Study on the influence of the turbulent-dominated gas flow on the characteristics of atmospheric pressure plasma jet

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The atmospheric-pressure plasma jet (APPJ) is an effective source for the production of non-thermal plasma with rich chemically active species, which is very suitable for biomedical and chemical application. In this plasma sources, a noble gas (usually helium, argon or their mixtures) flows through a thin dielectric tube and into the ambient air. The length of APPJ is an important factor that limits the size of materials to be directly treated. Many studies have shown that the gas flow rate has a great influence on the length of APPJ. In most of the plasma jet experiments, to obtain longer APPJ, the values of Reynolds number are sufficiently high, close to the laminar-to-turbulent transition. It is therefore necessary to understand the influence of gas flow under turbulent flow regime on the plasma jet. In this paper, based on two-dimensional fluid with incorporation k-ε turbulent model, we studied numerically the propagation and production characters of helium atmospheric pressure plasma jets propagating into humid air under turbulent flow regime, as well as the transition from the lamina to turbulent regime. The used electrode configuration in simulation is single ring electrode which is forced by positive voltage pulse. By increasing the helium flow velocity, the dynamics and structure of plasma jets under different regimes are studied comparatively. The dominant physics associated with the instability of the plasma caused by the turbulent-dominated helium flow is analyzed. In addition, the dependence of the turbulent-dominated plasma jet behaviors on other discharge parameters is also discussed.

Understanding the influence of gas flow rate is extremely important for tailoring plasma characteristics to match application requirements.