Capillary He and He-O_2 plasma jet simulation and experimental data

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Atmospheric pressure plasma jets are promising for applications in the area of material science and biomedicine[1]–[3]. The advantage of the APPJ compared to other atmospheric pressure plasma devices is their ability to deliver in remote locations a wide range of reactive species, charge species, high electric fields and UV photons. Among APPJ devices, helium plasma jets show very encouraging results for biomedical applications where it was observed that a small amount of oxygen in the helium gas increases its effectiveness against cancer cell [4]. Capillaries are of particular interest because they can deliver the plasma jet to previously inaccessible anatomical structures. In this work, the effect of oxygen admixtures on the evolution and interaction of a capillary helium plasma jet device with a dielectric surface is investigated.
For the experiments, 4.0 kV, 50 μs duration, 10 kHz pulses are used to excite the plasma discharge through a 20 cm long capillary soda lime glass tube with internal diameter of 0.9 mm. In order to capture the dynamic behaviour of the plasma jet, an Intensified Charged Coupled Device (ICCD) is used. For the simulation model, the gas mixing of the helium with the ambient air is treated through a gas dynamic model [5] that feeds its output to the plasma fluid model [6]. The simulations focus on the effects of the presence of the dielectric target and that of the oxygen admixtures (500ppm-2000ppm) on the plasma bullet shape and speed, the induced electric field, the secondary emission flux of electrons and the dynamic behavior of the chemical reactions (separating also the Penning reaction contributions) responsible for the plasma jet propagation. The numerical and experimental results have good agreement and show that the evolution of the helium plasma jet is highly affected by the introduction of oxygen admixtures.

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