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Propagation characteristics of plasma ballet in laminar gas-fed atmospheric pressure plasma jet using double coaxial glass tube

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An atmospheric pressure plasma jets (APPJs) have been used for several years in a wide field of applications. APPJs are driven by sinusoidal wave of several tens of kilohertz. We have developed a surrounding gas-fed type APPJ to improve the selectivity of various feeding gases expecting production of ROS and RNS with a shielding effect from the ambient air condition. A newly developed APPJ consists of a double coaxial glass tube. Two gases can introduce independently into the tube and the gas and plasma flows form a laminar flow and then interact outside of the glass tube. We report the characteristics of laminar flow atmospheric pressure plasma jets. Although the effect of laminar flow APPJ to the surface is very interested, the characterization of the laminar flow APPJ itself is more important for applications. In the case of helium (He) as an inner gas flow with an outer nitrogen (N2) gas flow, emission lines of nitric oxide, the first negative and second positive system bands of N2 were observed, while only the second positive system band was observed in the case of argon (Ar) as the inner one. Considering the Penning effects of each excited state, the metastable state of He have a higher energy than that of Ar resulting in energetic nitrogenous productions in the former case. The excited state in the core plasma is one of the important condition to determine the characteristics of the APPJ produced with a double coaxial glass tube. In this study, we evaluated the effect of core plasma dependence of the laminar flow APPJ by comparing the emission spectra of different core plasma APPJs. In addition, the properties of spatio-temporally localized luminous effects, i.e. "plasma bullet" in laminar APPJs were explored with an intensified video camera by comparing with conventional single APPJ.

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