Quantification of Viral Aerosol UV_{222} Dose-Response Behavior Using a Square Quartz Channel Reactor

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Far UVC radiation has gained attention for its potential use in occupied spaces. At present, the dominant source of Far UVC radiation is the optically-filtered krypton chloride excimer (KrCl*) lamp, which emits a primary peak centered at 222 nm. Measurement of UV_{222} dose-response behavior for aerosolized pathogens and challenge agents is not well-developed or standardized. This study presents a method for quantification of UV_{222} dose-response behavior of aerosolized viruses using a continuous-flow, square quartz channel reactor.

Figure 1 illustrates the device used to conduct these experiments. The device comprises a fused silica channel with a square cross-section (5 cm x 5 cm). Four opposing pairs of flat-panel plasma KrCl* lamps (5 cm x 5 cm) were mounted to the exterior wall of the square quartz channel. In any given experiment, 0, 1, 2, 3, or 4 of these opposing lamp pairs were illuminated to allow variation of the UV_{222} dose applied to the aerosolized suspension of viruses, which was introduced to the continuous-flow reactor using a 1-port Collison nebulizer. The entire air flow from the device passed through a bioaerosol sampler at a fixed flow rate to capture UV_{222}-irradiated, aerosolized viruses.

A microfluorescent silica detector (MFSD) was used to measure the fluence rate field within the irradiated zone of the reactor across a rectangular grid of sampling points. Together with measurements of the internal dimensions of the reactor, measured air flow rate, and knowledge of the illuminated lamp pairs, this information was used to calculate the UV_{222} dose delivered to aerosolized viruses during each experiment.

Aerosolized suspensions of viral challenge agents (phages MS2 and T1) have been introduced to the square quartz channel reactor system, with analysis of sub-samples of bioaerosol sampler collection liquid using plaque assays. The results of these experiments are illustrated in Figure 2. The data from these experiments illustrate the intrinsic kinetics of aerosolized virus inactivation by exposure to UV_{222}. These data will be critical to development of systems based on KrCl* lamps for disinfection of indoor air, as well as for development of near-field protection devices based on Far UVC radiation.

Future experiments will involve introduction of other viral challenge agents (*e.g.*, phage Φ6) and pathogens. The reactor system used in these experiments could easily be adapted to other sources of UVC radiation, including low-pressure mercury lamps and UV LEDs. Moreover, the same device could be used to quantify the intrinsic kinetics of UVC-based inactivation of other airborne challenge agents and pathogens, including other viruses and bacteria.

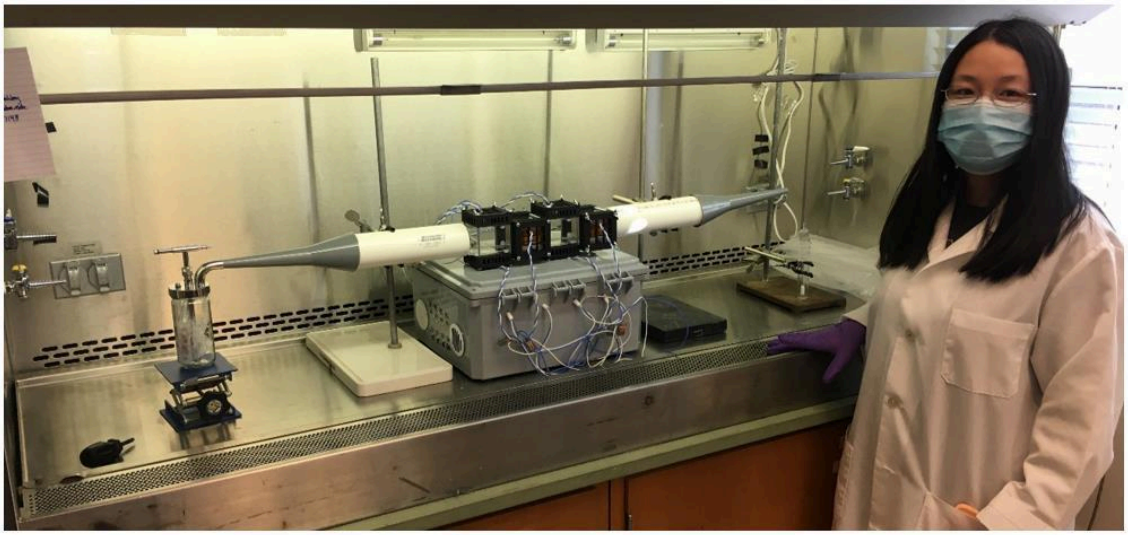

Figure 1. Square quartz channel reactor system. From left to right: 1-port Collison nebulizer for introduction of aerosolized challenge agent; conical transition section and PVC transfer tube for upstream flow conditioning; square quartz channel section with four pairs of opposing KrCl flat panel lamps; PVC transfer tube and conical section for downstream flow conditioning; bioaerosol sampler.*

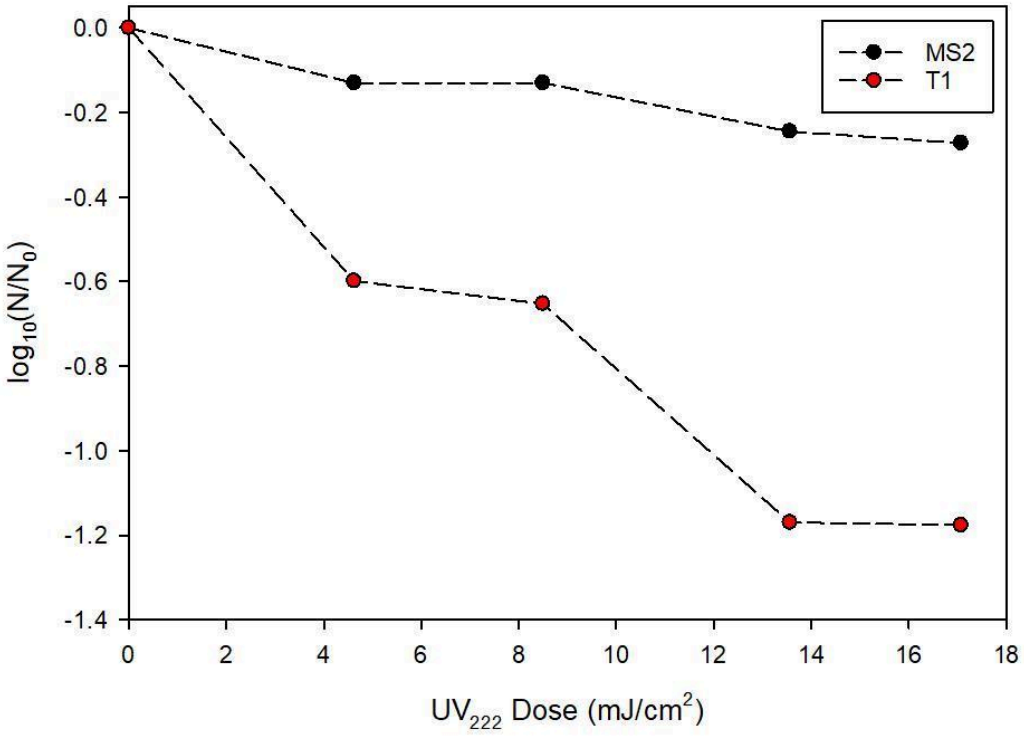

Figure 2. UV_{222} dose-response behavior for aerosolized MS2 and T1 phages.