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

T. Kawasaki¹, K. Koga², and M. Shiratani²

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 H₂O₂ scavengers [7, 8]. Therefore, these experiments allow us to discuss the effects of H₂O₂ 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. Based on the result, we experimentally confirmed that H₂O₂ 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