Characterization of a DC-Driven, Atmospheric-pressure, Non-thermal He/O_2 Plasma Microjet

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This work aims to study a direct-current driven, atmospheric-pressure non-thermal plasma microjet (PMJ) operated in air with compressed He/O_2 mixture as the working gas. The jet length is evaluated as a function of discharge current (2 to 40 mA), oxygen volume concentration in the gas mixture (0.1% to 25%) and gas flow rate (1-6 slpm). Self-pulsed mode (with negative differential resistance) and normal glow mode are observed distinctively in current-voltage curves. Non-dimensional Reynolds numbers are used to relate the visual appearance of the jet to the transition from laminar and turbulent flow of the gas mixture. End-on (at a distance of 20 mm from the exit nozzle of the PMJ) and spatially resolved side-on (3 – 15.7 mm from the exit nozzle of the PMJ) optical emission spectra are taken under various operating conditions to identify the active species created in the jet. Emission recorded include in particular the 306 nm system of OH ($A^2\Sigma^+$-$X^2\Pi$), the second positive system of N_2 ($C^3\Pi_u$ – $B^3\Pi_g$), H_α at 656.3 nm, a He emission at 706.6 nm and the oxygen line at 777.2 nm. The strong O 777.2 nm emission is most likely the result of penning ionization of O_2 molecules by He^* followed by the electron-impact dissociation of O_2^+. The relative intensity of the oxygen 777.2 nm line is found to increase with an increase of the operating current and peaks at an O_2 volume concentration of 0.1 -0.3 %. Ozone concentration and gas temperature are also evaluated at a distance of 30 mm away from the exit nozzle of the device are also evaluated for various operating parameters to address safety concerns in biomedical applications. The results reported here provide the means to fine tune the presence and concentrations of various reactive species in the PMJ by changing the discharge operating parameters.

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