC INVESTIGATION OF A MICROWAVE PLASMA SOURCE AT ATMOSPHERIC PRESSURE

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Microwave plasma sources at atmospheric pressure have a variety of different applications. On the one hand they can be used for the treatement of surfaces, for example the activation or cleaning, and on the other hand they can be applied for the conversion of gases, such as the abatement of waste gases or other chemical synthesis.

The presented atmospheric plasma source is based on an axially cylindric resonator which is powered by 2.45 GHz microwaves. The plasma is confined in a quartz tube and the gas is supplied via a metallic nozzle. For a successful application in industrial processes an easy ignition as well as stable plasma operation are indispensable. To gurantee ignition of the plasma without any additional igniters, detailed information about the electric field is necessary. Simulations of the electric field distribution of different configuration with the commercial simulation software COMSOL Multiphysics^{TM} were performed for this purpose. The simulation results could be verified by measurements with a network analyser and led to a configuration which provides an ignition of the plasma without any additional igniters as well as stable and efficient plasma operation.

The characterisation of the plasma was carried out by means of optical emission spectroscopy. Overview spectra of a humid air plasma exhibit NO- and OH-bands in the UV range as well as atomic oxygen lines in the IR range. The OH-bands were used to obtain the gas rotational temperature T_{rot}, which provides a good estimate of the gas temperature T_g. The electron temperature T_e was estimated by the excitation temperature T_{ex}, which was determined from a Boltzmann plot of the atomic oxygen lines. Maximum values of T_{rot} of 3600 K and about 2200 K higher excitation tempeartures of 5800 K were measured. Parametric studies of T_{rot} and T_{ex} in depenendence of the gas flow and the supplied microewave power showed that the maximum temperatures are independent of these parameters in the regarded range of an air flow of 10 sl/min to 70 sl/min and a supplied microwave power of 1 kW to 3 kW. However, the plasma volume depends on these parameters and increases with an increase of the microwave power and decreases when the gas flow is increased.