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## Surface sterilization using LF-Microwave Hybrid Plasma at Atmospheric Pressure

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The plasma sterilization method has outstanding characteristics such as a short treatment time, non-toxicity and low thermal damages on the surface of the materials. The effect of the plasma sterilization depends on plasma operating parameters such as input power, gasses flow rate and driving frequency. We have developed a new type of atmospheric-pressure non-equilibrium plasma source that combine microwave plasma with the LF (low Frequency) plasma as a hybrid plasma. The aim of this study is to investigate a surface sterilization effect using our self-designed LF-Microwave hybrid plasma source at atmospheric pressure. The hybrid plasma source is composed of rectangular wave guide which contains surrounding a cylindrical slotted antenna surrounding a quartz discharge tube, and LF discharge system which was installed in the quartz discharge. At the start of operation, an LF plasma is generated by applying a LF high voltage (10 kHz, 7 kV) to a cylindrical electrode at the atmospheric pressure. After the ignition of LF plasma, MW-LF hybrid plasma is produced by introducing the pulsed microwave in the rectangular waveguide. By using the continuous and pulsed microwave, the biological indicator having spore forming bacteria of  $3 \times 10^6$  CFU/carrier were sterilized in 3 min and 10 min for hybrid plasma at the atmospheric pressure, respectively. The temperature of the biological indicators installation position were about 105°C and 90°C, respectively. It is considered that the plasma sterilization was achieved by the effect of oxygen radicals and hydroxyl radicals produced by the hybrid plasma.