



UV-Fast: Development of spaces for large-scale sterilization by ultraviolet-C (UV-C) irradiation of personal protective equipment (PPE) in hospitals for their reuse

Desenvolvimento de espaços para a esterilização por irradiação ultravioleta-C (UV-C) em larga escala de Equipamentos de Proteção Individual (EPIs) nos hospitais para a sua reutilização

FCT Project Research4Covid-19

Reference: 011_595803006

Andrea Zille, PhD

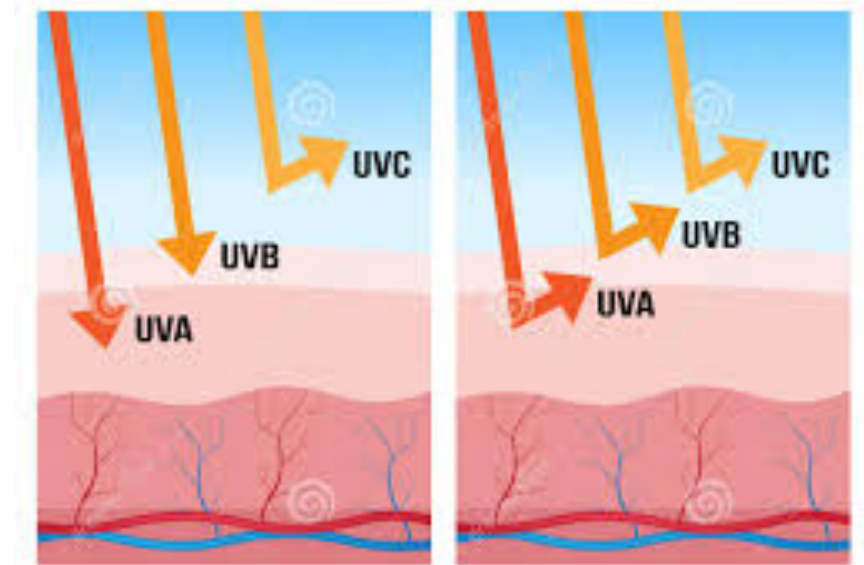
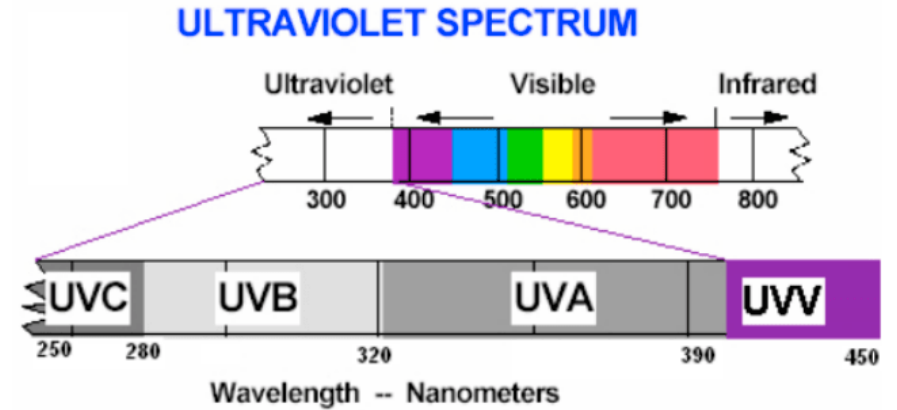


ULTRAVIOLET-C (UV-C)

Ultraviolet rays are electromagnetic waves which form part of light. Electromagnetic waves are divided into three main wavelength bands, expressed in nanometres (nm): Ultraviolet (UV) rays 100-400 nm Visible (light) rays 400-700 nm Infrared (IR) rays 700-800,000 nm.

UV rays in turn are broken down into three bands:

- UV-A (315-400 nm) with tanning properties;
- UV-B (280-315 nm) with therapeutic and vitamin “D” synthesising properties;
- UV-C (100-280 nm) with germicidal properties.

