Influence of humidity on formation of pulsed atmospheric pressure plasma streamers

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Atmospheric pressure plasma jet (APPJ) falls into one of the most promising non-equilibrium low temperature plasma sources which are convenient for multiple applications. In order to achieve the best possible results in applications and explain the mechanisms that lead to the modification of the samples it is necessary to perform a detailed diagnostics of plasma source. Many studies showed that the low-frequency plasma jet's plume is made of fast pulsed atmospheric pressure plasma streamers (PAPS). In this study we show that the change in the concentration of water vapour within the tube, where the feeding gas flows, significantly affect the formation of PAPS.

1. Introduction

The expansion of low temperature atmospheric pressure plasma sources used in the treatment of heat-sensitive samples carries step forward in future bio technologies, methods of healing, etc. These kind of plasmas are particularly suitable for treatment of the samples that do not tolerate vacuum and, more importantly, they produce a huge number of reactive chemical species in its composition.

We have designed and performed detailed diagnostics of atmospheric pressure plasma jet sources with several types of electrode geometries [1]. It is shown that the formation and propagation of PAPS is influenced by electrode geometry, but also by the presence of the water vapour in the helium flow. The propagation of PAPS as a function of humidity of working gas was observed by using an ICCD camera.

2. Experimental set-up

In this experiment we used APPJ [2] that operates at 80 kHz and at 6.5 kV of applied voltage. We have used transparent PET foils coated with indium tin oxide as the powered and the grounded electrode (15 mm wide). The electrodes were wrapped around the Pyrex glass tube (O.D. 6 mm and I.D. 4 mm). As a feeding gas we have used 4 slm of helium and mixture of helium and water vapour. To perform humidity measurements within the flow tube we set up Vaisala DMT143 dewpoint transmitter in front of the glass tube. For PAPS evolution we set up the ICCD camera that recorded the discharge axially along the glass tube and the plume.

3. Results

During the active discharge (water vapour not added in mixture) we noticed that the humidity measured in the helium flow is decreasing and the concentration of H_2O molecules changes from 400 to 25 ppm**.** Around 100 ppm of H_2O we observe shorter range of PAPS. At the concentration of 30 ppm PAPS starts to lose its original shape and it becomes increasingly blurred. At concentration of about 20 ppm, the PAPS appear blurred. On the contrary, a high concentration of water molecules (above 1000 ppm obtained with mixture of helium and water vapour) creates a saturated environment in which discharge starts to be quenched.

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3. References

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