

琉球大学学術リポジトリ

LF-マイクロ波プラズマを用いた表面滅菌に関する研究

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Thesis/Dissertation Title: Studies on Surface Sterilization using LF-Microwave Hybrid Plasma

Name: Norrawit Tonmitr

The plasma surface sterilization has emerged as a new method of sterilization for medical instruments with many advantages, including non-toxicity, short treatment time, and low thermal damage to the sterilized material compared to conventional sterilization methods. In this study, a new type of atmospheric pressure non-thermal plasma for surface sterilization as called LF-microwave hybrid plasma was developed. The LF-microwave hybrid plasma was produced by irradiation of microwave to LF plasma jet. Due to high-frequency microwaves, only electrons with a mass lower than that of ions can interact with and obtain energy from the microwave. As a result, the microwave-irradiated plasma contains a large number of reactive species, which are produced by the collisions of energetic electrons at low gas temperatures. The purpose of this study is to investigate the characteristics of the surface sterilization using the self-designed LF-microwave hybrid plasma. First, the LF-microwave hybrid plasma was modulated in time by using pulsed microwave to reduce the treatment temperature while maintaining the effect of surface sterilization for use in heat-sensitive materials. As a result, the gas temperature of the LF-microwave hybrid plasma produced by pulsed microwave can be much lower than that of the LF-microwave hybrid plasma produced by continuous microwaves. On the other hand, the analysis of the optical emission spectra indicated that a higher density of oxygen atom which contribute to the sterilization was obtained with the pulsed microwave in comparison with a continuous microwave. Next, to improve the production of reactive oxygen species, two types of discharge gas supply systems were investigated. Type I introduces argon and oxygen gas flows separately into the discharge region. Type II introduces a mixture of argon and oxygen gas into the discharge region. The results show that a larger amount of reactive oxygen species with lower treatment temperature were produced by Type II compared to Type I. Finally, the sterilization efficacy of the LF-microwave hybrid plasma was evaluated using biological indicators. The spore-forming

bacteria (*Geobacillus stearothermophilus*) with a population of 2.4×10^6 CFU/carrier were sterilized in 1 min at a treatment temperature of 82.4 °C using pulse modulated LF-microwave hybrid plasma with Type II gas supply system.