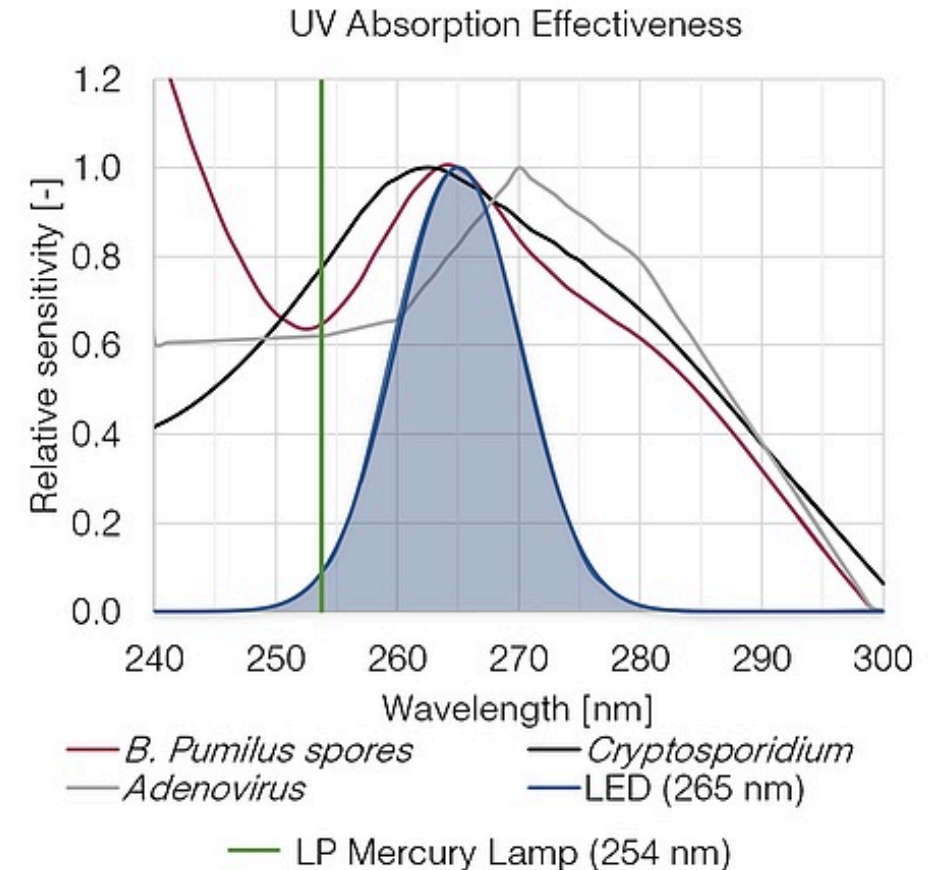


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ULTRAVIOLET-C (UV-C) STERILIZATION –THE LAMPS

The maximum UV absorbance of DNA, 260-265 nm, coincides well with peak output of low pressure mercury arc lamps at 253.7 nm.

Due to the high pressure exerted by the overwhelming patients of COVID-19 that require Hospital care, allied to SARS-CoV-2 highly infectious nature, the required PPE per each healthcare professional is numerous.

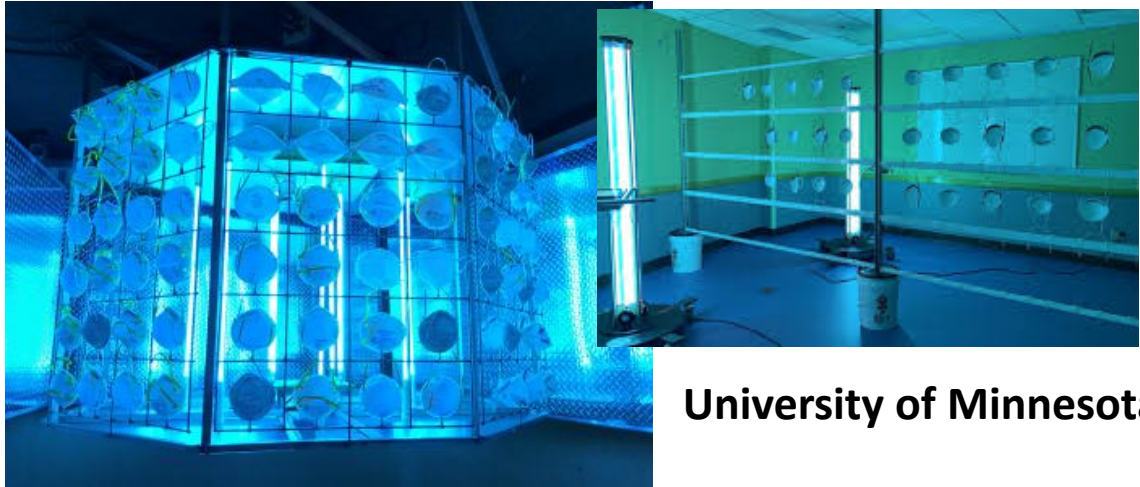


Disinfection effect is dependent on UV wavelength
Wavelength sensitivity varies by microbe
Source: S. Beck, et al. Water Research 70 (2015) 27/37

ULTRAVIOLET-C (UV-C) STERILIZATION

Development of a rooms dedicated for the large-scale sterilization of Hospital personnel protective equipment (PPE) through ultra-violet C (UV-C) envisaging their reuse.

