PROGRESS REPORT: TIME AND SPACE RESOLVED DETECTION OF NH-RADICALS IN AN RF-DRIVEN GLOW DISCHARGE USING COMBINED CRD AND 2-D LIF-SPECTROSCOPY

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Abstract. The combination of pulsed Cavity-Ringdown-Spectroscopy (CRDS) and spatially resolved Laser Induced Fluorescence Spectroscopy (2D-LIF) was tested as a versatile tool for plasma diagnostics and other fields of research where a non invasive method for measuring particle densities and distribution is needed. The setup was tested in three different environments. The distribution and number density of CS_2 molecules were monitored in molecular beam created by a pulsed nozzle. Two different types of plasma were investigated as well. The formation of NH-radicals in an NH_3/Ar discharge was examined. We used a laser plasma as an example of a thermal discharge and an RF-driven micro discharge as an example for a glow discharge operated at near-atmospheric pressures.

1. INTRODUCTION

In recent years the plasma community put much effort into the development of plasma sources for non-thermal discharges at high pressures. One way to reach this goal is the use of sources with electrode distances in the micrometer range. These structures provide very strong electrical fields at moderate voltages.

But there are some problems connected to these small dimensions if one tries to monitor plasma parameters such as particle densities, degree of ionization and the like. Classical techniques like the Langmuir probe are no longer applicable, because their influence on the discharge is huge. Because of this there is a need for new, non-invasive techniques.

Optical Emission Spectroscopy (OES) for example is a widely used tool for plasma diagnostics. The setup needed is very simple and can be implemented in very short time. But OES can only monitor species in electronically excited states. Depending on the particular discharge parameters these species are not necessarily in thermal equilibrium. Therefore estimations of temperatures can be way off. Further disadvantages include limited resolution (depends on the grating used) and low selectivity.

Another well knows spectroscopic method is Laser-induced Fluorescence Spectroscopy (LIF). A tuneable laser is used to selectively excite species in ground state, which then emit light at longer wavelength, that is detected perpendicular to the laser beam. If a photomultiplier tube is used as a detector very high sensitivities (<1ppt) are achievable. If this sensitivity is not needed an intensified CCD-Camera can be used to detect the fluorescence (2D-LIF). These detectors offer very short exposure times (down to 200 ps) and provide spatial resolution – which should be very valuable for inhomogeneous systems like micro discharges. LIF-Spectroscopy can deliver much more information about a discharge than OES – as species in the ground state are probed gas temperatures can be obtained, 2D-LIF is a very good technique to show the particle distribution in a discharge. However to calculate the absolute densities one needs a second technique. Cavity-Ringdown-Spectroscopy (CRDS) has the same sensitivity as 2D-LIF and offers access to absolute densities without any

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