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Diagnostics of AC power excited non-equilibrium atmospheric pressure plasma jet with vacuum ultraviolet spectroscopy

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Introduction: Non-equilibrium atmospheric pressure plasma jets have been applied to bio-medical treatment, soft-material processing, etc. In these plasma treatments, behaviors of reactive species should determine the performance of plasma treatment. Therefore, it was required to diagnose the behaviors of reactive species generated by the plasma jet. The behaviors of reactive species are frequently complicated by gas-phase reactions of reactive species with ambient gas in atmosphere, while spectroscopic methods are applied to understand the behaviors. Vacuum ultraviolet (VUV) spectroscopy is one of useful techniques to measure high energy photon in VUV region and the quantitative behaviors of radical. In our group, AC excited non-equilibrium atmospheric pressure plasma which has an electron density as high as 10^{15} cm^{-3} [1,2] has been developed, and the behaviors of radicals generated by the plasma were measured by using vacuum ultraviolet absorption spectroscopy (VUVAS).[3] However, plasma bio-medical applications are frequently carried out under open air condition. In this study, behaviors of reactive species and high energy photon in VUV region generated by the atmospheric pressure plasma under open air have been measured by using VUV spectroscopy.

Experiment: The AC excited non-equilibrium atmospheric pressure plasma jet with pure Ar gas was generated under a condition of the gas flow rate of 2 slm and the discharge voltage of 9 kV. The plasma discharge repeated with a period of 8.3 ms. In order to investigate the influence of ambient air, VUV absorption spectroscopy with a D_2 lamp as a light source was carried out. In the measurement, absorption length was 2 mm and observed wavelength was resonance lines of N atom (λ:120.0 nm, $2p^23s^4P-2p^34S^o_{3/2}$).

Results: Figure 1 shows the temporal changes of the absorption intensity due to ambient air as a function of distance from the plasma source and emission intensity of N atom (a wavelength of 120 nm) at the distance of 4.5 mm from the plasma source. The emission intensity of N atom was observed with a period of 8.3 ms. On the other hand, the absorption intensity due to ambient air shows very complicate temporal-change with a period of around 8 ms. From the results, the entrainment of ambient air to plasma jet changes spatially and temporally. It is supposed that the behavior of reactive species are affected by that of ambient air.

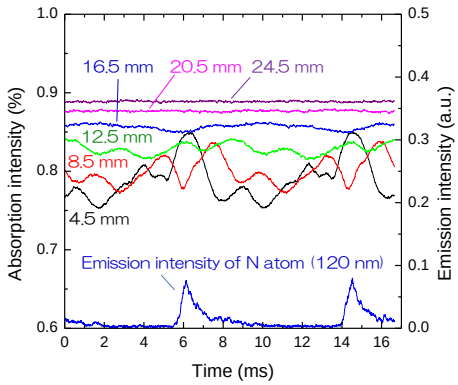

Fig.1 Temporal change of absorption intensity due to ambient air at each distance from plasma source.

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