大気巻き込み型プラズマジェットによる連鎖球菌の殺菌効果向上

Sterilization efficiency of the Atmospheric Pressure Jet Entrained Ambient Air

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Atmospheric Pressure Plasma Jet (APPJ) has attracted tremendous attention recently for its low-cost and wide-range in bio-applications, such as skin sterilization, blood coagulation, wound healing, and tissue regeneration, among others [1]. Reactive species such as O atom and OH are efficiently enhanced by generation entrainment of air in the discharge region.

We used an APPJ, constructed with a stainless steel (SUS) tube electrode, having a small hole for adiabatic expansion. In a volume surrounding the electrical grounded aluminum tube and enclosed by exit hole with different diameters of 1 or 3 mm, the pressure is enforced to entrain by reduction of the expansion. (Figure 1). An AC power source of 60 W with frequency of 22 kHz was applied to the electrode of APPJ. Helium (99.99%) was used as the working gas at a flow rate of 4 slm.

Figure 2 shows simulation results that helium mole fraction. At the hole exit of the SUS tube, flow speed increased and pressure reduced. As the result, ambient air was entrained into discharge region through the jet exit due to Bernoulli's principle. Optical emission spectroscopy (OES) was carried out to confirm the entrainment. For the APPJ with larger exit diameter (3 mm), the OES intensities were higher 2 times of OH radical and 3 times higher of O atom. This entrainment effect provides higher sterilization efficiency of *S. mutans* on agar plate. Inactivation area shows 2.5 times wider. Therefore, we concluded that the oxygen and water in ambient air could be the precursors to generate OH radical and O atom. These reactive species lead to the faster sterilization rate.

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Reference: [1] T.-V. Woedtke, H.-R. Metelmann and K.-D. Weltmann, Contrib. Plasma Phys. 54, 104-117 (2014).

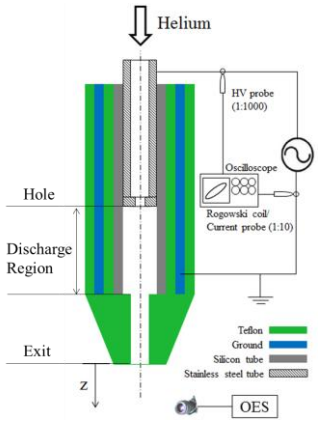

Figure 1. Schematic of APPJ and experiental setup. (left)

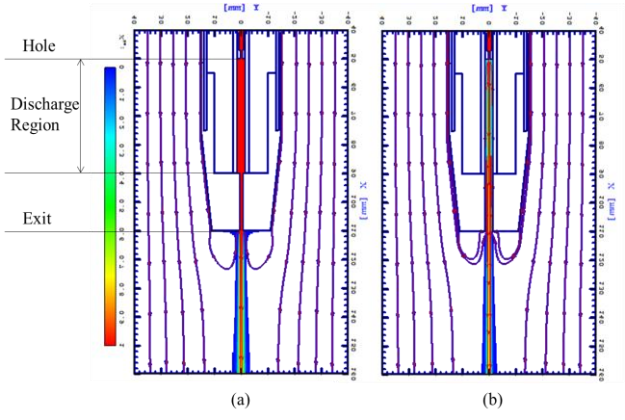

Figure 2. Simulated results of He mole fraction with exit diameter of (a)1 mm and (b) 3 mm. (right)