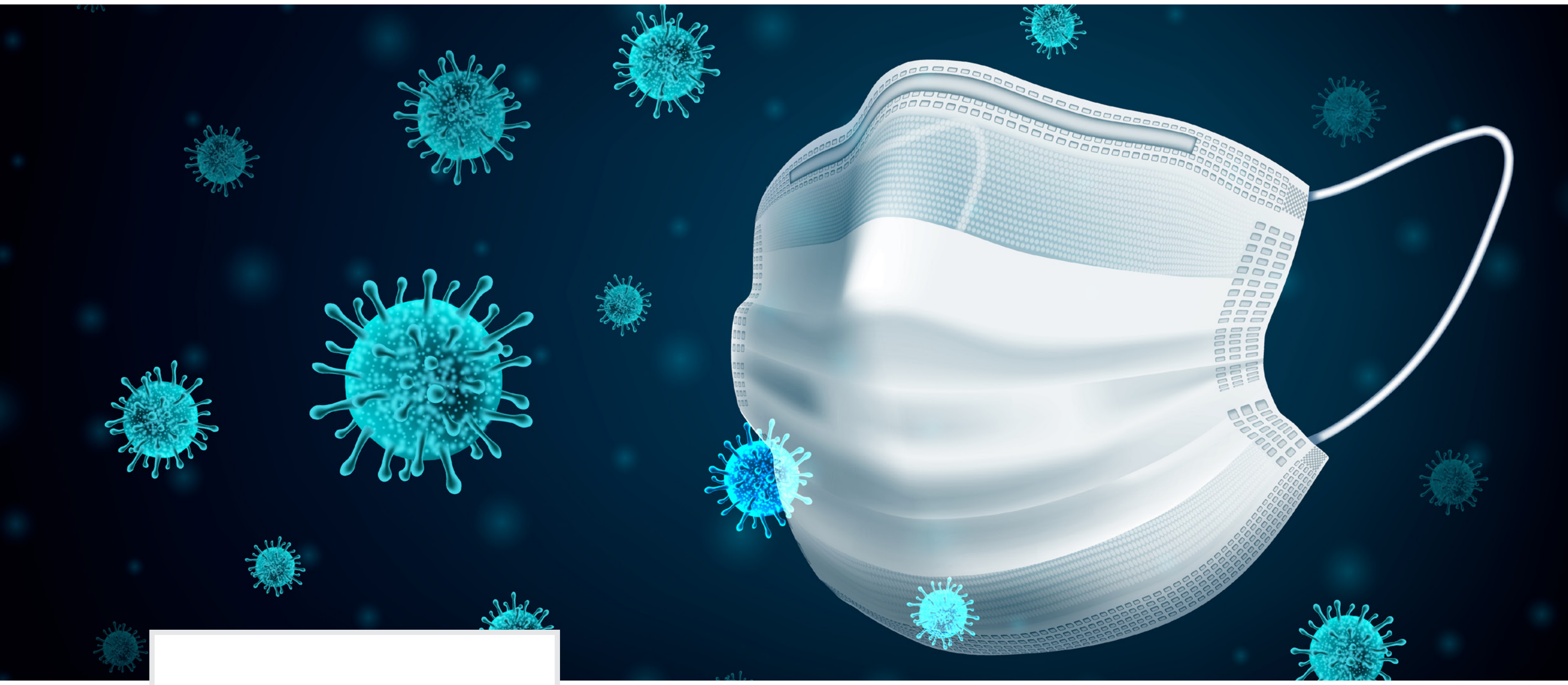
Application Note · UVP Crosslinker



Challenge

Access to a steady supply of N95 respirator masks is inadequate due to the COVID-19 pandemic

Solution

Irradiation and reuse of existing N95 masks using the UVP Crosslinker

Ultraviolet-based Disinfection for the Inactivation of Viruses on Respirator Masks

Abstract

We are writing this at the time of the ongoing SARS-CoV-2 outbreak and, despite commendable efforts by the private sector and governments globally, access to a steady supply of N95 respirator masks is lacking. Several private sector companies have committed to making surgical masks to protect healthcare workers but have not communicated how they will meet the rigorous NIOSH particle filtration standards, if address them at all. While some of these efforts are well-intentioned, they do very little to protect workers from aerosolized virus from the sputum of infected patients, which creates microdroplets that can easily pass through materials that do not meet NIOSH standards. Instead, a more desirable approach would be the irradiation and reuse of existing N95 masks. Until recently, a hospital approved UV germicidal irradiation (UVGI) protocol for masks was not available. We hope that health workers do not routinely resort to reusing masks, but if they do, then they can rest assured that integrating our CL-3000 crosslinker into a hospital approved UVGI workflow, will generate reproducible results that are scalable, and safe for the end user.

