Measurements of atomic nitrogen in an atmospheric-pressure plasma jet

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Atmospheric-pressure plasma jets (APPJ) are widely studied for multiple, novel applications in plasma medicine. To guarantee the safe and efficient use of these devices it is vital that a thorough understanding of the physics and chemistry of these plasmas is established. Reactive oxygen and nitrogen species (RONS) such as O, N, OH, NO are expected to play a crucial role in the applications of APPJs. However, so far they are only poorly understood, mainly because they are difficult to measure experimentally.

We present an experimental technique to directly measure atomic nitrogen, one of the important RONS in APPJs. Our two-photon absorption laser-induced fluorescence (TALIF) diagnostic uses 206.65 nm photons from a Nd:YAG-pumped tunable dye laser for excitation of ground-state N atoms. Fluorescence of 3 spectral lines in the range 742-746 nm is observed using a 10 nm FWHM interference filter and an intensified CCD camera. The ns-pulsed laser is sent through the plasma jet at a point 1 cm from the output of the plasma channel.

The plasma jet under study is a micro-scaled APPJ device designed for optimal access for optical diagnostics. It has been studied extensively in the past with for instance measurements of gas temperature, helium metastable, ozone, singlet delta oxygen and atomic oxygen densities. The plasma setup consists of 2 plane parallel stainless steel electrodes with quartz windows to enclose the discharge region along both sides, but allowing access with the 206.65 nm laser beam. The core plasma channel is typically 30 mm long and has a 1x1 mm cross-section. Helium gas at 1 slm with a molecular nitrogen admixture of up to a few percent are fed through the channel. The plasma is created by applying a 13.56 MHz voltage to the top electrode via an impedance matching network.

With our TALIF diagnostic we studied the influence of the nitrogen admixture concentration on the observed fluorescence intensity, and therefore the N atom density in the APPJ. In figure 1 the fluorescence intensity for different nitrogen admixtures is presented and it is clear that there is an optimum in the fluorescence intensity at about 0.2% nitrogen admixture.

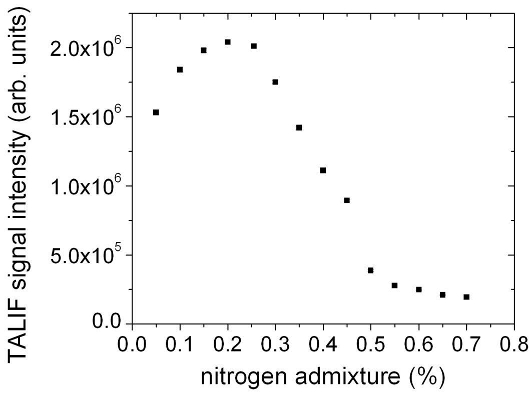

Figure 1: *TALIF signal as a function of the nitrogen concentration in the plasma jet feed gas.*