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(G*) Microscale electric field detection improvements: Steps toward tailoring cold atmospheric pressure plasma

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Cold atmospheric plasma science is a continuously growing domain. Agriculture, material synthesis, medicine, air and surface decontamination, food processing, among many more, applications fields of this omnipresent, yet invisible to broad society, technologies seem limitless. The knowledge about plasma sources and the underlying physics is constantly improved with new designs and multidisciplinary applications. The ability of cold atmospheric pressure plasma to generate reactive species (RONS) relevant for the most prominent applications, such as wound healing, pathogen inactivation, methane reforming, originates from the electric field characteristics of the plasma. It is thus of the utmost importance to have an efficient, sensitive, and high-resolution detection technique to determine the plasma electric field in time and space. The method of choice is electric field-induced second harmonic (E-FISH), a by now well-established nonperturbative technique for measuring the amplitude and orientations of cold atmospheric plasma electric fields. It exploits the appearance of hyperpolarizability in gas when subject to an electric field. A laser is used to probe the medium and the optical second harmonic signal is detected to determine the electric field in the gas. Although E-FISH allows tunable time resolution, only limited by the pulse duration of the used laser, which can go down to the femtosecond, it has been shown that E-FISH presents some issues. Spatial resolution along the beam axis is of the order of the interaction length of the beam and the plasma, and sensitivity only goes down to the order of 100V/cm using a PMT for detection. Work on enhancing these two characteristics of E-FISH have been made by our team and collaborators. Using a femtosecond laser, novel approaches were developed and optimized. The presented results confirmed the improvement of the electric field detection technique, the E-FISH, and will certainly deepen our knowledge on the spatio-temporal electric field distribution of cold atmospheric plasma.

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