ElectroClave UV-C Disinfection and N95 Facemasks – March 23, 2020

Given it's unique 360-degree disinfection capabilities—no other UV-C cabinet provides 360-degree UV-C light illumination without shadowing—the Seal Shield ElectroClave UV-C disinfection cabinet can be used to disinfect the surface of N95 facemasks. Though the ElectroClave was designed to both disinfect and manage mobile devices (cellular phones, tablets and similar small electronics). The ElectroClave can disinfect most surfaces with a minimum 3-log microbial reduction; greater microbial reduction is possible with longer cycle times. Notably, human coronavirusus which are genetically similar to COVID-19, namely SARS and MERS, have shown sensitivity to exposure to UV-C. Based on the 80% sequence similarity between SARS and the novel coronavirus, Dr. Charles Chiu, an infectious disease professor at the University of California, San Francisco, agreed that researchers should, "primarily rely on the data from SARS coronavirus."

There is ample evidence that the ElectroClave can effectively disinfect the surface of N95 facemasks. Additional testing is underway to determine the magnitude of microbial reduction *within* the porous matrix of the filtration medium, as opposed to the surface of the mask. The built-in filtration medium, though, should trap pathogens and make this less of a concern.

A frequently expressed concern about the utilization of UV-C light to disinfect N95 masks—for good reason—is the extent to which UVC light might degrade the masks' filtration medium, potentially rendering their filtration capacity out of specification. Importantly, the LEDs utilized by the ElectroClave have a significant advantage over the more ubiquitous mercury vapor bulbs from a material degradation standpoint. Traditional mercury vapor UV-C bulbs emit over a very broad spectrum. Material degredation primarily occurs above 280nm and below 254nm, both of which are within the broad spectrum emitted by mercury vapor bulbs utilized by UV robots and many other UV disinfection cabinets. The LEDs utilized in the ElectroClave emit in the very narrow range of 265-275nm. Essentially, the ElectroClave's targeted approach allows the emission of UV-C in the range required to kill microbes, but not in the range which causes meaningful material degredation.

Nebraska Medicine has developed a very comprehensive methodology for disinfecting N95 masks with UV light. See https://www.nebraskamed.com/sites/default/files/documents/covid-19/n-95-decon-process.pdf That process specifically identifies the risk of material degredation with mercury vapor bulbs and the dosage levels necessary for effective disinfection. The ElectroClave delivers sufficient energy to accomplish effective disinfection, while mitigating the degredation inherent with mercury vapor bulbs.

As to the energy delivered by the the ElectroClave, the ElectroClave is designed with 17 UV-C LEDs within each shelf or disinfection bay. Each of them emits 2.1 mW of radiant power. This amounts to 35.7 mW of total radiant power, distributed across approximately 100 in^2. At every location within a disinfection bay, the dosage or *rate* of energy delivery is at least 51.5 uW/cm^2. The ElectroClave's cycle times are adjustable by the user, and the dosage for the most common cycle time, 60 seconds, is approximately 3.09 mJ/cm^2

– or 0.003 J/cm^2. Such a dosage is more than enough to deactivate/kill microbes at the surface of an object. This is part of a larger body of evidence that demonstrates how UV-C LED technology can be superior to low-pressure mercury lamp technology where space constrictions are present.

After 100 disinfection cycles (i.e., 100 minutes of time in the ElectroClave), the total energy delivered to the object would be only 3.09x100 = 309 mJ/cm^2 – or 0.3 J/cm^2 – well below the suggested maximum levels for an N95 mask by Lindsley et al. in their 2015 study (J. Occup. Environ. Hyg. 2015; 12(8): 509-517, full text link).

The Lindsley study focused on *filtration capacity* of the N95 facemask (also called *penetration*) and then the material properties of the N95 mask layers. They found a small loss of filtration capacity from UV exposure (again, from mercury vapor UV bulbs), but not enough to go out of spec.

Further supporting information is on the following page.

