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Investigation of Chemical Interactions by Atmospheric Pressure Low Frequency Plasma Jet using a Chemical Probe

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To date much attention has been given to the plasma-liquid interactions for biomedical applications since high reactive species can be supplied under low temperature condition to enhance the chemical reactions in liquid surface. Low frequency (LF) plasma jet is one of the convenient tools to produce and supply reactive species under atmospheric pressure condition with low cost. There are other kinds of atmospheric pressure plasma jets (APPJs) such as an rf(~MHz) plasma jet and a microwave(~GHz) plasma jet. Though these APPJ sources need matching units, high density plasma production can be expected[1].

To develop APPJ for bio-applications, it is important to investigate interactions between plasma and liquid because biomedical cells exist under liquid environment. To progress knowledge of the fundamental chemical and physical processes occurring in liquid, it is necessary to obtain accurate quantitative estimates of reactive species generation by the APPJ irradiation. A variety of techniques are suitable for detection such as electron spin resonance (ESR) spin trap and chemical probes. Since ESR technique requires a rather complicated measurement system, we have used a chemical dosimetry technique based on a terephthalic acid (TA). TA reacts with hydroxyl radicals (OH) to form 2-hydroxyterephtalic acid (HTA), that gives a bright stable fluorescence at 425 nm for analyzing using an excitation wavelength of 315 nm[2].

This paper presents fundamental research to investigate chemical interactions occurred by the low frequency (~ 20 kHz) plasma jet using the TA chemical probe. Figure 1 shows a temporal variation of fluorescent intensity at 315 nm as a function of LF APPJ irradiation time at a He flow rate of 1, 3, and 5 slm, respectively. As increasing LF plasma jet irradiation time, fluorescent intensity increased linearly at 1 slm. However, in the case of a He flow rate of 3 and 5 slm, the fluorescent intensity increased linearly then saturated. This result indicates the inadequate TA concentration and/or its volume to react with OH radical. Further study will be discussed to characterize a comparable LF plasma jet parameter using the TA probe.

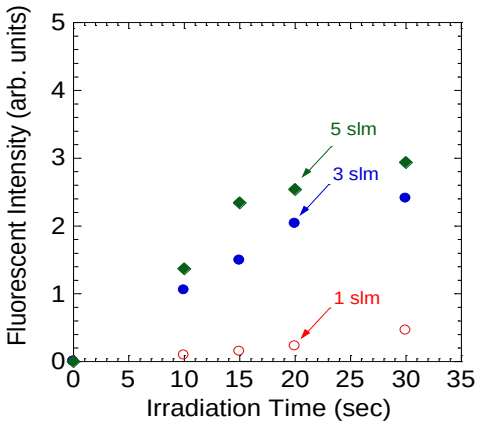

Fig. 1 Temporal variations of fluorescent intensity at a He flow rate of 1, 3, and 5 slm, respectively.

References:

1) D. B. Kim, H. Jung, B. Gweon, S. Y. Moon, J. K. Rhee, and W. Choe: Phys. Plasmas, 18, 043503 (2011).

2) R. W. Matthews: Rad. Res., 83, 27 (1980).