Due to the high pressure exerted by the overwhelming patients of COVID-19 that require Hospital care, allied to SARS-CoV-2 highly infectious nature, the required PPE per each healthcare professional is numerous.



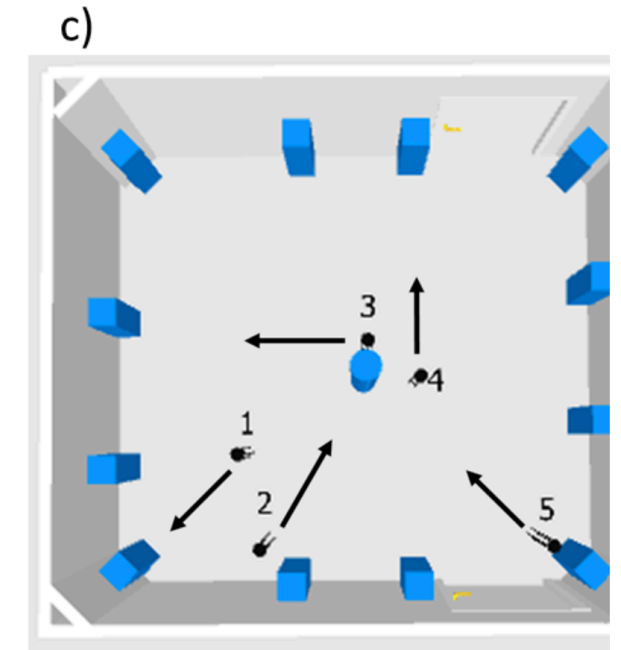
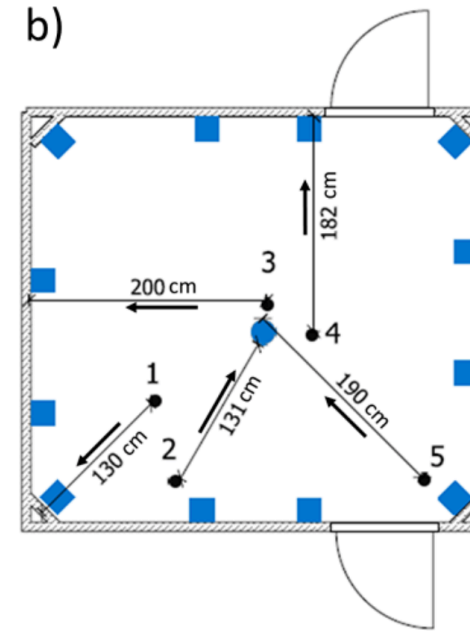
Lehigh University

University of Minnesota



Nebraska Medicine

ULTRAVIOLET-C (UV-C) STERILIZATION ROOM Pedro Hispano Hospital, Matosinhos, Portugal