Introduction

Shortwave ultraviolet (UVC) light has germicidal properties by acting directly on the DNA/RNA of microorganisms. DNA/RNA absorb ultraviolet light maximally at approximately 260 nm, which, as a consequence, damages the DNA/RNA structure. Although microorganisms have mechanisms with which to repair the damage, these repair mechanisms cannot counteract extensive high-intensity UV doses, which ultimately inactivate or kill the microorganism.

Still, ultraviolet light is considered an ancillary disinfectant to chemical disinfectants in the healthcare environment[1]. Two often cited examples include the occurrence of UV-resistant microorganisms[2] and UV irradiation of medical equipment which poses a risk to healthcare workers if not used properly[3,4]. The concern over UVC resistant pathogens should be handled on a case-by-case basis and consultation with infectious disease experts is recommended but concerns over safety are easily mitigated. More importantly, UVC light has several advantages over chemical disinfectants, which can leach into the environment, produce disinfection byproducts, and lead to the inevitable development of resistant pathogens[5]. It therefore makes sense why many researchers continue to explore the efficacy of UV-based disinfection on microorganisms[6–28].

At Analytik Jena, we produce equipment capable of generating shortwave UVC doses commensurate with the values reported in the referenced publications. Importantly, our high-precision CL-3000 crosslinker (Figure 1A) is capable of producing a cumulative dosage of 1 J/cm^2, well beyond any requirement observed in our literature review. The CL-3000 provides near-uniform UVC light (Figure 1B and 1C) with a ~10% coefficient of variation and less than 2 mJ/cm^2 difference between the highest and lowest reading. Most importantly, the CL-3000 has real-time monitoring of UVC dosage to assure reproducible dosing irrespective of space and time.

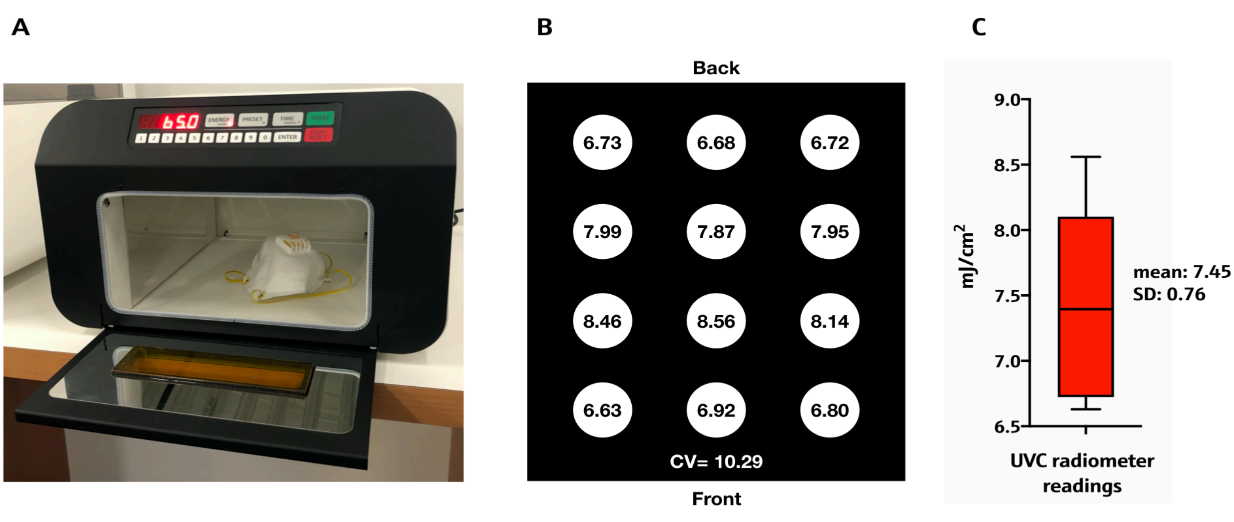


Figure 1. The UVP Crosslinker CL-3000 is a compact, high-intensity, high-uniformity irradiation device. A) Image of the CL-3000 with the front door open and N95 mask placed on the floor of the instrument. B) Diagram depicting the position and intensity of radiometer readings (units mJ/cm^2). C) Box whisker summary plot of data from Figure 1B.

