EXPERIMENTAL STUDY OF SPORE ETCHING OF MICROORGANISMS IN OXYGEN PLASMA USING OPTICAL AND MASS SPECTROSCOPY

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Utilizing plasma to achieve sterilization is an alternative to conventional sterilization means as far as sterilization of heat-sensitive materials and innocuity of sterilizing agents are concerned. Plasma sterilization is a surface sterilization process due to the limited ability of electrons and charged particles and/or VUV/UV emission generated during the plasma generation. However, plasma sterilization has the remarkable advantage that toxic residues are not produced on the sterilized objects after treatments. In addition, it is not only capable of killing bacteria and viruses, but also capable of removing the dead bacteria and viruses from the surface of the objects being sterilized. There are several mechanisms which may be responsible for the sterilization. These factors are the heat, UV radiation, plasma particles, and reactive neutral species. The extent of the influence of each factor depends on the plasma operating parameters such as power and gas mixture and flow rate. In our previous work, a six-log reduction in spores could be achieved only several minutes irradiation with low-pressure oxygen/air simulated surface-wave plasmas and the chemical etching reaction from the reactive oxygen radicals make more efficient inactivation rate [1-2]. In this work, we follow up to the previous studies[3-4], in order to investigate the contribution of various effects, especially the etching phenomena by the reactive oxygen radicals in the inactivation of spore forming bacteria.

The experimental setup used for the sterilization tests consists of a stainless steel cylindrical vacuum chamber having a diam eter of 400 mm and a height of 400 mm with a microwave launcher and 2.45 GHz microwave generator. The plasma is produced at a pressure of 13 Pa and a total gas flow of 200sccm by a microwave power source. The quadrupole mass spectroscopy and optical emission spectroscopy were used to diagnose the plasma parameters during plasma treatment of microorganisms.

[1] M. Nagatsu, F. Terashita, H. Nonaka, L. Xu, T. Nagata, Y. Koide, Appl. Phys. Lett. 86 (2005) 211502.
[2] M. Nagatsu, F. Terashita, Y. Koide, Jpn. J. Appl. Phys., 42 (2003) 858.
[3] M. K. Singh, A. Ogino, M. Nagatsu, New J. Phys.,11 (200 9) 115027.
[4] Y. Zhao, M. K. Singh A. Ogino, M. Nagatsu, Thin Solid Film, 2009 online available.

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