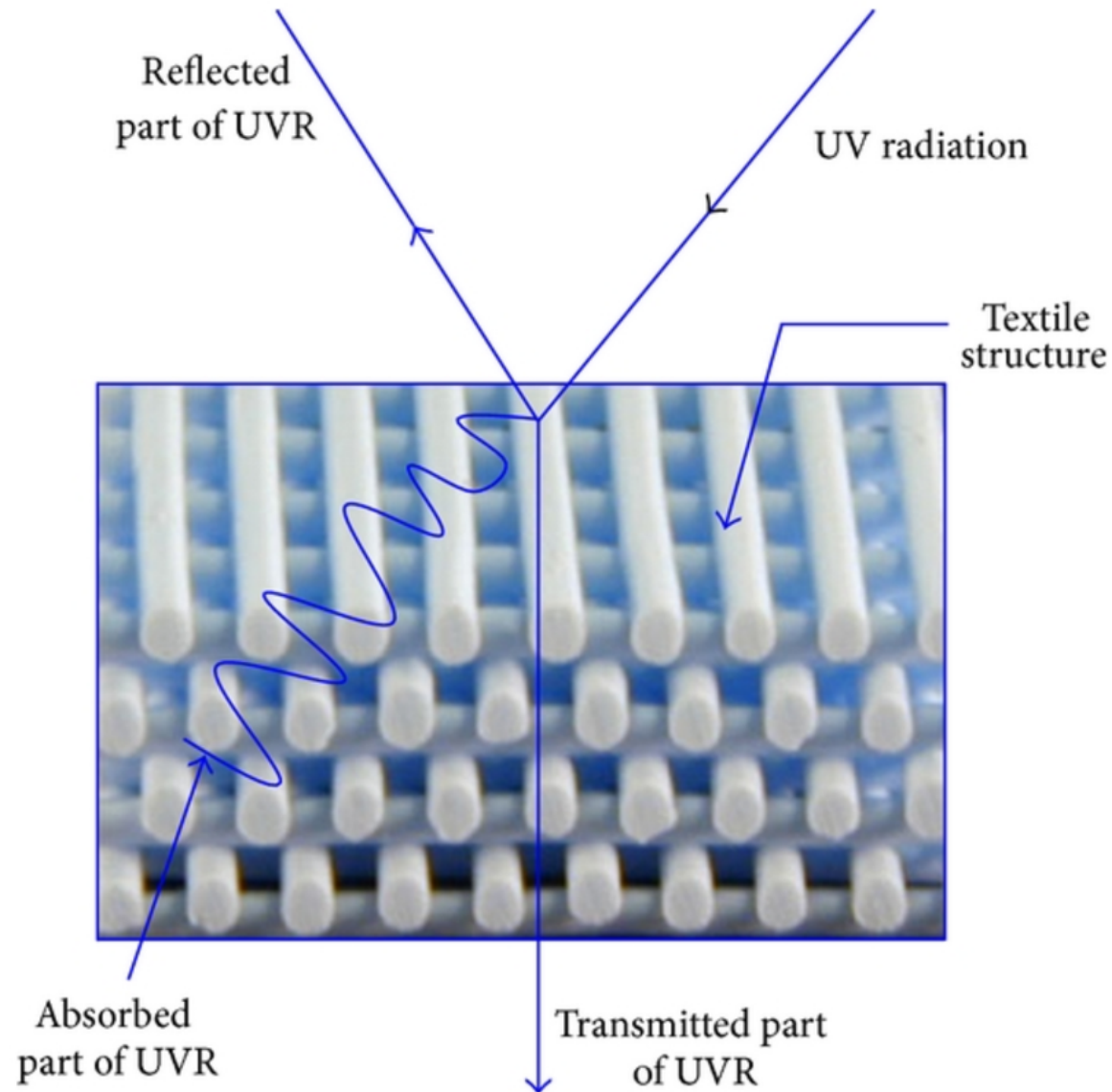
a) UV-C lights in operation, b) and c) room blue prints in 2 dimensions and 3 dimensions, respectively. The numbers depict the different sites analysed using the radiometer. The lamps and central tower are highlighted in blue, and the arrows represent the direction of the reading.

ULTRAVIOLET-C (UV-C) STERILIZATION ROOM Pedro Hispano Hospital, Matosinhos, Portugal



a) Central tower, b) Emergency stop button (2 panic buttons inside and 2 outside the room), c) Control cabinet with wireless programmer, d) Operation warning lights and door automatic magnetic locking system, e) Detail of the used UV- C lamps.

ULTRAVIOLET-C (UV-C) STERILIZATION ON TEXTILES



Textiles are volumetric materials and the effect of UV-C is not well studied. The structure and orientation of the fibers can influence the sterilization efficiency.

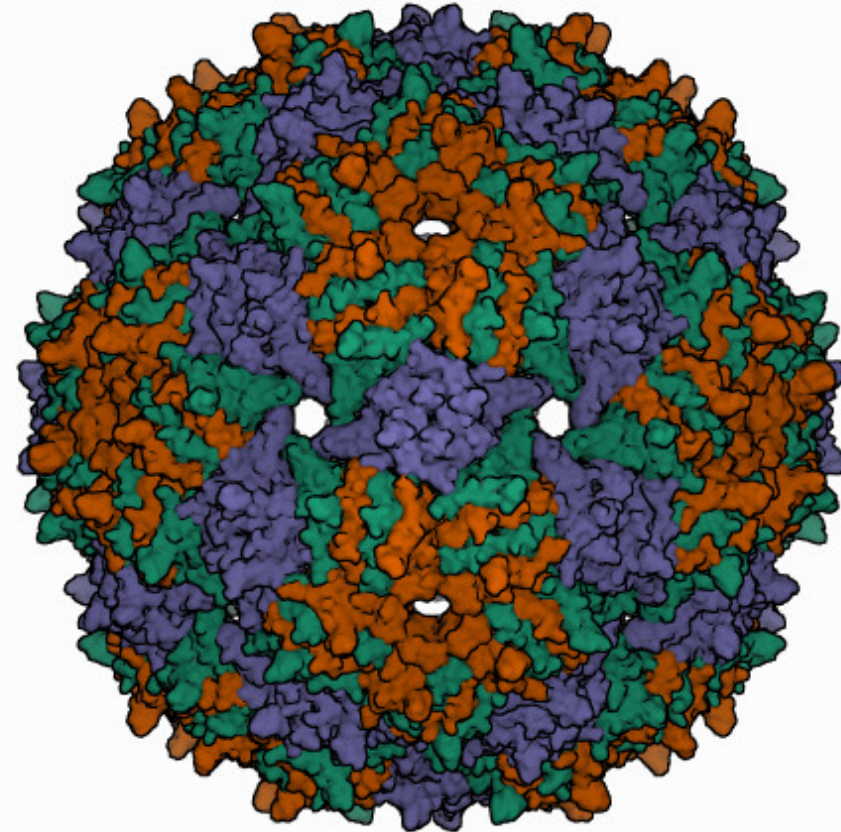
ULTRAVIOLET-C (UV-C) STERILIZATION TESTS

