Oxygen Radical Measurement of Atmospheric Pressure Microwave Line Plasma by Vacuum Ultraviolet Absorption Spectroscopy

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1. Introduction

Atmospheric pressure plasma is attractive due to its cost benefit and a variety of possibilities for industrial applications. Recently, we have developed atmospheric pressure microwave line plasma (APMLP) source of ~1 m in length, using a loop waveguide with a long slot and a microwave circulator that can control energy flow in one direction. APMLP is expected to be applied to surface cleaning, modification and eatching system. In our previous work, we have reported spatial uniformity of electron density (~10^{20} m^{-3}), gas temperature, and light intensity of the APMLP[1]. In view of the industrial application, not only plasma parameters measurement but also radical density measurement is important.

From viewpoint of the organic matter decomposition, oxygen radical is one of the important reactants[2]. In this study, O radical density of APMLP is measured by vacuum ultra violet absorption spectroscopy (VUVAS) and O_2 gas flow rate dependence of O radical density is measured. Furthermore, spatial dependences of O radical density along the long plasma is measured.

2. Experimental setup

In the experiment, Ar gas with small amount (0.08%) of O_2 gas is introduced into the plasma through the waveguide. Concentration of oxygen radicals[O(^{3}p)] were measured using VUVAS with micro-discharge hollow cathode lamp (MHCL) as a light source with He (99.8%) + O_2 (0.2%) at 1 atm gas and a VUV spectrometer. The light passes across the effusing gas from the plasma and is collected by the VUVAS. Both the light source and the VUV spectrometer is gas-sealed by a MgF_2 windows. The optical emission line of O(I)(^{3}S-^{3}P) triplet at 130.22, 130,49 and 130.60 nm is used for the measurement of atomic oxygen (O).

3. Result and discussion

Fig 1. shows ratio of absorbed light intensity to that of the light source, which is indicative of the O radical density. The light absorption ratio is 3.5% and is almost uniform along the plasma of 60 cm-length within a variation of ±10%. The O radical density is evaluated considering the O emission profile to be 2.7 × 10^{13} cm^{-3}.

Acknowledgments

Part of this work is supported by KAKENHI. The authors would like to thank Prof. Hori for the help for the VUVAS measurement.

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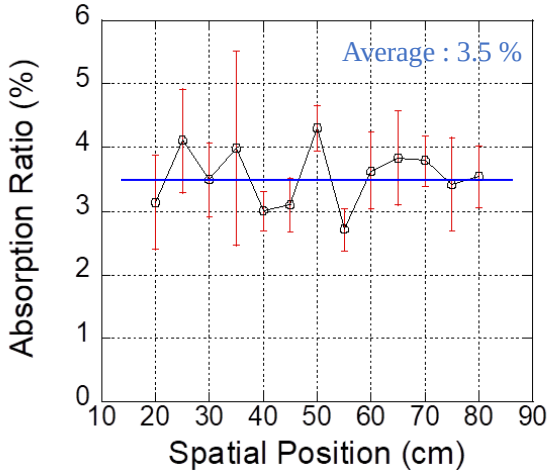

Figure 1. Spatial profile of relative O density.