Visualization of reactive species produced by ethanol/argon plasma jet with a gel-type chemical probe

Tran Trung Nguyen*, Hiroto Matsuura**

* Graduate School of Engineering, Osaka Prefecture University, Japan
** Graduate School of Engineering, Osaka Metropolitan University, Japan

Atmospheric pressure plasma jets (APPJs) have been widely employed in plasma biomedicine and material processing because of their promising applications. Helium (He) plasma jet is a useful tool in medicine application. However, He gas is one of the economically inefficient choices for most industry-scale applications due to expensive rare gas and requires a significant amount. Therefore, our group used a cheaper working gas—argon (Ar), as a replacement for He. The Ar plasma jet is known to be difficult to sustain, and unstable. This is one of the challenges for surface treatment, especially for etching, cleaning, sterilization, and clinical application. So, improvement of stable Ar plasma source is still required for the generation of high concentration, large volumetric, and uniform discharge.

Recently, studies have illustrated that by adding a small amount of ethanol with Ar gas, the argon plasma jet can be transited from filamentary discharge to diffuse discharge with a lower breakdown voltage [1, 2]. Our group used needle electrode configuration to study the effect of ethanol on the Ar plasma jet characteristics [3]. Plasma jets with various working gases such as Ar-ethanol, Ar-water mixtures can be widely practical application in medicine, biochemistry, or surface treatment. However, the reactive species generation distribution or their reaction mechanism of Ar-ethanol, Ar-water mixtures plasma jets have not been studied enough.

In this study, the influence of Ar-ethanol flow rates variation on the reactive species concentration distribution is studied by using a PVA-KI chemical probe. Our interest has been focused on the reactive species generation and transportation induced by the plasma jet, particularly, on the Ar-ethanol flow dependence of the total amount of reactive species in the plasma-jet system.

References

[1] Sun W T et al 2007 J. Appl. Phys. 101 123302.
[2] Wenjie Xia et al 2018 Plasma Sources Sci. Technol. 27 055001.
[3] Tran T Nguyen et al 2019 Plasma Res. Express 1 015009.