To submit to 2025 AVS 71, APRIL 10 2025 (NO later). AVS conference takes place in Charlotte, NC - Sep 21-26 2025
2700 characters with SPACES Maximum

SURFACE STERILIZATION VIA UVC: REDUCING TO LESS THAN 10^{-6} THE PROBABILITY OF ONE REMAINING PATHOGEN – A REPRODUCIBILITY & ACCURACY

Nicole Herbots [1,2,3,4, a), b)], Viraj Y. Amin [1,2,3] ·Aarnav Sathish[a)2,3], Arjun Prabhu [a)]

[2] Aditya Tyagi[2, a)], Nachiket Rajinikanth [1,2], Zaid Abu-Salah[1,2], Yash Soni[2,3], Kush Patel[2,3,4], Ashwin Suresh[2 3,5], Shreyash Prakash[2,3], Nimith Gurijala[2,3,6] , Siddarth Jandhyala [2,3,7], Arjun Sekar[2,8], Srivatsan Swaminathan [2,3,9], Robert J. Culbertson [3] E.J. Culbertson, MD[2,10]

[1]UNIVERSITY OF MISSOURI KANSAS CITY, *Department of Medicine and Biological Sciences*, 5100 Rockhill Rd, Kansas City, Missouri 64110, USA
[2]SiO2 INNOVATES LLC (*Est 2016),* 211 E Balboa Dr, Tempe, AZ 85282
[3]ARIZONA STATE UNIVERSITY, *Department of Physics,* Tyler & Rural, Tempe, AZ 85287-1504, USA
[4] UNIVERSITY OF CALIFORNIA SANTA CRUZ, CA
[5]UNIVERSITY OF ARIZONA, TUCSON
[6]WASHINGTON UNIVERSITY IN ST. LOUIS *Department of Bio-Medical Engineering,* 1 Brookings Dr, St. Louis, MO 63130
[7]DUKE UNIVERSITY,
[8] NORTHWESTERN UNIVERSITY, CHICAGO, ILLINOIS
[9] ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI, *1 Gustave L. Levy Place New York, NY 10029-5674,*

[a)] *American Vacuum Society member. (Please identify all AVS member authors.)*
[b)] *Corresponding author electronic e mail: nicole.herbots@asu.edu a)*

Antimicrobial resistance (AMR), viruses, pandemics and hospital-acquired infections are rising as global threats. Three million of US AMR infections kill 50,000/y and 1.3 M/ globally [1], [2] If the trend is not reversed, AMR infections will pass cancer as leading cause of death by 2050. In 2009-19, outbreaks occurred every 2 years instead of ~ four years in the past 200 years: H1N1 (2009), MERS (2012), Ebola (2014), Zika (2015), and Covid (2019).

Surface sterilization that is effective, rapid, reliable, safe, easy-to-deploy, and low-cost is needed to combat AMR, nosocomial infections, and viruses. Sterilization defined by the US FDA, the EU and the International Standard Organization (ISO) [3] is *reduction of the probability for a single viable microorganism to remain after sterilization to* 10^{-6}, a Sterility Assurance Level (SAL) of 6. FDA-approved methods are vaporized hydrogen peroxide (VHP), Ethylene Oxide (EtO), gamma irradiation (g), or autoclaving. These are difficult to use in public spaces, and are time-, materials-, and energy-costly. VHP, EtO, and g are environmentally harmful.

This study seeks to establish quantitatively whether low-cost low power UVC LEDs can sterilize surfaces rapidly, effectively, and reliably to a SAL of 6 without such drawbacks. UVC neutralizes pathogens by disrupting their DNA/RNA. UVC has only been shown to be effective for disinfection (SAL = 3)[4]. This work measures the SAL of 260–280 nm UVC LED irradiation using *Lactobacillus a.* (*L. a*) as test pathogen. Two independent studies are conducted with two *L. a.* solutions calibrated each to 10 and 100 M of Colony Forming Units (CFU's)/m inoculated in 3 sets of ten 100 mm agarose plates to culture in parallel. One control 'No UVC' set of ten inoculated surfaces is compared to two irradiated sets, UVC1 and UVC2. The UVC source consists of four 260-280 nm power calibrated LED [5] . One half of each plate in UVC1 and UVC2 is irradiated for 180 s at 1 cm, while the other half unirradiated.

Irradiation with 260-280 nm UVC LEDs irradiation within 1 cm for 3 min. at a power density of 0.8 ± 0.04 mW/cm^2 sterilizes to a SAL ≥ 8, two orders of magnitude better than the minimum SAL of 6. Reaching a high SAL of 8 can also be useful for studies with other pathogens.

---

[1] https://www.utmb.edu/mdnews/podcast/episode/preventing-amr-from-surpassing-cancer#:~:text=In%20the%20US%2C%20there%20are,of%20worldwide%20death%20by%202050
[2] https://www.nature.com/articles/d41586-024-03033-w
[3] ISO/TS 11139 (2018).
[4] **Ultraviolet Germicidal Irradiation Handbook** UVGI for Air and Surface Disinfection, 2009, Wladyslaw Kowalski, Ed. Srpinger (2009)