PO1058

Schlieren photography of gas flow structuration in atmospheric pressure plasma jet

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The non-stop considerable interest for nonthermal atmospheric pressure plasma jets is still growing for decays due to its importance in plasma physics technology, medicine and industry. The unique ability to generate highly reactive chemical species in a localized area together with the separation of formation and application zone makes the plasma jet one of the best simple to handle tools for gentle but efficient treatment. Moreover, plasma jets are environmentally friendly, comparably cheap (no need for expensive vacuum equipment) and have a simple structure. Such devices are also safe, reliable, compact and easy to use. The typical construction of an atmospheric pressure plasma jet consists of a thin capillary with different electrode configuration. The working gas is blown from the capillary with a defined speed and leads to various dynamics in ambient air. Development of new designs and controlling the already existing plasma jet systems require deep understanding of the plasma and gas–surface interactions. One of the possibilities to look at the invisible laminar/turbulent nature of the gas stream is to use Schlieren photography. The first part of this work investigates the influence of gas flow rate on the length of the laminar part of the gas stream with and without the plasma discharge. Furthermore, the behavior of gas flow during the treatment of flat samples as well as tubes and 3D structures is investigated. Modeling in COMSOL helps to obtain more information about the stream gas dynamics and demonstrates the trustworthiness of the experimental results. Schlieren photos clearly show that plasma discharges drastically change the gas flow dynamics. The results illustrate significant changes of the dynamics in gas outflow with plasma on or off. Accordingly the presence of charged particles in a plasma jet increases the turbulent region of the gas stream. The size, curvature and pores of the solid substrate cause additional changes in gas stream dynamics that are recognized on Schlieren photos.

Keywords
atmospheric pressure plasma
plasma jet
Schlieren photography
gas flow dynamics