A-I30 AAPPS-DPP2020

4th Asia-Pacific Conference on Plasma Physics, 26-31Oct, 2020, Remote e-conference

Experimental identification of reactive oxygen species transported in the liquid depth direction by plasma direct irradiation

T. Kawasaki[1], K. Koga[2], and M. Shiratani[2]

[1] Department of Electrical Engineering, Nishinippon Institute of Technology,

[2] Graduate School of Information Science and Electrical Engineering, Kyushu University

e-mail (speaker): tkawasak@nishitech.ac.jp

Plasma-induced biomedical effects in liquid may depend on the generation and penetration depth of reactive oxygen species (ROS) in liquid by plasma irradiation [1, 2]. In our previous works, ROS transportation through a liquid layer has been studied using a gel chemical reagent [3-6]. The gel reagent can visualize two-dimensional (2-D) ROS distribution in liquids in plasma-liquid systems. In this work, we experimentally studied key species for ROS transportation in the liquid depth direction by using scavengers that remove specific reactive species.

Fig. 1 shows the schematic diagram of experimental setup and the corresponding plasma jet. The target in a Petri dish had a two-layered structure: an upper layer of liquid and a lower layer of KI-starch gel reagent (ROS detector). The water layer surface was irradiated with plasma jet for 5 min. This two-layered target enabled the visualization of a 2-D distribution pattern of ROS after passing through the liquid layer. A scavenger was added into the water layer to remove specific reactive species. We studied the effects of scavenger concentration on ROS transportation in the depth direction.

Fig. 2 shows the 2-D ROS distribution pattern for the catalase concentrations of (a) 0, (b) 0.05, and (c) 0.1 mM. Catalase is well known as one of the H_2O_2 scavengers [7, 8]. Therefore, these experiments allow us to discuss the effects of H_2O_2 on the ROS transportation in the water layer. For the catalase concentration of 0 mM, the ROS was detected all over the gel reagent at the depth of 1 mm. However, the area that ROS was detected decreased with increasing the catalase concentration. No ROS was detected at the liquid depth of 1 mm when the catalase concentration was 0.1 mM. Fig. 2 shows the relationship between the catalase concentration and the maximum absorbance that relatively corresponds to the ROS concentration. Based on the result, we experimentally confirmed that H_2O_2 is one of the key species for the ROS transportation in the liquid depth direction.

In our presentation, we are going to report the effects of other scavengers on the ROS transportation under various liquid depths.

References

[1] D. Xu *et al.*, PLoS One **10**, e0128205 (2015).

[2] S. Sasaki *et al.*, J. Phys. D: Appl. Phys. **49**, 334002 (2016).

[3] T. Kawasaki *et al.*, Jpn. J. Appl. Phys. **54**, 086201 (2015).

[4] T. Kawasaki *et al.*, Appl. Phys. Express **9**, 076202 (2016).

[5] T. Kawasaki *et al.*, J. Appl. Phys. **119**, 173301 (2016).

[6] T. Kawasaki *et al.*, IEEE trans. Plasma Sci. **44**, 3223 (2016).

[7] H. A. Aboubakr *et al.*, J. Phys. D: Appl. Phys. **49**, 204001 (2016).

[8] J. Julák *et al.*, Plasma Phys. Rep., **44**, 125 (2018).

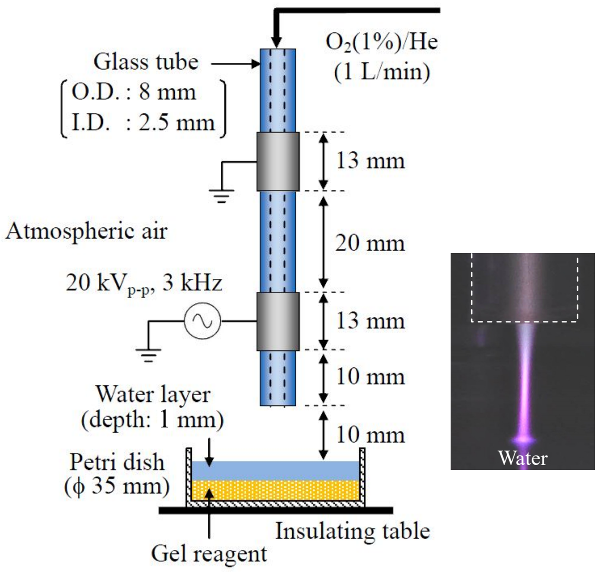

Fig. 1. Schematic diagram of experimental setup and typical plasma jet.

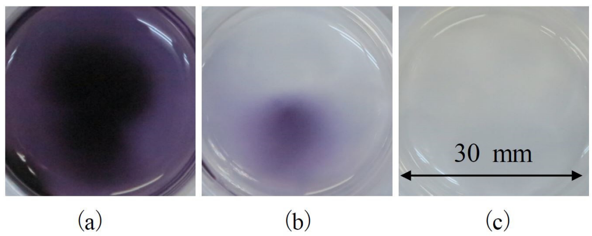

Fig. 2. Visualized 2-D distributions of ROS after passing through water layer for the catalase concentrations of (a) 0, (b) 0.05, and (c) 0.1 mM.

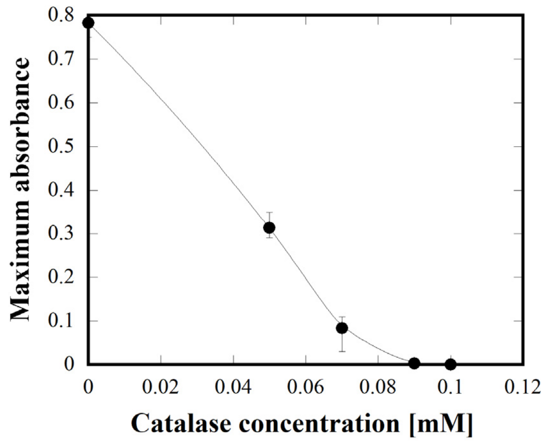

Fig. 3. Effects of catalase concentration on maximum absorbance.