Rapid Destructions of Biological Species in the Air using Atmospheric Pressure Non-thermal Plasma

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Airborne biological particles are ubiquitous in the environments, including a variety of microorganisms (bacteria, fungi, and viruses), allergens, plant debris, endotoxin, glucans and skin scales. Exposure to those pathogenic microbes or derivatives was shown to cause numerous adverse health effects. In addition, the contamination of the environments as a result of either intentionally or accidentally released biowarfare agents can induce great harm and fear among the public as manifested by the anthrax events in 2001 in the United States. Biological aerosol exposure has become one of the major concerns for the residential, healthcare, and government sectors. The outbreaks of SARS in 2003 and influenza H1N1 viral infections across the globe in 2009 prompted worldwide attention for effective biological monitoring and control measures.

Here, non-thermal plasma generated by a dielectric barrier discharge (DBD) system was applied to inactivating aerosolized *Bacillus subtilis* and *Pseudomonas fluorescens* as well as indoor and outdoor bioaerosols. The culturability, viability, and diversitylosses of the microorganisms in air samples treated by the plasma for 0.06-0.12seconds were studied using culturing, DNA stain as well as polymerase chain reaction-denaturing gradient gel electrophoresis (PCR–DGGE) methods. In addition, the viable fraction of bacterial aerosols with and without the plasma treatment was also quantified using qPCR coupled with ethidium monoazide (EMA).

It was shown that less than 2% of B. *subtilis* aerosols survived the plasma treatment of 0.12 s, while none of P. *fluorescens* aerosols survived. Viability tests, EMA-qPCR results and Scanning Electron Microscopy (SEM) images demonstrated that both bacterial species suffered significant viability loss, membrane and DNA damages. Exposure of environmental bacterial and fungal aerosols to the plasma for 0.06 s also resulted in their significant reductions, more than 95 % for bacteria and 85-98 % for fungal species. PCR-DGGE analysis showed that plasma exposure of 0.06 s resulted in culturable bacterial aerosol diversity loss for both environments, especially pronounced for indoor environment. The results here demonstrate that non-thermal plasma exposure could offer another highly efficient air decontamination technology.

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