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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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Abstract

Title Studies on Surface Sterilization using LF-Microwave Hybrid Plasma

The plasma surface sterilization has emerged as a new method of sterilization for medical instruments with many advantages, including non-toxicity, short treatments, and low thermal damage to the sterilized material compared to conventional sterilization methods. 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 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 shown in the results, the gas temperature of the LF-microwave hybrid plasma produced by pulsed microwave can be reduced and much lower compared to the LF-microwave hybrid plasma produced by continuous microwaves. On the other hand, the analysis of the optical emission spectra and chemical indicator experiment indicated that the number of reactive oxygen radicals produced in the LF-microwave hybrid plasma also depends on the pulse width and duty ratio of the microwaves. Moreover, to improve the performance of surface sterilization, 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. 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.

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