Kim et al., Applied and Environmental Microbiology 2016, 82(1), 11-17
Full paper: https://sealshield.box.com/v/UVC-LEDs-vs-Mercury-Lamps

Comparison of microbial reductions between the 254-nm lamp and 266-nm UV-LED. *Fig. 2 shows the viable – count reduction levels of E. coli O157:H7, S. Typhimurium, and L. monocytogenes spread on selective media after treating with the 254-nm UV lamp or the 266-nm UV-LED. Both treatments presented the same pattern of foodborne pathogen reductions; that is, higher doses induced higher levels of inactivation. The 266-nm UV-LED treatment at a dose of 0.7 mJ/cm² achieved 6-log reductions of E. coli O157:H7 and S. Typhimurium, respectively, and a 5.3-log reduction of L. monocytogenes. In other words, the 266-nm, 0.7mJ/cm² UV-LED treatment demonstrated that nearly all inoculated pathogens were inactivated at this dose. On the other hand, the reduction levels with UV lamp treatment were 3.06-, 1.42-, and 0.34-log reductions of E. coli O157:H7, S.Typhimurium, and L. monocytogenes, respectively, which were significantly less (P 0.05) than the UV-LED inactivation levels at the same dose.*

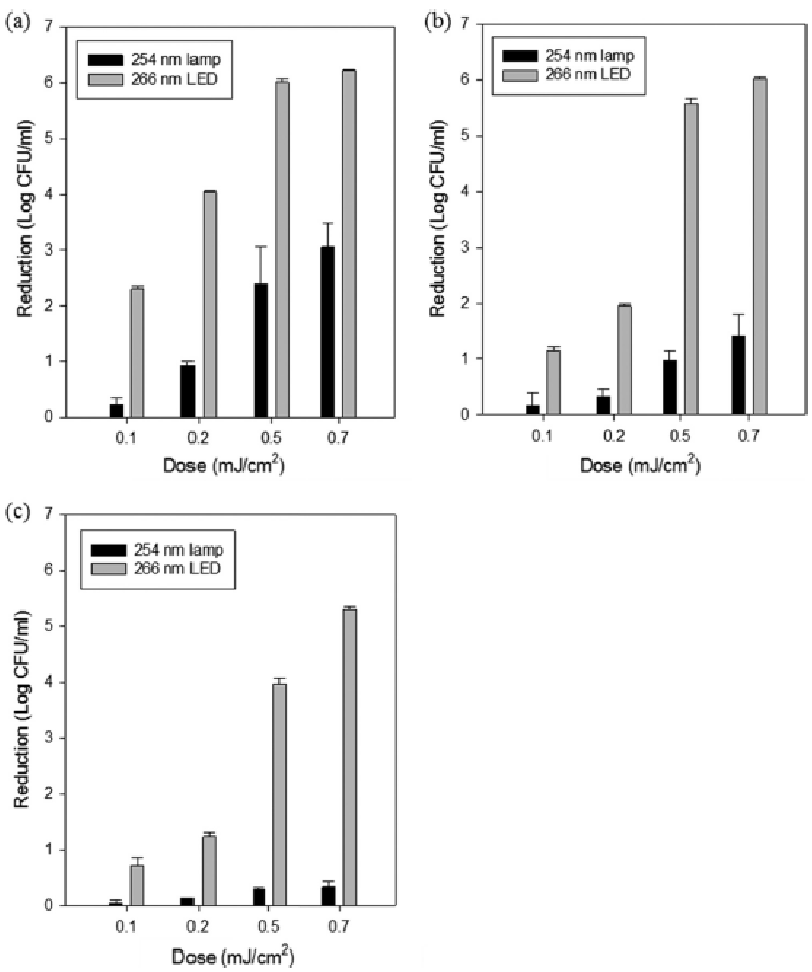

FIG 2 Reduction of *E. coli* O157:H7 (a), *S.* Typhimurium (b), and *L. monocytogenes* (c) cells on each selective medium (*E. coli* O157:H7; sorbitol MacConkey agar, *S.* Typhimurium; xylose lysine desoxycholate, *L. monocytogenes*; Oxford agar base with antimicrobial supplement) treated with a 254-nm UV-lamp and 266-nm UV-LED PCBs at 0.1, 0.2, 0.5, and 0.7 mJ/cm².