Numerical study on the stability of helium atmospheric pressure plasma jets propagating into humid air

Yanhui Wang, Yuanyuan Jiang, and Dezhen Wang

School of Physics, Dalian University of Technology, Dalian 116024

e-mail:wangyh@dlut.edu.cn

Recently, atmospheric pressure plasma jet has attracted considerable attention because of its unique properties and novel applications. The length and stability of the plasma jet are important factors in many applications. It has been shown both numerically and experimentally that the helium flow can control the length and stability of the plasma jet. In the laminar regime, an increase in the helium flow velocity results in a direct increase in the plasma jet length. However, high gas flow rate will cause the transition from laminar to turbulent regimes, which leads to the plasma jet becoming unstable and smaller. It is therefore necessary to understand the dependence of the stability of plasma jet on helium flow velocity. In this paper, based on two-dimensional fluid with incorporation k-ε turbulent model, we studied numerically the stability of helium atmospheric pressure plasma jets propagating into humid air under different helium flow rates. The used electrode configuration in simulation is single ring electrode which is forced by positive voltage pulse. To reveal the dependence of plasma jet stability on helium flow rate, the dynamics and structure of plasma jets under laminar and turbulent regimes are studied comparatively. Especially, the dominant physics associated with the instability of plasma jet caused by the turbulence-dominated helium flow is analyzed. In addition, the dependence of the instability resulting from turbulent regime on other discharge parameters is also discussed.

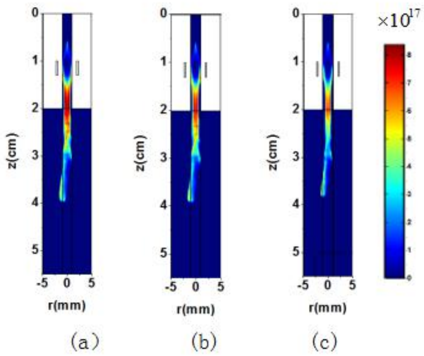

Figure 1 Plasma jet under turbulent regime at different helium flow velocities.

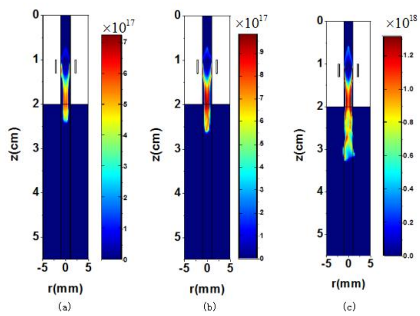

Figure 2 Plasma jet under turbulent regime at different applied voltages for a constant helium flow velocity.

References

[1] Ranhua, Qing Xing, Anton Yu. Nikiforov, et al. J.Appl. Phys. **112**,033305,(2012).

[2] Amanda M. Lietz, Eric Johnsen, and Mark J. Kushner. Appl. Phys. Lett. **111**,114101,(2017).

[3] Karakas E, Koklu M, Laroussi M. J. Phys. D: Appl. Phys. **43**,155202,(2010).