To prepare for inevitable shortages of N95 masks, the University of Nebraska Medical Center has produced a comprehensive UV irradiation protocol for respirator masks[28] employing the use of UV Torch towers "equipped with eight 254 nm bulbs to produce 200 μw/cm2 [from] 10 feet for a dosage of 12 mJ/minute". The CDC has proposed guidelines for mask reuse in certain circumstances[29] (e.g. pandemic planning), but does not currently have a protocol for ultraviolet germicidal irradiation (UVGI) of masks. This may stem from concerns over mask integrity during UVGI treatment from past reports[26, 31]. Most recently, Stanford University reported that UVGI did not visibly damage masks or significantly affect the filtration efficiency, while achieving greater than 99% disinfection efficiency for up to 10 disinfection cycles[32]. We recommend users adhere to cautions from the mask manufacturer and regularly inspect masks for structural damage after each disinfection cycle.

At Analytik Jena, we agree UV irradiation is an effective disinfection strategy. This view is shared by the International Ultraviolet Association, which recently published a COVID-19 Fact Sheet. We are concerned mostly with the uniformity of exposure in at least one of the two previously mentioned procedures—simply put, shadows inherently interfere with UV irradiation coverage. Therefore, we believe our crosslinker has the following advantages for UVGI of masks over the UV tower-based strategies:

- More uniform lighting
- Fixed distance between sample and UV source
- Higher UV output
- Embedded radiometer to track dosage for reproducibility
- Safety Interlock to prevent accidental exposure
- Small footprint to accommodate limited spaces
- Closed system to accommodate scaling up disinfection

Following the University of Nebraska protocol, our instrument can irradiate 6 masks in less than 1 minute, which accounts for flipping the mask over, since the UVC light source is above the sample. Users can scale up easily, since the footprint of our instrument is comparable to that of a microwave. Below we describe how to set up our instrument based on the approved protocols[28,31].

Operating the CL-3000 as part of an approved UVGI Workflow

To operate the CL-3000 simply follow the instructions below:

Note: we recommend users follow the instructions described by the University of Nebraska Medical Center protocol and/or Stanford University. We are simply describing how to use our device to achieve the same irradiation levels.

1. Set the dosage on the instrument by selecting ENERGY, then pressing 6-3-0 for 63.0 mJ/cm^2, and then press ENTER.
2. Place mask into chamber and close door.
3. Hit START.
4. Open door and flip mask over and repeat step 3.
5. Remove the sample and continue following the UNMC protocol (see Demo video).

Note: As an added precaution, users may consider repeating steps 1-3 with an empty crosslinker in between sets of masks if residual contamination is a concern.

Disclaimer: We do not advocate specific treatments or approaches. We are simply sharing the most recent evidence from the medical community to help other health workers during the SARS-CoV-2 pandemic.

Technical Data

General Tehnical Data	
Wavelength	**Short-Range Wavelength: 254 nm**
Number of Tubes	**6 x 8 W Fluorescent bulbs**
Dimensions (H x D x W)	**Short-Range Wavelength (254 nm):** **External: 26.7 cm x 43 cm x 40 cm, 10.5 in x 17 in x 16 in** **Internal Chamber: 15 cm x 35 cm x 27 cm, 6 in x 14 in x 11 in**
Weight	**15 lbs (6.8kg)**
Environmental Conditions	**15 °C – 35 °C, 70 % air humidity, max 2000 m NN**

Part Numbers and Description

Part Number	Description
849-95-0615-01	**UVP Crosslinker (CL-3000), 254 nm, 100 – 115V**
849-95-0615-02	**UVP Crosslinker (CL-3000), 254 nm, 230V**

Mid-Range Wavelength: 302 nm (CL-3000M) and Long-Range Wavelength: 365 nm (CL-3000L) UVP Crosslinkers are available to order, but are not applicable to this application note.

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en · 04/2020