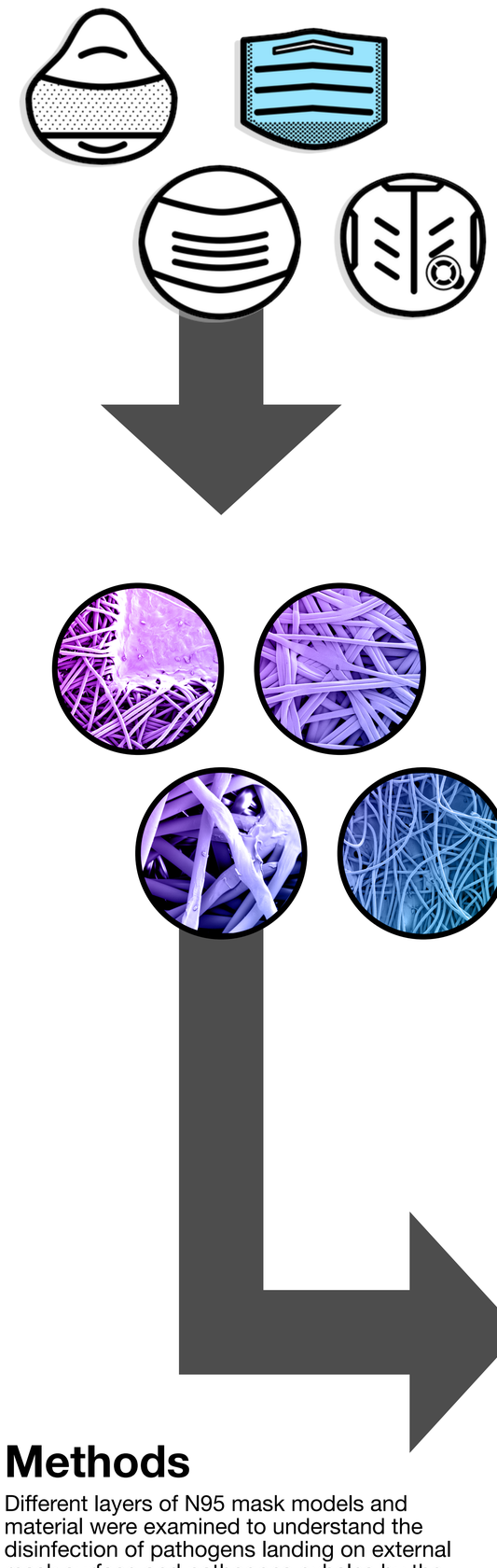
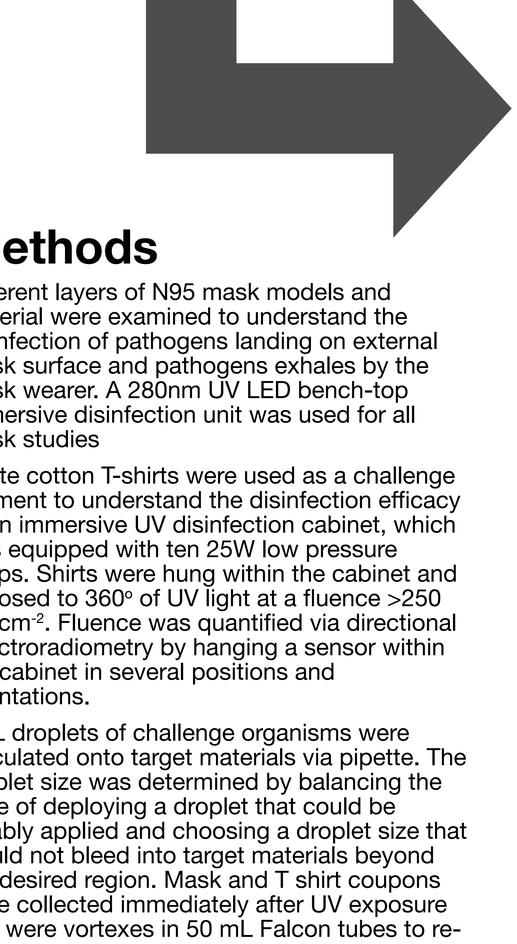
Disinfection of porous materials using immersive UV-C technologies

Introduction

Immersive UV-C technologies have several applications in making shared spaces safer and reducing the transmissivity of pathogens. Much of the existing research regarding surface disinfection has focused on hard, non-porous materials and has ignored porous materials due to the complexities involved in characterizing disinfection. This study has focused on front facing respirators and cotton T-shirts





Methods

Different layers of N95 mask models and material were examined to understand the disinfection of pathogens landing on external mask surface and pathogens exhales by the mask wearer. A 280nm UV LED bench-top immersive disinfection unit was used for all mask studies

White cotton T-shirts were used as a challenge garment to understand the disinfection efficacy of an immersive UV disinfection cabinet, which was equipped with ten 25W low pressure lamps. Shirts were hung within the cabinet and exposed to 360° of UV light at a fluence >250 mJ cm^{-2}. Fluence was quantified via directional spectroradiometry by hanging a sensor within the cabinet in several positions and orientations.

5 µL droplets of challenge organisms were inoculated onto target materials via pipette. The droplet size was determined by balancing the ease of deploying a droplet that could be reliably applied and choosing a droplet size that would not bleed into target materials beyond the desired region. Mask and T shirt coupons were collected immediately after UV exposure and were vortexes in 50 mL Falcon tubes to re-suspend target organisms.