Three different UV-C lamps were used: 30 W, 55 W and 75 W. All lamps were heated at least for 10 min prior to each test.

The model bacteria used were:

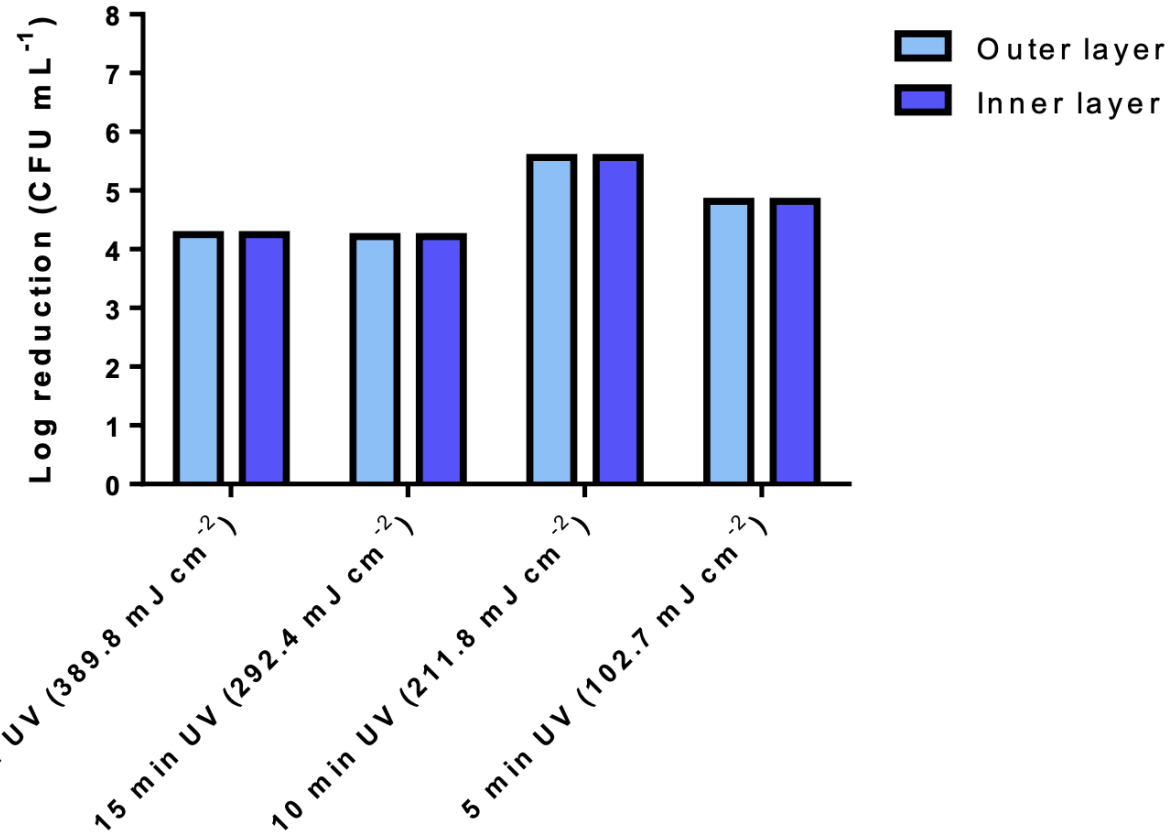
- *E. coli* ATCC® 25922TM
- *Staphylococcus aureus* ATCC® 6538TM.

