

MODELING OF PLASMA CHEMISTRY OF HAND PLASMA STERILIZATION DEVICE

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Bacterial, fungal and viral infections are a serious health problem in many countries through the world. Antibiotic-resistant bacteria are known to be prevalent and often virulent. Novel antimicrobial strategies are urgently needed. Cold gas air plasma is a promising technology in several areas of medicine.¹⁻⁴ We have developed a hand plasma sterilization device based on surface discharge in air at atmospheric pressure. We demonstrated that 5 log reduction of *E. coli* (*in vitro*) was achieved in a few seconds of plasma exposure.⁵

The ultimate goal of this project is to use numerical modeling to help design practical devices. As the first step of the study, we focus on the modeling of plasma chemistry of the hand plasma sterilization device in humid air. Our model is based on a zero-dimensional plasma fluid model with the local field approximation. The model includes 48 species and 630 reactions. The loss of species at surfaces is included in the model since the discharge is sustained near surfaces. Electron density and electric field are given as input parameters from our experiments. In a typical condition, electron density is fixed at 10^{17} m^{-3} and electric field at $3 \times 10^6 \text{ V/m}$. Both the electron density and electric field are assumed to last for 100 ns with a repetition rate of 10 kHz to simulate filament-like microdischarges. Starting from a low initial density with a fixed electron density and electric field as mentioned above, a periodic steady state is reached in 1000 cycles (0.1 s).

Initial simulation results indicate many reactive species are generated in discharge region, including O_2^* , H_2O_2 , N_2O , NO_2 , NO , O , OH , NO , HO_2 . The creation and loss reactions of O_3 , NO , and NO_2 are tightly coupled each other.

We have been developing a flow tube reactor to measure the concentrations of reactive species. Our plasma chemistry model is evaluated and revised based on the experimental results. We will present the experimental results and the comparison with simulation results in the presentation.

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