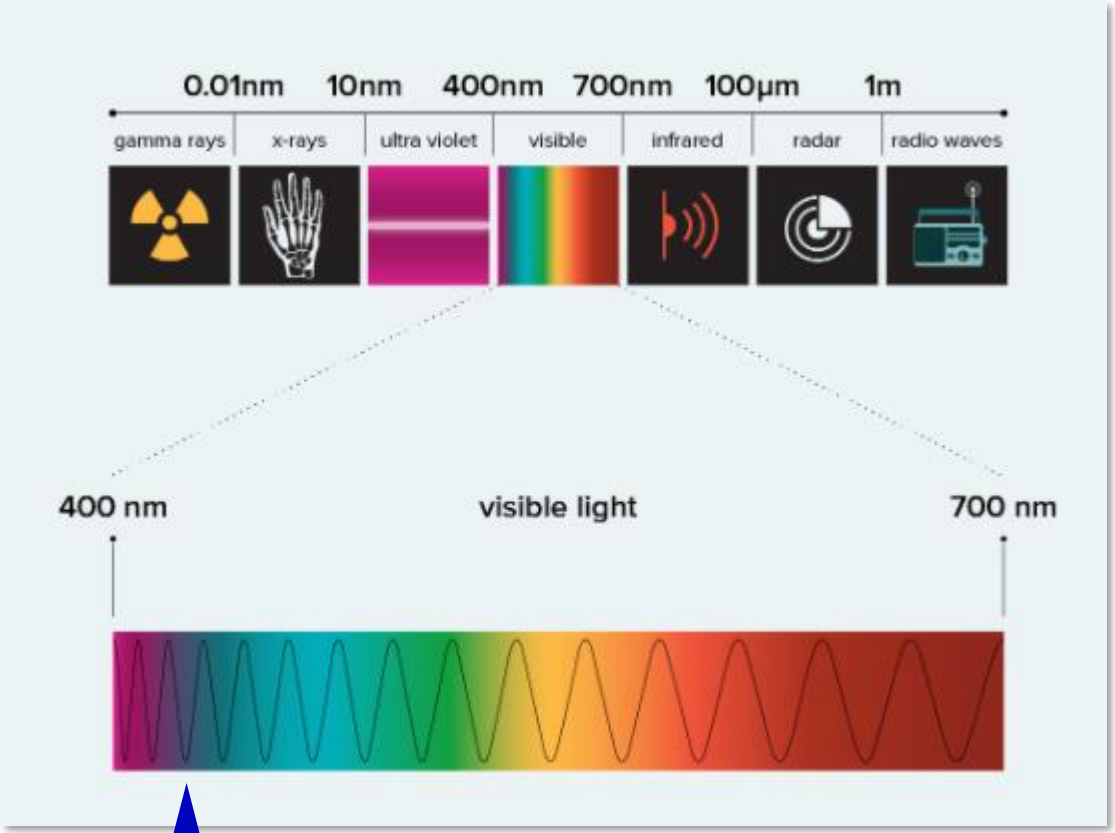
What is 405nm Blue Light Disinfection

What is 405nm visible light?



405nm

Visible light refers to the light waves which can be detected by human eye, which sit between 400nm to 700nm.

Blue light specifically lies between 400nm to 500nm in the blue/violet spectrum.

405nm is a form of blue light which was first discovered for its disinfection capability in 1892 in London.

Since then numerous tests and research papers have been conducted to demonstrate the anti-microbial nature of 405nm light.

405nm disinfection light is unique, as unlike UV light it is safe, allowing it to be applied continuously in areas that are occupied by people

405nm light
Independent Studies List

Independent Research List

Updated 14/12/2021

Sep-21	Pulsed blue light inactivates two strains of human coronavirus	https://www.sciencedirect.com/science/article/pii/S1011134421001615
May-21	Antimicrobial visible LED light is confirmed to deactivate viruses including SARS-CoV-2	https://www.ledsmagazine.com/lighting-health-wellbeing/article/14203380/antimicrobial-visible-led-light-is-confirmed-to-deactivate-viruses-including-sarscov2
Apr-21	The virucidal effects of 405 nm visible light on SARS-CoV-2 and influenza A virus	https://www.biorxiv.org/content/10.1101/2021.03.14.435337v2.full.pdf
Dec-20	Inactivation of Bacterial Pathogens following Exposure to Light from a 405-Nanometer	https://journals.asm.org/doi/10.1128/aem.01892-08?permanently=true&
Nov-20	Light-based technologies for management of COVID-19 pandemic crisis	https://www.sciencedirect.com/science/article/pii/S1011134420304498
Oct-20	The Disinfection Efficacy of 405 nm Light	https://uvsolutionsmag.com/articles/2020/the-disinfection-efficacy-of-405-nm-light/
Jan-20	Non-ionizing 405 nm Light as a Potential Bactericidal Technology for Platelet Safety	https://www.frontiersin.org/articles/10.3389/fmed.2019.00331/full
Feb-18	Efficacy of antimicrobial 405 nm blue-light for inactivation of airborne bacteria	https://www.spiedigitallibrary.org/conference-proceedings-of-spie/10479/104791G/Efficacy-of-antimicrobial-405-nm-blue-light-for-inactivation-of/10.1117/12.2289987.short?SSO=1
Feb-18	Antimicrobial blue light inactivation of Neisseria gonorrhoeae	https://ui.adsabs.harvard.edu/abs/2018SPIE10479E..0OW/abstract
Sep-17	Antimicrobial 405 nm light for clinical decontamination - Hospitals	https://pureportal.strath.ac.uk/en/studentTheses/antimicrobial-405-nm-light-for-clinical-decontamination-investiga
Sep-14	405 nm light technology for the inactivation of pathogens and its potential role for environmental disinfection and infection control	https://pubmed.ncbi.nlm.nih.gov/25066049/