Bacteriophage MS2 Virus ATCC® 15597B1TM, and *Escherichia coli* ATCC® 15597TM as its host

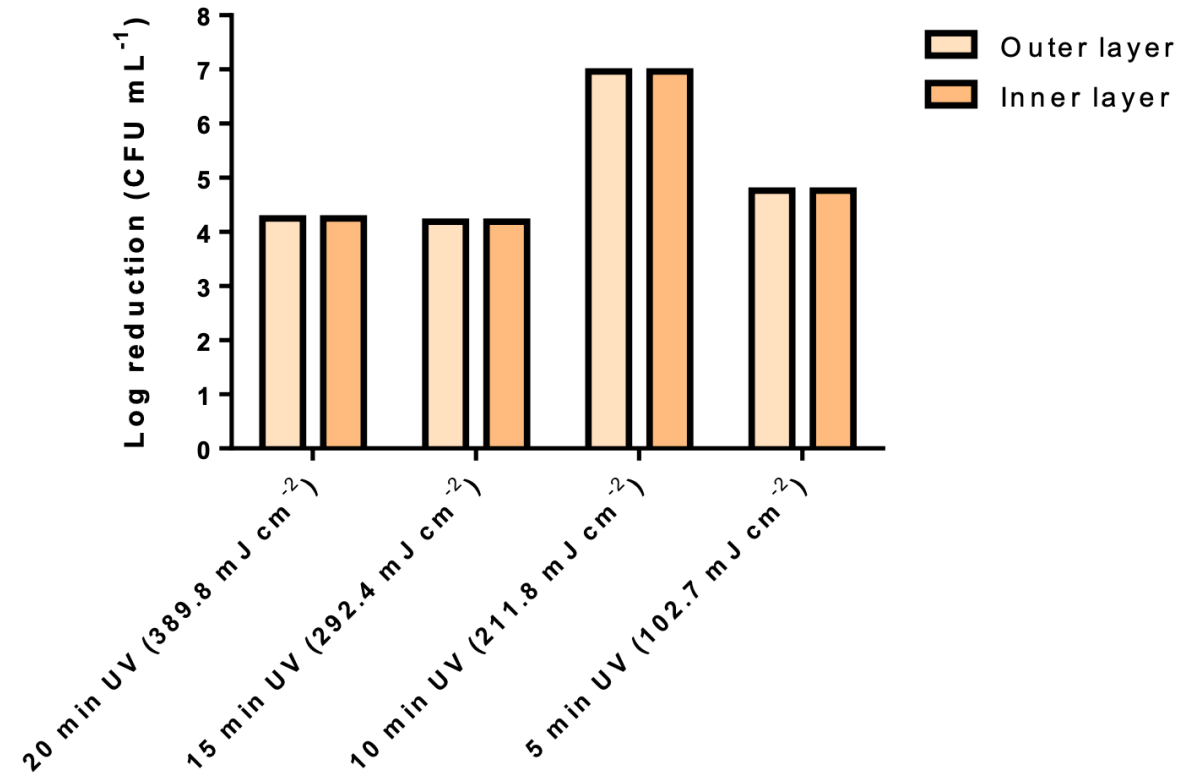


MS2 bacteriophage particle architecture, source: Protein Data Bank.

