Role of reactive species for bactericidal effect in air surface micro-discharge plasma

Tetsuji Shimizu[1], Yukinori Sakiyama[2], David B. Graves[2], and Gregor E. Morfill[1]

[1] *Max-Planck Institute for extraterrestrial physics, Garching, 85748, Germany*
[2] *University of California Berkeley, Berkeley, 94720, USA*
E-mail: tshimiu@mpe.mpg.de

The usage of cold atmospheric plasmas has high potential for sterilization because the plasma can produce relevant agents, e.g. reactive oxygen species, UV light [1][2]. In order to achieve an efficient and safe plasma treatment, it is necessary to understand the reactions of reactive species on bacteria. The air plasmas generate a very wide variety of reactive species and the gas phase air plasma chemistry is highly complex. So as a start-up of this topic, we estimated the ozone concentration in our plasma by UV absorption measurements and tested bactericidal property using *Escherichia coli*.

The plasma was produced using a surface micro-discharge (SMD) electrode which has an Al_2O_3 plate sandwiched by a planar metal electrode and a stainless steel mesh grid. By applying a sinusoidal high voltage of 10 kV_{pp} between the metal and mesh electrode, the plasma was produced on the mesh side. To vary the input power, frequency of applied voltage was changed from 5 Hz to 10 kHz. On the SMD electrode, a quartz tube of 10 mm high and 30 mm in diameter was placed. To make an almost closed volume, a ceramic plate was placed on the quartz tube. The ozone concentration in this closed volume was measured. For testing the bactericidal property from the plasma, *E. coli* inoculated on agar plates was placed instead of the ceramic plate.

When the input power was low, the ozone concentration was monotonically increased in the closed volume. Using very high specific input powers, the performance of ozone production was drastically changed and the ozone concentration was kept low (ozone-less mode) [3]. In the presentation, we will report time evolutions of ozone concentration in the closed volume and discuss the relation between the ozone concentration and bactericidal property.

References

[1] Stoffels E., Sakiyama Y., Graves D. B., IEEE Trans. Plasma Sci. (2008), **36,** 1441–1457.
[2] Kong M., et. al., New J. Phys. **11**, (2009) 115012.
[3] Kogelshatz U., Eliasson B., Hirth M., Ozone Sci. Eng. (1988), **10**, 367-377.