SOLUTION CHEMISTRY INDUCED BY HE+O$_2$ GAS PENETRATION AND CHEMICAL REACTION OF ANTIBACTERIAL SPECIES

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In recent years, a growing amount of literature suggests that the bactericidal effect of low-temperature atmospheric-pressure plasmas is chemistry driven. Antibacterial species generated by plasmas, such as O, OH, H$_2$O, and H$_2$O$_2$, are capable of reacting strongly to the substance in bacteria, resulting in bacterial inactivation. However, since bacteria cells are usually embedded in solution/tissue in most practical cases, the antibacterial species in the gas phase do not act directly on the bacteria cells as they must penetrate into the liquid phase in which bacteria find themselves. So far, the mass transfer of antibacterial species from the gas phase to the liquid phase, and the associated chemical processes, are poorly understood. In this paper, reaction chemistry in water and normal saline induced by He+O$_2$ plasmas is investigated by means of a fluid model. It is shown that most species can only penetrate into a liquid layer of no more than 1um. However H$_2$O$_2$ and HO are capable of penetrating beyond the one-micrometer limit and additionally their penetration depth increases with plasma treatment time. On the other hand, reactive nitrogen species are generated due to some nitrogen in air being dissolved in the liquid before plasma treatment. Their effects are also investigated. Implications of our results are discussed on inactivation of bacteria.

* Work supported by National Science Foundation of China