ULTRAVIOLET-C (UV-C) STERILIZATION TESTS - Bacteria

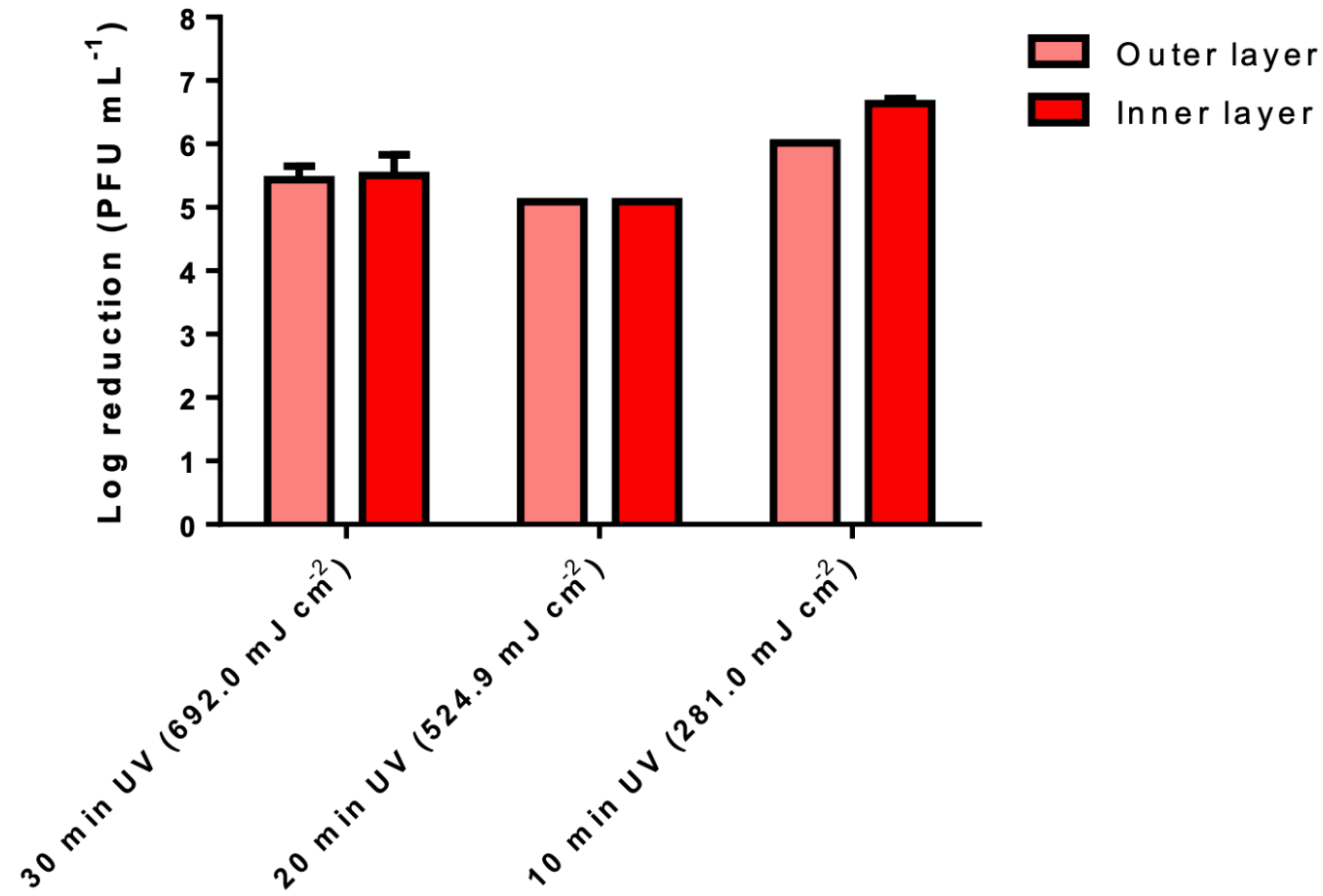
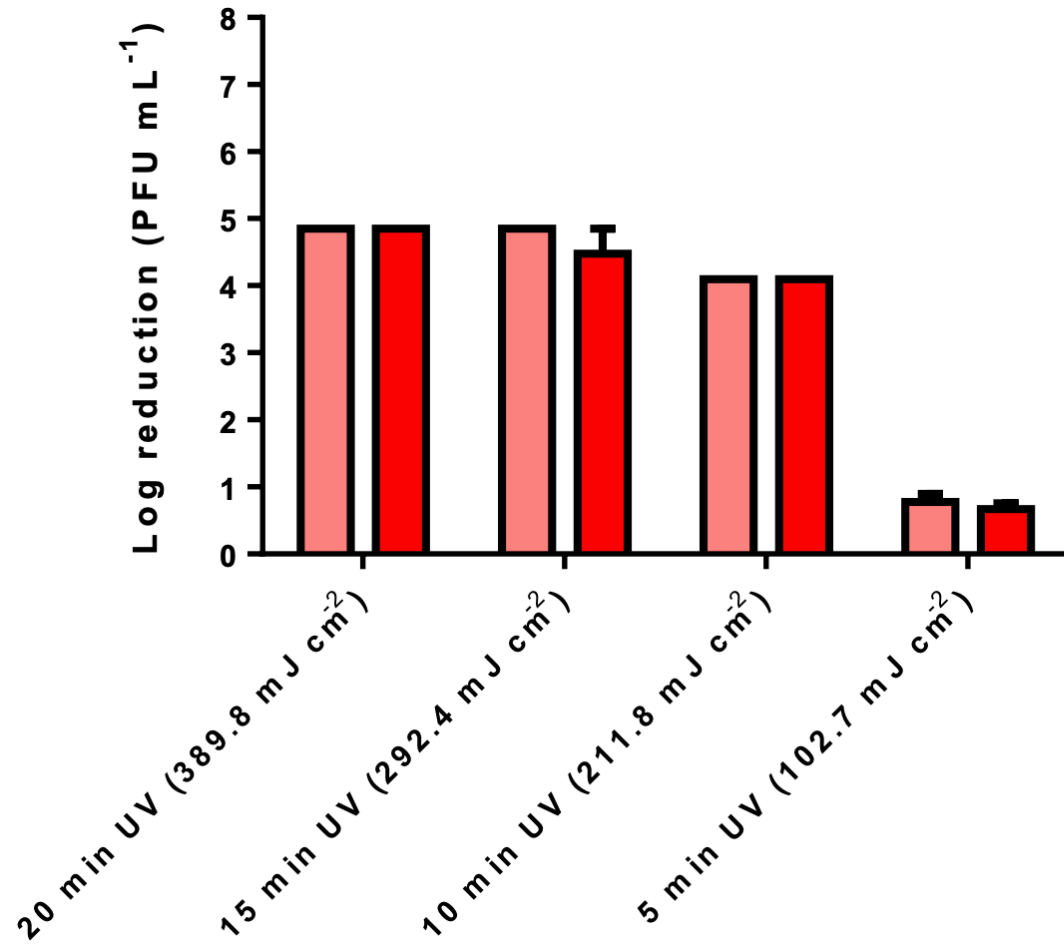


