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Novel diagnostics for direct measurements of radical densities in atmospheric pressure plasma jets[1]

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Atmospheric-pressure plasma jets (APPJs) are widely studied for potential applications in industry and healthcare, e.g. surface modification of plastics, plasma medicine and photoresist removal. These plasmas can operate in open air, remain at room temperature and still have a non-equilibrium chemistry. Even though the exact mechanisms through which APPJs affect target surfaces remain largely unknown, it is clear that reactive species play a pivotal role in the success of APPJs. Therefore, reactive species diagnostics of APPJs play an important role in further developing our understanding of the plasma chemistry and will enable increases in treatment efficacy. Two-photon Absorption Laser Induced Fluorescence (TALIF) is a well-known technique for the measurement of absolute densities of atomic radicals such as O, N and H. Unfortunately, application of this technique on APPJs that are operating under realistic conditions for applications, i.e. in open air and with complex admixtures, is not straightforward. The highly collisional environment of APPJs means that collisional quenching of the laser-excited state becomes significant and needs to be taken into account. For well-controlled atmospheres and simple admixtures the effect can be estimated using quenching coefficients, however under realistic operating conditions the identity and density of the quenching partners is unknown due to the complexity of the plasma chemistry. I will present a picosecond TALIF diagnostic which uses a sub-nanosecond laser and iCCD camera that allows the measurement of the quenching-affected fluorescence decay rate directly, enabling absolute measurements of O and N density maps in the open-air effluent of an APPJ.

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