

WATER DISPENSER NOZZLE DISINFECTION

Many leading water dispensers treat water before dispensing it through a nozzle. However, the nozzle, which remains wet after dispensing water, becomes susceptible to external contamination of bacteria and fungi.

This application note showcases how Silanna's 235nm Far UVC LEDs provide a novel method to disinfect the nozzle and other damp areas around it.

1. Introduction

Water dispensers are very popular in public and private places such as hospitals, schools, gyms, and offices. Many leading water dispensers treat the water using special filters and Ultraviolet C (UVC) light before dispensing the water. However, cleaning the nozzle on a water dispenser is time-consuming and tricky. The nozzle is exposed to external contamination and provides a favourable environment for bacteria and fungi to grow. Any clean water dispensed through an unclean nozzle may still be contaminated. This application note discusses a novel approach to irradiating the nozzle and its surroundings using a safer UVC light to keep it free from germs. Many researchers have shown that the most effective UVC disinfection is at 265nm (265 nanometres) & 275nm wavelength light. These wavelengths kill germs and, at the same time cause permanent damage to human skin and eyes¹. Thus, 265nm or 275nm source cannot be used for this application.

2. Why use Silanna's far UVC Light Emitting Diode (LED)?

The standard for occupational exposure to UV radiation is based on the Threshold Limit Values (TLV) published by the American Conference of Governmental Industrial Hygienists². TLV specifies how much UV light a person is allowed to be exposed to in an eight-hour time period. As the wavelength of UVC light decreases, the TLV increases, making lower wavelengths safer for applications where humans may be present.

The TLV for Silanna's 235nm LEDs are four times and six times higher for skin and eye exposure respectively, compared to 265nm & 270nm light. Wavelengths below 230nm generate harmful ozone that requires special care. Silanna's state-of-the-art SF1 series LED is an ideal candidate for this application. Silanna's 235nm products are packaged in four different types: 120D flat lid, 30D Parabolic Lens, 15D TO-39 and a 120D 4-in-1 (Figure 1) to address this application.

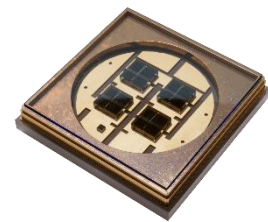


Figure 1: Silanna 4-in-1 LED

3. Optical Simulation – 232nm Far UVC-Based Disinfection

This application note uses Silanna's 4-in-1 package as the UVC light source. Studies³ show that Far UVC wavelengths of 232nm can deactivate at least 99.9% of common disease-causing pathogens such as *S. aureus*, *P. aeruginosa* and *E. coli*. The efficacy of 232nm light not only matches the efficacy of 265nm & 270nm light, but

it is twice as good as a 254nm lamp. The Far UVC light at 232nm has 4x higher TLV than the 265nm light, making it suitable for the nozzle disinfection application.

A simulation was performed on a typical water dispenser to determine the irradiation on surfaces in the nozzle. The simulation is performed by placing two LEDs on either side of the nozzle as shown in Figure 2 and Figure 3. A specially designed UVC transmitting lens focuses the light only on the nozzle, avoiding any light escaping the nozzle cavity. The simulation results in the first row of Table 1 show that 99.9% to 99.99% of the harmful pathogens can be deactivated within 20 minutes of exposure.

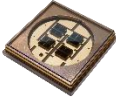
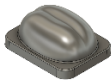
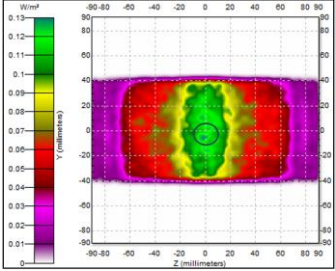
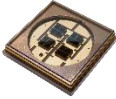

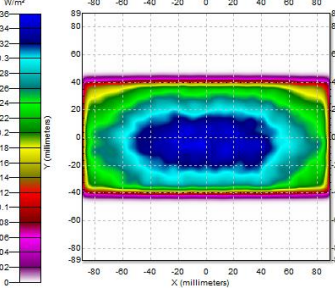
In a similar approach, using custom-designed secondary optics the bottom surface of the nozzle cavity shown in Figure 3, can be irradiated to achieve up to 99.99% deactivation in 12 minutes. The second row in Table 1 illustrates this scenario.

In summary, Table 1 shows the time taken to achieve a two to four-log reduction of the common pathogens. Frequent, short irradiation of this Far UVC light on the nozzle and the bottom of the cavity will help reduce the growth of bacteria and fungi. By design, the light stays within the dispenser’s cavity, thus causing minimal exposure to personnel operating the dispenser.