S. Aureus – Gram Positive



E. Coli – Gram Negative

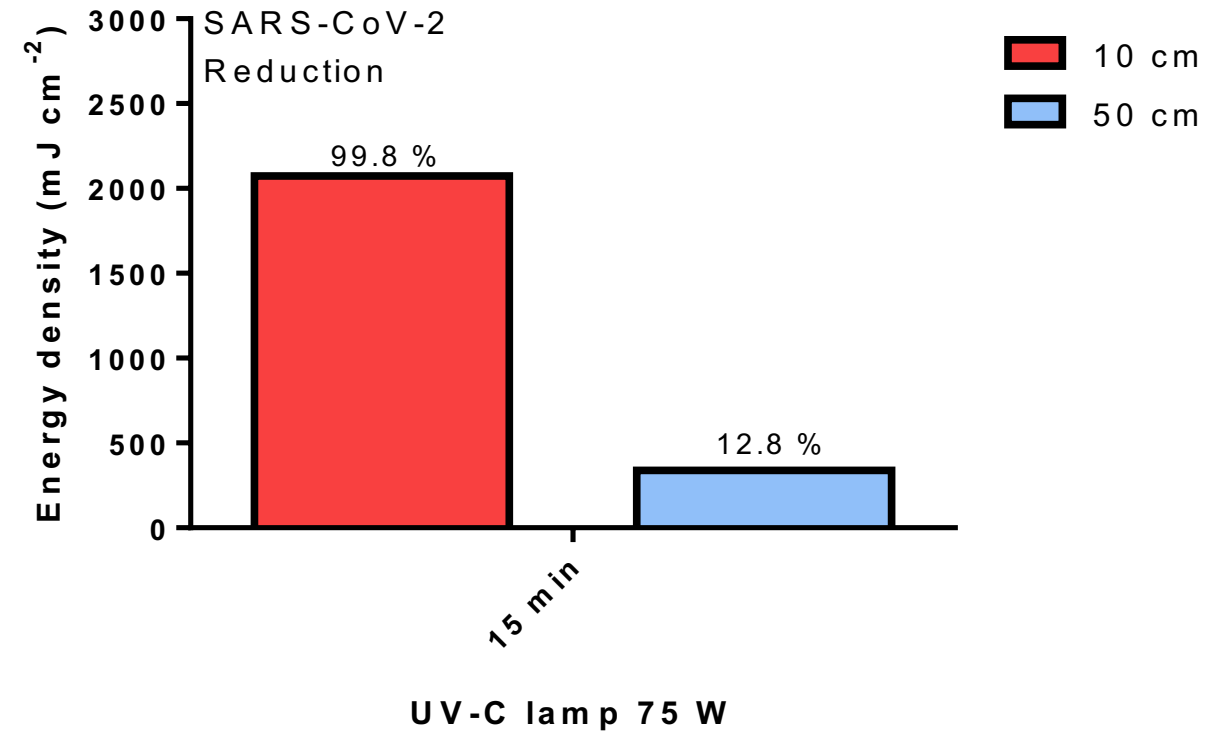
ULTRAVIOLET-C (UV-C) STERILIZATION TESTS - Virus



Bacteriophage MS2 Virus (1x10¹² PFU mL⁻¹) Log reduction using a 75 W UV-C lamp.

ULTRAVIOLET-C (UV-C) STERILIZATION TESTS – SARS-CoV-2

Duration of UV exposure (min)	Distance to UV lamp (cm)	Energy density (mJ cm ⁻²)	Ozone (ppm)	Elimination (%)
15	50	2073.5	>1	12.8*
15	10	388.9	0.9	99.8



OPEN SCIENTIFIC QUESTIONS

- 1) SARS-COV-2 virus seems more resistant of what expected.
- 2) This results on SARS-COV-2 need to be complete with a viability test to understand if the virus is inactivated before the genome destruction.
- 3) It is necessary to understand the role of the Ozone in the sterilization process of textiles
- 4) Study the interaction between the UV-C penetration and the textile structures.

THANK YOU FOR YOUR ATTENTION!