Over 20 additional research papers in link below

https://worldwidescience.org/topicpages/h/high-intensity+405-nm+light.html

405nm light
Independent studies on effectiveness against coronavirus and other virus

405nm reduction on human coronavirus

https://www.sciencedirect.com/science/article/pii/S1011134421001615

Pulsed blue light inactivates two strains of human coronavirus

Chukuka S. Enwemeka [a], Violet V. Bumah [a], John L. Mokili [b]

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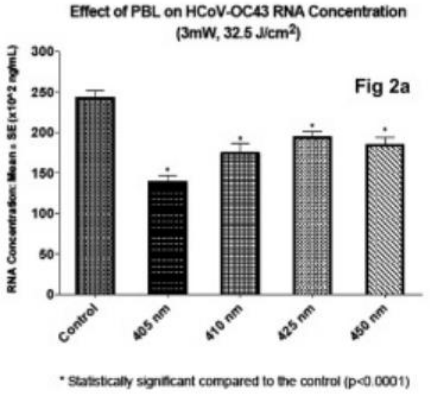
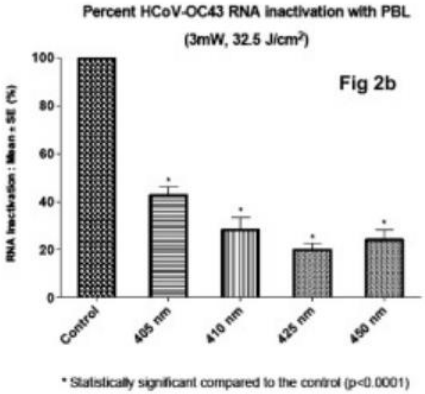
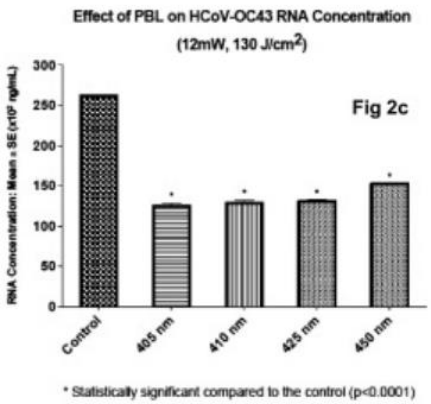
https://doi.org/10.1016/j.jphotobiol.2021.112282

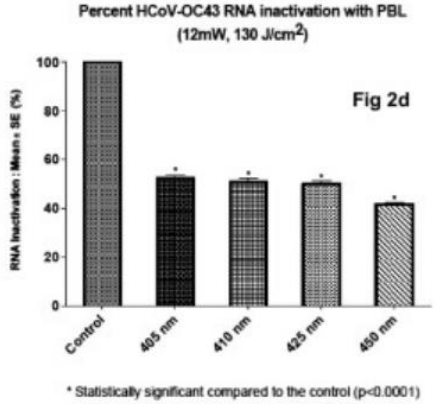
Highlights

- Pulsed blue light (PBL) inactivates multiple coronavirus strains.
- PBL inactivates surrogates of SARS-CoV-2; HCoV-229E and HCoV-OC43.
- PBL is more antiviral against beta coronavirus HCoV-OC43.
- The antiviral effect of PBL is greater at higher irradiance and dose.
- Our results suggest that 100% coronavirus inactivation is possible.









405nm reduction on human coronavirus

https://www.nature.com/articles/s41598-021-97797-0

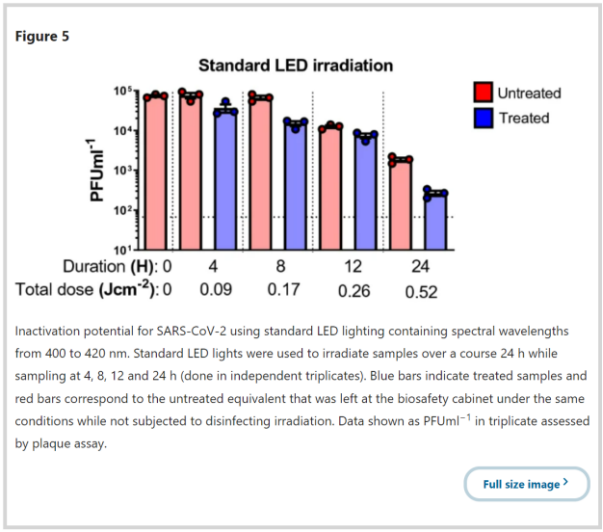
Article | Open Access | Published: 30 September 2021

