22P019-O

Characteristics of Vacuum Ultraviolet Emission in Coaxial Type Low-pressure Micro Plasma

同軸型低気圧マイクロプラズマの真空紫外放射特性

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In the coaxial type low pressure micro plasma, the radiated ultraviolet (UV) rays were measured by vacuum ultraviolet (VUV) spectroscopy measurement. Here, the VUV emission characteristics in the low-pressure micro plasma will be reported.

1. Introduction

In the recent days, the plasma display panel (PDP) uses Ne-Xe mixture gas and generates the micro plasma for high-pressure condition. However, self absorption of 147nm VUV emission by Xe atom happens in the high-pressure gas, and luminance efficiency is drastically decreased.

Fujiyama et al. has succeeded in generating the high ionizing level micro plasma for the electronic density exceed $10^{11}cm^{-3}$ in the low-pressure and short gap length area by using resonantly confinement effect of electron at 2^{nd} harmonic ECR condition and mirror magnetic field confinement effect [1]. Therefore, it is thought that the high-efficiency VUV rays source is obtained by generating the micro plasma in the low-pressure and short gap length area, and by decreasing self-absorption.

In the present study, the VUV rays emitted from the low-pressure micro plasma source were examined by using VUV spectroscopy measurement.

2. Experimental

Figure 1 shows the experimental setup. The chamber has been exhausted to the vicinity of 10^{-6}Torr with the turbo-molecular pump and the rotary-pump. Pure Xe gas was injected, and the low power microwave of 2.45GHz was applied by a coaxial cable in the TEM mode. Micro plasma was generated between the coaxial electrodes in the mirror-type magnetic field. VUV spectroscope was used for the spectral instrument. And the disperse wave length of the VUV spectroscope can change arbitrarily by using scan controller. Photo-multiplier was used for photo detection. The output signal amplified by the photo-multiplier was measured with the oscilloscope. Moreover, VUV spectroscope has been exhausted to the vicinity of 1×10^{-3}Torr with the turbo-molecular pump and the rotary-pump.

3. Results and Discussions

The emission spectrum distribution was observed by using scan controller. In the result, the emission peak of Xe could be confirmed at the wavelength of about 147 nm. In the present experiment, it was investigated on the magnetic field dependence of the Xe peak at wavelength 147nm. Figures 2 and 3 show the magnetic field dependence for the gap length of 1mm and 3mm, respectively. It is noted that the emission peak

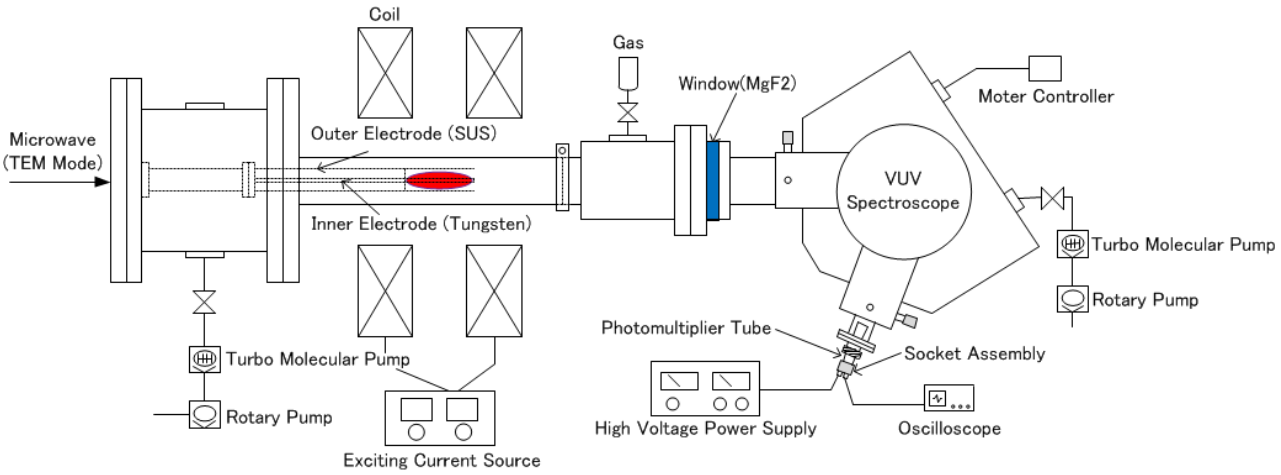

Fig.1. Experimental Setup

strength had the maximum value at ω_c/ω=0.5 as shown in Fig.2 and the emission peak strength had the maximum value at ω_c/ω=1.0 as shown in Fig.3. Therefore, in the shorter gap length, the maximum VUV peak intensity is obtained at the 2nd harmonic condition, ω_c/ω=0.5. It means that the 2nd harmonic ECR plasma can emit VUV effectively in micro plasma with narrow gap length. It can be explained by the experimental result so that the electron density had the maximum value at ω_c/ω=0.5. On the other hand, for the wide gap length, the electron temperature had the maximum value at ECR condition, ω_c/ω=1.

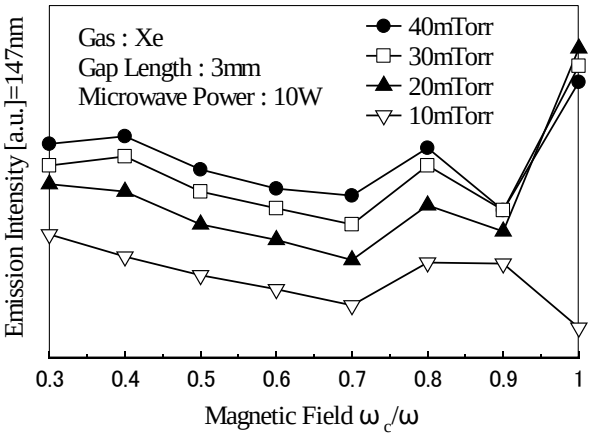

Fig.3. Magnetic Field Dependency of Emission Peak Intensity (Gap Length=3mm)

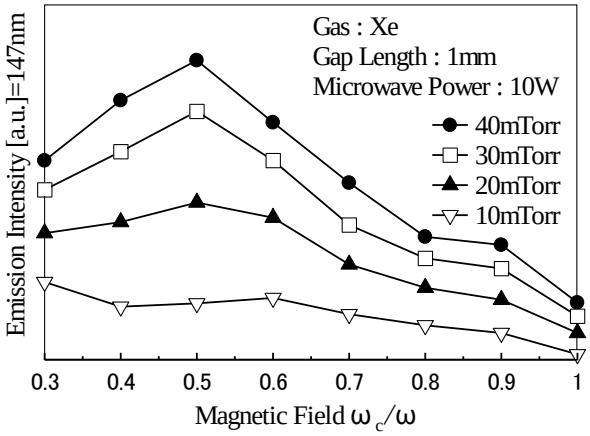

Fig.2. Magnetic Field Dependency of Emission Peak Intensity (Gap Length=1mm)

4. Conclusion

In this study, the VUV rays emitted from the low-pressure micro plasma source were examined by using VUV spectroscopy measurement. And, it was investigated on the magnetic field dependence of the Xe peak at wavelength 147nm. In the result, it was noted that the 2nd harmonic ECR plasma can emit VUV effectively in micro plasma with narrow gap length because the electron density had the maximum value at ω_c/ω=0.5.

Reference

[1] H. Fujiyama et al: Proc. of the 17th International Symposium on Plasma Chemistry (ISPC-17), Toronto (2005).