Figure 2: Water dispenser with 235nm LED

Table 1: Disinfection time for various pathogens on the nozzle and bottom surface

UVC light source	Simulation result	Efficacy	Time to disinfect in minutes		
			S. aureus	P. aeruginosa	E. coli
Nozzle  + 		99% (2 log)	6	3	8
		99.9% (3 log)	8	5	17
		99.99% (4 log)	17	17	50
Bottom Cavity  + 		99% (2 log)	4	2	6
		99.9% (3 log)	6	4	12
		99.99% (4 log)	12	12	37

4. Conclusion

This study provides high confidence that an optimal solution is possible with 232nm LEDs coupled with custom-designed UVC optics that will effectively eliminate common pathogens from the nozzle and the bottom surface of the nozzle cavity. In daily operation, the LEDs can be turned on at regular intervals or after frequent access to the water dispenser. By understanding the total radiation limits specified by the TLV, the system significantly simplifies the UV radiation safety risk assessment compared to 265nm & 275nm light.

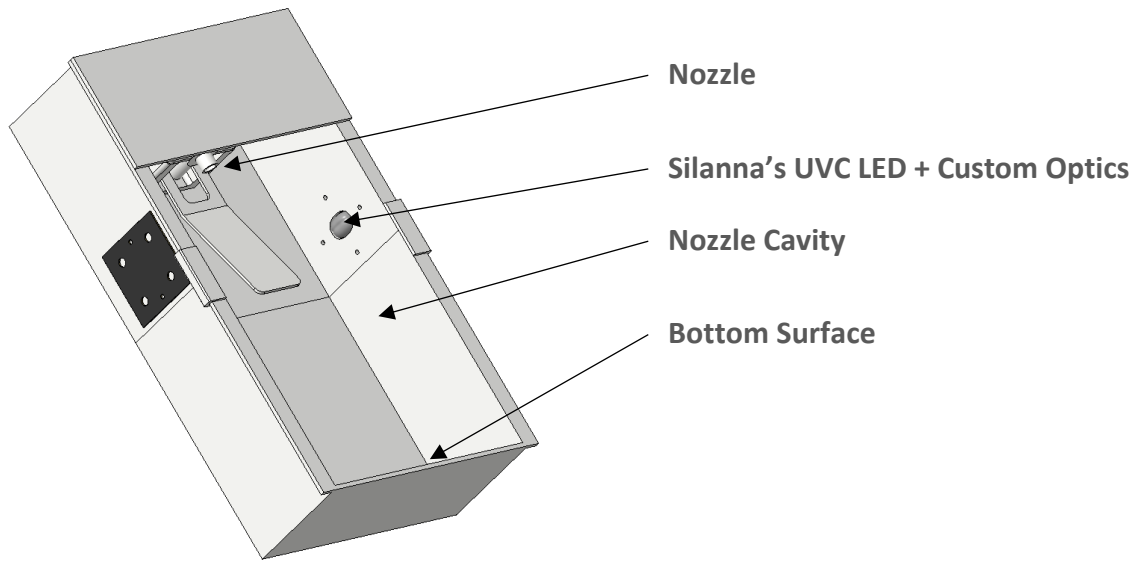


Figure 3: Dispenser setup showing nozzle and nozzle cavity for simulation

References:

1. Maximilian Görlitz, et al., Assessing the safety of new germicidal far-UVC technologies (2023).
2. David H. Sliney, A Need to Revise Human Exposure Limits for Ultraviolet UV-C Radiation (2021).
3. Amodeo D., et al., Exploring the Full Spectrum of UVC Radiation: Analysis of biocidal potential from Far-UVC to UVB boundary frequencies (2024), *University of Siena, Siena, Italy*.
4. Ahmed Kamel, Ana Palacios, Manuel Fuentes and Marta Vivar, Analysing the Reciprocity Law for UV-LEDs in Water Disinfection of *Escherichia coli*, *Enterococcus faecalis*, and *Clostridium perfringens* (2023) *Universidad de Jaén, Linares, Spain*.

This document is provided for your reference only and neither it nor its contents are to be relied upon as authoritative or without your own independent verification or taken in substitution for the exercise of your own judgment. You shall only use the information and data contained in this document solely in the context in which this document was given and not for any other purposes, commercial or otherwise. To the fullest extent permitted by applicable law, no representation or warranty, either expressed or implied, is provided in relation to the accuracy, completeness or reliability of the information and data contained in this document. The information and data contained in this document is subject to change without notice and its accuracy is not guaranteed. In providing this document, the party providing this document Silanna has not undertaken to provide you with access to any additional information or updates. To the fullest extent permitted by applicable law, none of the Company or any of its affiliates, agents, employees, officers, advisers or representatives shall have any liability whatsoever (in negligence or otherwise) for any loss or damage howsoever arising, whether directly or indirectly, from any reliance on, or use or distribution of, this document or its contents or otherwise arising in connection with this document.

This document is not directed to, or intended for distribution to or use by, any person or entity that is a citizen or resident or located in any locality, state, country or other jurisdiction where such distribution, transmission, publication, availability or use would be contrary to law or regulation or which would require any registration or licensing within such jurisdiction.