Oxygen radical measurement of atmospheric pressure microwave plasma employing vacuum ultraviolet absorption spectroscopy

[1]Hansin Bae, [1]Koike Yosuke, [1]Hirotsugu Koma, [1]Haruka Suzuki and [1,2]Hirotaka Toyoda

[1]*Nagoya University, Japan*

[2]*PLANT, Nagoya University, Japan*

[1,2]*Furo-cho, Chikusa-ku, Nagoya 464-8601, Japan*
phone: +81-52-789-4697, fax: +81-52-789-3152
e-mail: b_hanshi@nuee.nagoya-u.ac.jp

1. Introduction

Large area surface treatment including surface cleaning, modification and film deposition using atmospheric pressure (AP) plasma has been given much attention because of its cost benefit and a variety of possibilities for industrial applications. So far, we have developed a one-dimensionally long-scale AP microwave plasma source using a loop waveguide with a long slot and a microwave circulator that can control energy flow in one direction. Using this plasma source, spatially-uniform line plasma at a plasma density of about 10^{20} m^{-3} was realized not only by rare gases, but also by N_2 gas [1]. To apply this plasma source to surface treatment of organic matter decomposition, oxygen radical is one of the important reactants[2] and measurement of the O radical is important for the evaluation of this plasma source. In this study, O radical density in the AP microwave plasma is measured by vacuum ultra violet absorption spectroscopy (VUVAS) and dependences of O radical densityt on spatial position as well as O_2 gas flow rate are investigated.

2. Experimental setup

In the experiment, an AP microwave plasma source of 1 m in length [1] is used, as shown in Figure 1. Ar gas with small amount (0.01 ~ 0.5 %) of O_2 gas is introduced into the plasma through the waveguide. Concentration of oxygen radicals[$O(^3p)$] were measured using VUVAS with microdischarge hollow cathode lamp (MHCL) as a light source and a VUV spectrometer. The MHCL works at 1 atm. with He (99.8%) + O_2 (0.2%) gas and the VUV light passes across the effusing gas from the plasma

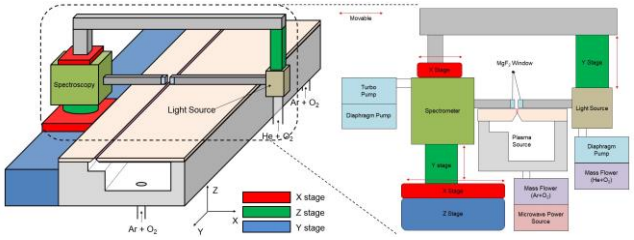

Fig. 1 Experimental setup.

and is collected by the VUV spectrometer. The optical emission line of O(I)(^3S-^3P) triplet at 130.22, 130,49 and 130.60 nm is used for the measurement of atomic oxygen of the ground state (O). Oxygen radical density can be calculated from the absorbance.

3. Result and discussion

As the first approach to diagnose the O radical of the AP microwave plasma, relative O radical density is measured as a function of the O_2 flow rate ratio. By changing the O_2 admixture ratio, the O radical density shows its maximum at an admixture ratio of ~0.1% and decreases with further increasing the O_2 flow rate ratio. The O radical decrease is probably due to O radical loss through the reaction with O_2 and through O recombination.

Acknowledgments

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

References

[1] H. Toyoda et al.: 10th Int. Workshop on Microwave Discharge (Zvenigorod, 2016).
[2] James Y. Jeong et al.: J. Phys. Chem. A, **2000**, 104(34).