Complex porous objects can be disinfected by immersive UV-C light *if* the material type and distribution of light is properly understood

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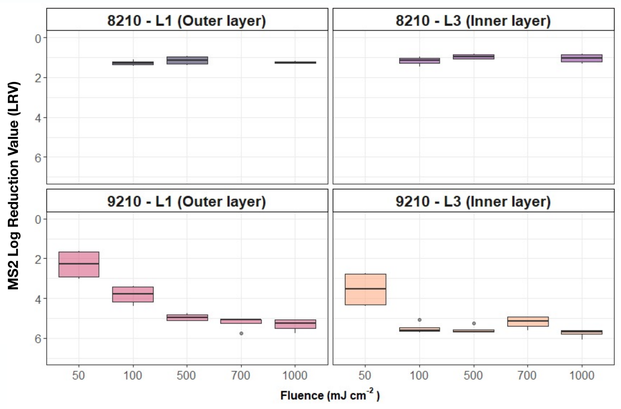
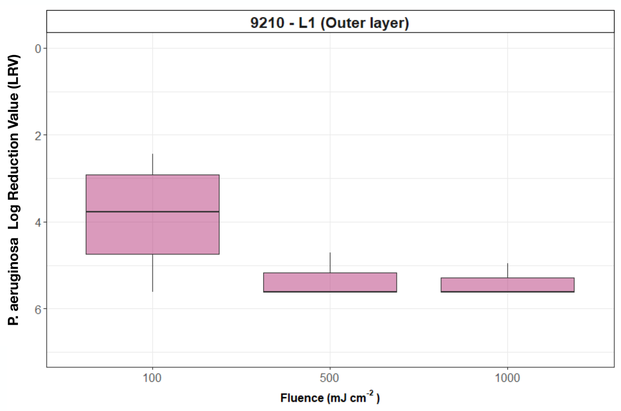
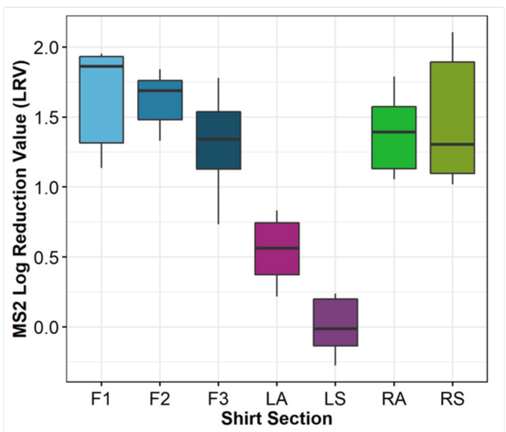
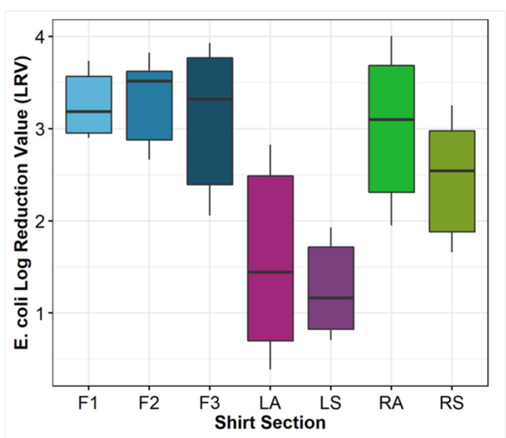
- **The material type of front-facing respirators was the primary driver of disinfection efficacy and not all mask models are suitable for 280nm UV-C disinfection**
- **Hydrophobic outer layers (9210 model) proved to be easier to disinfection challenge organisms when compared to hydrophilic outer layers (8210 model)**
- **Disinfection of cotton textiles using Low Pressure lamps showed a > 1-log reduction for both e.Coli and MS2 in all properly illuminated regions**
- **Unoptimized hanging positions resulted in major differences in disinfection efficiency**
- **The results of these studies highlight the impacts of micro and macro geometry on the efficacy of immersive UV-C technologies**
- **Both the characteristics of target porous materials (hydrophobicity, layers, weaving, etc.) and the physical distribution of UV-C light are important considerations when developing immersive UV-C products**









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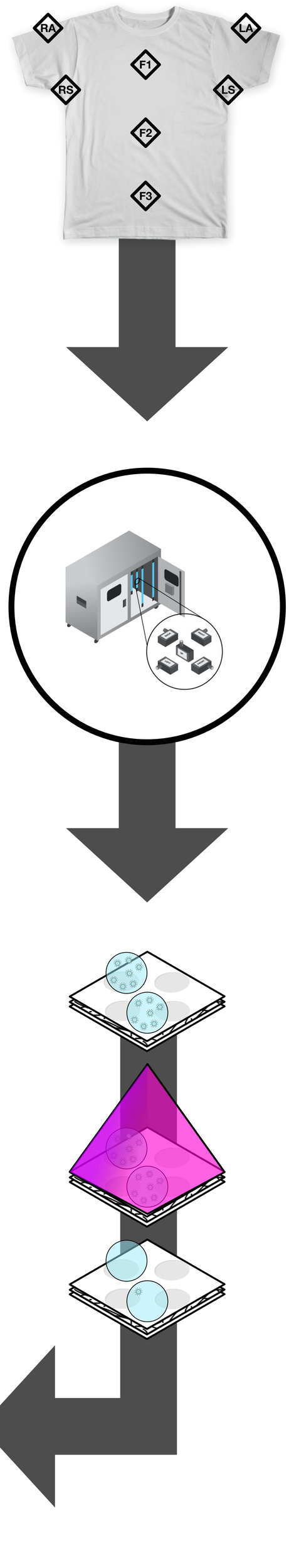

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