The dependence of UV induced degradation rates of bacterial on aerosol particle size

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Solar UV light driven degradation of the viability of airborne disease causing organisms is critical to accurately simulating the threat from a deliberate biological weapons release. Such simulations are essential for understanding the extent of biological weapons releases as well as planning the civil response, Stuart et al, (2005).

The rate of UV inactivation as a function of available UV wavelengths as well as organism containing particle size are necessary for reasonable estimation of inactivation rates, Kesavan et al. (2014). Previous measurements of the action spectrum, or fraction of spores killed as a function of given photon dosages as a function of wavelength, have not investigated the influence of particle size, Munakata et al. (1996), Griego and Spence (1978), and Chen et al. (2009). Conceptually, particle size is essential in that dead organisms on the outside of a larger aerosol particle can shield organisms within the particle core.

To characterize kill rates as a function of particle size and UV wavelength, we measured the kill fractions of monodisperse spore containing particles deposited on a surface with known exposures for discrete wavelengths at 285 nm, 295 nm, 310 nm, and 365 nm. We used vaccine grade *Bacillus anthracis var. Sterne* rather than simulants such as *Bacillus atrophaeus* (BG). To perform calibrated dosages on particles of known size, an Inkjet Aerosol Generator (IJAG) was used to create known numbers of particles at a known, monodisperse size. Particles were collected onto a nanopore filter which is smooth on the length scale of the particles. SEM microscopy was used to characterize deposition. For single spore preparations, known volumes of dilute suspensions of spores were deposited on the exposure area.

UV LEDs were used to generate light at specific wavelengths, with full width half max emission bands of 10-12 nm in wavelength. A plano-convex silica lens was used to defocus the LED emission before passage into a silica homogenizing rod. The resulting UV spot at the exit of the rod was uniform UV illumination across the cross section of the rod. UV illumination was measured with a calibrated UV meter.

For small particles, especially single spore particles, complete kills were approached at long exposure times for all UV wavelengths. As expected, a finite amount of spores survived regardless of exposure times for larger particles. Using these measurements, we expect to enable prediction of solar UV organism inactivation at any location, time of day, cloud cover, and ozone column.

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