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Influence of target on electric field in kHz-driven atmospheric pressure plasma jet in Helium

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The understanding of the dynamic of impingement of atmospheric pressure plasma jet is the key for their use in many applications. The electric field strength has been measured above and onto different surfaces, dielectric, metallic or liquid, by means of Stark polarization spectroscopy. In the case of dielectric surfaces, the electric field strength values are compared with measurements based on Pockels effect obtained with an imaging polarimeter.

1. Introduction

The term "atmospheric pressure plasma jets (APPJ)" represents many diverse plasma sources having usually in common to be operated with a flow of noble gas inside a small diameter tube. They have been the focus of many studies because of their potential interest in biomedical applications and surface treatment technologies. For all these applications, it is always crucial to understand and control the interaction of the APPJ with a target which can be dielectric or conductive, solid or liquid. The surface exposed to an APPJ can be physically and/or chemically modified by the plasma, but the target can also influence the discharge development. A key parameter to study the properties of APPJ in contact with targets is the electric field induced by the plasma above and onto various surfaces.

In this study, electric field in helium plasma jet impacting dielectric, metallic or liquid surfaces is measured by means of Stark polarization spectroscopy as described in [1]. The results on dielectric surfaces are compared with surface electric field strength measurement based on Pockels effect obtained with an imaging polarimeter described in [2]. The influence of gas mixing between helium and surrounding atmosphere is also monitored with Schlieren imaging.

2. Experimental setups

The jet source used for this work has been described in [1,2]. The powered electrode is a needle metal tube (inner diameter of 0.8 mm) centered inside a Pyrex capillary (inner diameter 2.5 mm, outer diameter 4 mm). A metal ring (3 mm long) on the outer side of the capillary is used as the grounded electrode. The gap between the two electrodes was 5 mm, while the distance from the grounded electrode to the end of capillary was 20 mm for the entire study. Helium flow through the capillary is regulated using mass flow controller in range of 700-2000 SCCM. The jet is powered by sine voltage at 30 kHz, 2 kV in amplitude. The jet source was most of the time vertical above a target. The targets used were glass disks, grounded disks, or distilled water reservoir.

3. Results analysis

We had already measured that electric field strength in the plume of this APPJ is increasing with distance from the capillary tip because of gas mixing with air and constriction of the plume [1]. At a given distance from the tip of the capillary, the field strength at the impact on a target is significantly higher than without surfaces. It is shown that enhancement of field due to the surface happens only on a very thin layer above the surface. Very high values of electric field (up to 40 kV/cm) can be obtained on surfaces. The gas flow dynamics above the surface is also strongly modified by the plasma.

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4. References

[1] A. Sobota et al (2016) *Plasma Sources Science and Technology*, **25** (6), 065026.

[2] E. Slikboer et al, contribution to ICPIG 2017