

## Measurement of reactive species in Plasma Babbled-up Water affecting human cultured cells

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As a method to introduce reactive species generated by plasma into water, plasma babbling method was proposed. In this method, it is possible to introduce reactive species into water effectively, compared with conventional method in which plasma is irradiated from above the liquid surface. By plasma babbling method, we measured ozone and hydrogen peroxide concentration in water with various plasma. Ozone was generated in oxygen and air plasma, and was 8.6  $\mu\text{M}$  and 0.5  $\mu\text{M}$  respectively. Also, hydrogen peroxide was generated at all kinds of plasma. Both ozone and hydrogen peroxide were measured the most at oxygen plasma. As measurement result, it was revealed that the amount and type of reactive species depend on kinds of plasma gas.

In recent years, atmospheric low-temperature plasma is being applied for medical fields. In addition, for the purpose of large capacity treatment, research about plasma-treated water in which plasma is introduced attracts a lot of attention[1]. However, to apply plasma for medical application, it is necessary to investigate the influence of plasma on living bodies. This main factor is considered to be reactive species such as ozone ( $\text{O}_3$ ) and hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) generated by plasma. The amount and type of reactive species depend on kinds of plasma gas[2]. In this study, we investigated reactive species introduced in water by various kinds of gas plasma and the influence of them on human cultured cells.

As a method to introduce reactive species into the solution, we proposed a plasma bubbling method. In this method, the multi-gas plasma jet (PCT-DMFJ02, Plasma Concept Tokyo) is placed at the bottom of the container containing liquid. Then plasma is introduced as bubbles into the liquid directly. Therefore, the contact area between water and plasma is much larger than a conventional method in which plasma is irradiated from above the liquid surface. Thus, reactive species generated by plasma can be introduced into the liquid efficiently. In addition, since plasma is not influenced by ambient air, it is possible to specify reactive species derived from its own plasma gas. In this study, the water introduced reactive species by plasma bubbling method is called as Plasma Babbled-up Water (PBW).

After 200 mL pure water was babbled with argon, nitrogen, carbon dioxide, air and oxygen plasma at the plasma gas flow rate of 3 L/min for 5 minutes,

ozone and hydrogen peroxide concentration in liquid were measured by absorption spectrophotometry. The results are shown in Fig.1. Ozone was measured in oxygen and air plasma, and the concentration was 8.6  $\mu\text{M}$ , and 0.5  $\mu\text{M}$  respectively. Also hydrogen peroxide was measured at all kinds of plasma. Both ozone and hydrogen peroxide were generated the most at oxygen plasma.

In the presentation, we will report the measurement results of reactive species other than ozone and hydrogen peroxide, and of reactive species in solvent other than pure water. In addition, influence of reactive species in PBW on human cultured cells will be reported also.

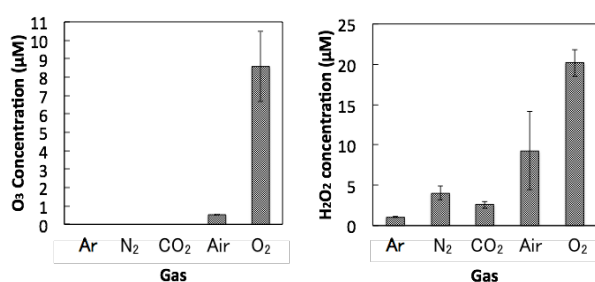


Fig.1:  $\text{O}_3$  and  $\text{H}_2\text{O}_2$  concentration at each Plasma Babbled-up Water

### 3. References

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