Bactericidal effect in different gas compositions using Surface Micro-Discharge (SMD) plasma

Jin Jeon[1], Yangfang Li[1], Tetsuji Shimizu[1] , Julia Zimmermann[1], Gregor Morfill[1]

[1] *Max Planck Institute for extraterrestrial Phyics, 85748 Garching, Germany*
E-mail: jeon@mpe.mpg.de

The usage of cold atmospheric plasma for biomedical application is a rapidly growing field of research with a wide application spectrum. Here atmospheric plasmas, as the application of which has been derived and inspired from the semiconductor fabrication research as well as the space research, have been utilized to inactivate microorganisms such as bacteria, spores and viruses. There are still many unclear mechanisms, e.g. how the cold atmospheric plasma interact and inactivate microorganisms. One possible answer is that the reactive species play an important role by making the cell wall of microorganisms permeable and penetrate to the inside.

The bacteria samples, Escherichia coli inoculated on agar, are treated by a Surface Micro-Discharge (SMD) electrode at atmospheric pressure. The electrode consists of a grounded planar metal plate, and a metal mesh with a dielectric in between. The plasma discharge is produced on the mesh electrode side by applying high voltage in the kilovolt range (peak-to-peak) at several kilohertz. The bacteria samples are placed 6mm away from the electrode.

The SMD-electrode is placed into a vacuum sealed chamber. Using this chamber, the gas composition for the plasma environment can be manipulated by leading different gas mixtures into the chamber. At a constant flow rate of 2slm, the chamber is filled with the gas mixture after less than 10 minutes. During this filling process, the exhaust valve of the chamber is open so that the pressure in the chamber remains constant at the ambient pressure.

The plasma is ignited in different gas conditions, by changing the ratio of oxygen and nitrogen. The electrical property of the discharge is then studied for different conditions. Compared to the bacterial experiment, using E.coli as a testing microorganism, the possible major and minor players for bacterial inactivation by the atmospheric plasma is discussed.