Reactive Species Transfer into Liquid Phase through Humidified Air Plasma Effluent

Dept. of Electronic Eng., Tohoku Univ.,

°Keisuke Takashima, Hideaki Konishi, Keisuke Shimada, Yutaka Kimura, Toshiro Kaneko

E-mail: takashima@ecei.tohoku.ac.jp

The humidified air plasma has potential to exhaust gas containing plasma-generated reactive oxygen and nitrogen species (RONS) (air plasma effluent) which could be utilized for agricultural applications, such as sterilization on growing plants. Air plasma effluent allows us to treat three-dimensional surface structure of plants with the plasma-generated RONS (Fig.1). However, water droplet on plant structure surface could isolate conidia of pathogenic fungi, such as *C. gloeosporioidis (C. glo.)*, from the RONS in the plasma effluent and can initiate the germination of conidia and infection into plants. Therefore, the sterilization effects on such water encapsulated fungi is of importance in plasma-agricultural applications and can be achieved by liquid phase RONS either dissolved from the plasma effluent or produced in the liquid phase by the dissolved RONS' reactions (reactive species transfer).

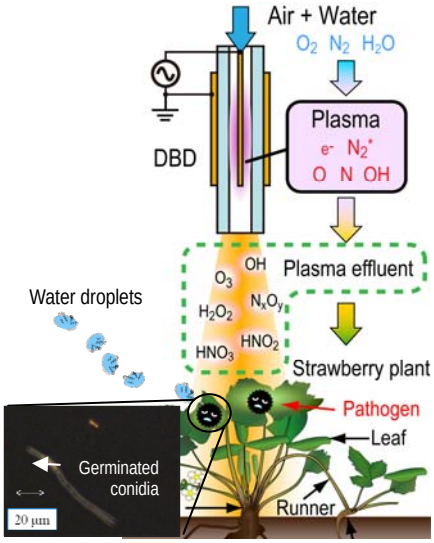

Fig. 1. Schematic of strawberry pathogen control with humidified air plasma effluent.

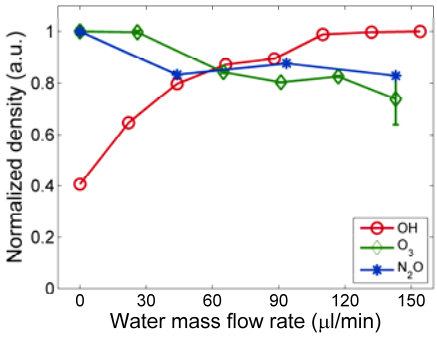

Fig. 2. Reactive species densities in the humidified air plasma effluent under various water flow rate into the discharge plasma.

In this study, the reactive species transfer into the liquid phase is controlled with discharge parameters and water flow rate into the discharge plasma (Fig. 2). Water flow rate into the discharge increased OH density in the plasma effluent, which indicates the production reaction between OH and the other reactive species undergoes in the plasma effluent, such as HNO_3 production. Dissolution of such water related reactive species resulted in the increase of $NO_3^-{}_{aq}$ among the measured RONS ($NO_3^-{}_{aq}$, HNO_{2aq}, $NO_2^-{}_{aq}$, H_2O_{2aq}) in the water droplet at 10cm downstream. While $NO_3^-{}_{aq}$ correlated with the germination suppression of *C.glo.* conidia, NO_{3aq}^- concentration was neither sufficient to suppress the *C.glo.* germination nor dominant factor of the *C.glo.* germination suppression. This indicates the germination suppression effect of the plasma effluent resulted from byproducts of $NO_3^-{}_{aq}$, which could be made from OH in the plasma effluent, such as HNO_2, H_2O_2, and HO_2, which could produce short-lived reactive species in the liquid phase [1]. Therefore, reactive species transfer through the plasma effluent could play key roles in the plasma agricultural applications.

[1] S. Goldstein, *et al.*: Chem. Rev. **105** (2005) 2457-2470.

© 2016年 応用物理学会