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窒素・酸素混合ガス表面波プラズマによる芽胞菌不活化における励起原子種の効果

Effect of Reactive Atomic Species in N_2/O_2 Surface-wave Plasma on Inactivation of Spore-forming Microorganisms

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1. Introduction

With the advantages of low-temperature, non-toxic, and shorter time treatment, plasma sterilization attracted much attention from researchers. To figure out the plasma inactivation mechanism of spore-forming microorganisms is important to improve the sterilization property. But so far, the mechanism of low temperature plasma sterilization is still not fully understood. In our previous work, N_2 and O_2 gas mixture surface-wave plasma (SWP) generated in a 30 cm diameter SUS cylindrical chamber was used for the low-temperature plasma sterilization of medical instrument. Different possible factors such as oxygen etching, UV radiation and ion bombardment were studied to figure of the sterilization mechanisms. To a further study on the sterilization, the information of neutral species generated by plasma discharge is inevitably important.

Spectroscopy measurement does little influence to the processing plasma. Among different spectroscopy diagnosis methods, only the resonant absorption spectroscopy can directly determine the absolute density of reactive species. In this study, surface-wave plasma produced with N_2/O_2 mixture gas was used for investigating the mechanism of the inactivation of *Geobacillus stearothermophilus* spores. The effect of N atomic species in N_2/O_2 surface-wave plasma on inactivation of spore-forming microorganisms was investigated by using VUV absorption spectroscopy technique with a compact coaxial microwave plasma light source.

The transition lines used for N atom density measurements were $2p^23s\ ^4P_{5/2}–2p^3\ ^4S^\circ_{3/2}$ at 119.995 nm, $2p^23s\ ^4P_{3/2}–2p^3\ ^4S^\circ_{3/2}$ at 120.022 nm and $2p^23s\ ^4P_{1/2}–2p^3\ ^4S^\circ_{3/2}$ at 120.071 nm of N atom. First we need to find the best operation of the light source, such as finding the optical emitting intensity with different mixing ratio of N_2 and Ar, reducing the self-absorption of the N_2 microwave plasma discharge in the light source. Then this measurement system will be used to diagnosis the N atom density under different plasma sterilization conditions to figure out the role of the N atom density during the inactivation of spore-forming microorganisms.

2. Experimental

The experimental setup consists of a stainless steel cylindrical vacuum chamber (300 mm in diameter and 300 mm in height) with a microwave launcher and 2.45 GHz microwave generator, as shown in Figure1. The light source was installed on one side (10 cm away from the top) of the chamber and the VUV monochromator (Acton Research Corp., VM–502) was fixed at the opposite port. Two MgF_2 glass windows were inserted to separate it into three different pressure areas. Inside the chamber, the absorption length L is constricted to about 30 cm. The pressures both in the monochromator and processing chamber could be kept on 10^{-5} Torr by separated two-stage differential pumping systems.

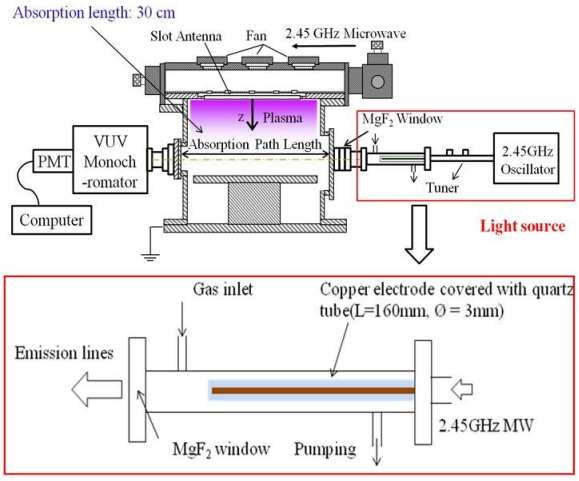

Fig. 1. Schematic drawing of the experiment set-up.