ABSTRACT

Cold atmospheric plasmas have shown their potential as a novel effective and affordable bio-decontamination technique. The plasma can inactivate various microorganisms in liquids, and on surfaces and can also trigger a sequence of biological responses in cells and tissues. It is believed the effects of plasma are mainly due to the action of reactive oxygen and nitrogen species supported by electric fields and UV radiation. Nevertheless, plasma–liquid and plasma–bacteria interaction mechanisms are yet to be fully established.

This thesis focuses on the investigation of plasma-induced effects on bacteria. The theoretical overview of plasma and plasma-liquid interactions as well as the antibacterial and antibiofilm mechanisms of plasma is presented. Common healthcare-associated pathogens *Escherichia coli*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa* were used in experiments. Two types of plasma discharges were applied to study various plasma-induced effects on bacteria, such as bacterial viability, membrane integrity, metabolic activity, intracellular ROS accumulation, and morphological changes.

The air transient spark discharge demonstrated a high bactericidal efficacy on planktonic bacteria in saline. Gram-negative *E. coli* was found more susceptible to plasma than Gram-positive *S. aureus*. Physicochemical measurements of plasma treated saline revealed H_2O_2, NO_3^-, •OH and $ONOO^-$ combined with decreased pH, and increased oxidation-reduction potential facilitated the bactericidal effect of plasma. The pulsed streamer corona discharge was applied on bacterial biofilms on surfaces. The insights into plasma effects on biofilm of various types, age, and content of moisture are provided. Also, a possibility of biofilm dissemination after plasma treatment was evaluated. The measurements of gas-phase species revealed plasma-generated O_3 and NO_2 being dominant species controlling plasma antibiofilm effects. Based on these findings, plasma inactivation mechanisms for the $Gram^-$ and $Gram^+$ bacteria as well as for different forms of biofilms were discussed.

Keywords: cold plasma, plasma treated liquid, reactive oxygen and nitrogen species, transient spark, corona discharge, planktonic bacteria, bacterial biofilm