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Inactivation of *Geobacillus Stearothermophilus* Spore Wrapped by Tyvek Sheet Using Bubble Discharge Plasma in Water

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1. Introduction

In recent years the inactivation of microorganisms in liquid with atmospheric pressure non-thermal plasmas has gained increasing attention.[1] The possible application of this technology is the sterilization of heat sensitive medical devices such as endoscopes, dental devices.

Plasma discharge in liquid phase generates UV radiation, shock waves, free electrons and reactive species [2]. Reactive species are well accepted to be one of the most lethal factors that are responsible for plasma induced bacteria inactivation. Plasmas with different working gas have been demonstrated to be effective in bacteria inactivation in aqueous environment.[3] However most of these work focused on the sterilization effect on the common bacteria, especially the *Escherichia coli* had been wildly used as a biological indicators. Spores are the most resistance bacteria to the heating, chlorination and UV radiation for its special structure. In our experiment, we used the *Geobacillus stearothermophilus* spore, the most commonly used biological indicator in healthcare, to evaluate the reliability of the sterilization process.

2. Experimental setup and procedure

A schematic diagram of the experiment set-up is shown in Figure 1.[4]　A thin porous ceramic plate with a diameter of 50 mm and a thickness of 1 mm was used as a dielectric barrier of parallel plate electrodes. We sealed this ceramic plate over a punched metal plate inside a hollow cylindrical metal frame as the grounded electrode. Over the ceramic plate, we fixed a top punched metal plate with a hole diameter of 4 mm as the top electrode by inserting a thin dielectric insulator top punched metal plate and ceramic plate. With argon and oxygen as a working gas, pulsed glow discharges were generated at a voltage of 1.8~4.0 kV of the 5 kHz square-waves with a pulse-width of about 750 ns.

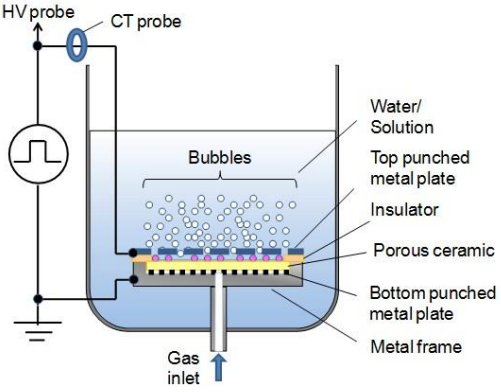

Figure 1 Schematic drawing of the experimental set-up[4].

Sakiyama and coworkers had demonstrated the reactive oxygen species (e.g., •OH, $•O_2^-$, $^1O_2$, H_2O_2, O_3) and reactive nitrogen species (e.g., NO, ONOO–, HONOO) were very important to inactivate the bacteria.[2] The oxygen and nitrogen discharge need a high voltage at atmospheric pressure, but argon is easy to discharge and need a relatively low voltage. Hence the working gas we prepare to use in the sterilization experiment is argon, oxygen and nitrogen.

Figure 2 shows the results of decolorization of Indigo Carmine(IC) inside and outside of Tyvek bag by treating the bubble discharge plasma. It is found that the IC inside the Tyvek bag was still decolorized with a slower decomposition rate than that of the outside one.　This might be due to OH or H_2O_2 generated by bubble plasma. The biological indicator will be put in the Tyvek bag inside the water to be treated by plasma. The inactivation effect will be tested by the colony forming unit counting.

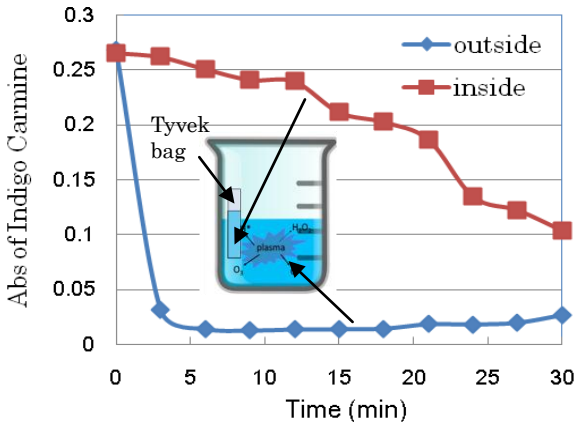

Figure 2 Results of IC decomposition inside Tyvek bag.

References

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