The virucidal effects of 405 nm visible light on SARS-CoV-2 and influenza A virus

Raveen Rathnasinghe, Sonia Jangra, Lisa Miorin, Michael Schotsaert, Clifford Yahnke & Adolfo García-Sastre

Scientific Reports **11**, Article number: 19470 (2021) | Cite this article

2121 Accesses | **52** Altmetric | Metrics



Conclusions

We have demonstrated the basic science of inactivation of enveloped viruses such as SARS-CoV-2 and Influenza-A using 405 nm visible light within the context of the applied science required for this technology to have an impact upon the current COVID-19 pandemic. Without the need for exogenous photosensitizers and by using safe, commercially practical irradiance levels, our results can be easily translated to the clinical environment.

405nm light
Independent tests on bacteria

405nm reduction on BACTERIA Reduction after 30mins

ASM Journals / Applied and Environmental Microbiology / Vol. 75, No. 7
/ Inactivation of Bacterial Pathogens following Exposure to Light from a 405-Nanometer Light-Emitting Diode Array

17 December 2020

Inactivation of Bacterial Pathogens following Exposure to Light from a 405-Nanometer Light-Emitting Diode Array

Authors: Michelle Maclean, Scott J. MacGregor, John G. Anderson, and Gerry Woolsey | AUTHORS INFO & AFFILIATIONS

FIG. 2.

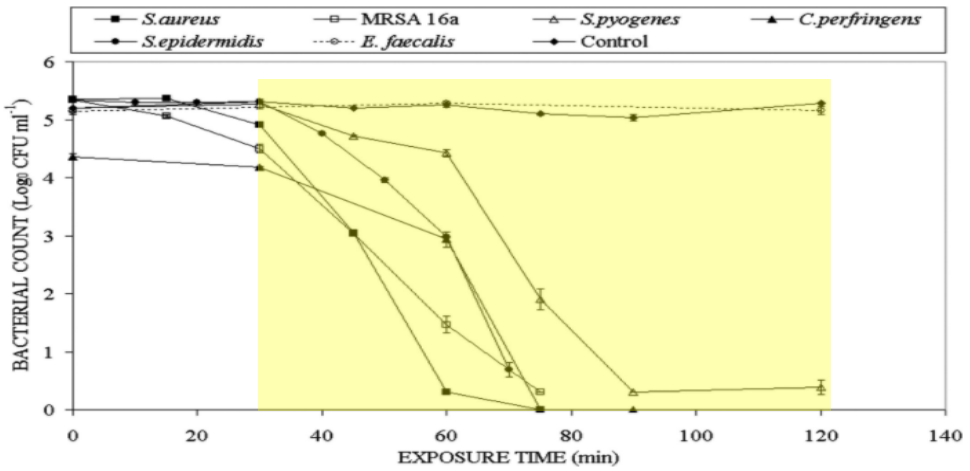


FIG. 2. Results of 405-nm light inactivation of MRSA and other medically important gram-positive bacteria at an irradiance of 10 mW cm^{-2}.

https://journals.asm.org/doi/10.1128/aem.01892-08?permanently=true&

'This study has successfully demonstrated the bactericidal effect of visible 405nm light on selected medically important gram-positive and gram-negative bacteria.'

405nm reduction on BACTERIA
11 different bacteria organisms effectively reduced

TABLE 2 Energy densities and germicidal efficiencies for the inactivation of a range of bacterial species using narrow-spectrum 405-nm light

Organism[a]	Dose (J cm^{-2})	Log_{10} reduction	Dose/log_{10} reduction	GE (% uncertainty)[b]
Staphylococcus aureus	36	5	7.2	0.14 (±2)
MRSA	45	5	9	0.11 (±0)
Staphylococcus epidermidis	42	4.6	9.1	0.11 (±4)
Clostridium perfringens	45	4.4	10.2	0.10 (±2)
Streptococcus pyogenes	54	5	10.8	0.09 (±5)
Acinetobacter baumannii	108	4.2	25.7	0.04 (±7)
Proteus vulgaris	144	4.7	30.6	0.03 (±5)
Pseudomonas aeruginosa	180	4.2	42.9	0.02 (±4)
Klebsiella pneumaniae	180	3.9	46.2	0.02 (±8)
Escherichia coli	180	3.1	58.1	0.02 (±5)
Enterococcus faecalis	216	2.6	96	0.01 (±0)

https://journals.asm.org/doi/10.1128/aem.01892-08?permanently=true&

'This study has successfully demonstrated the bactericidal effect of visible 405nm light on selected medically important gram-positive and gram-negative bacteria.'

405nm significant antimicrobial properties Bacteria and fungi

405 nm light technology for the inactivation of pathogens and its potential role for environmental disinfection and infection control

M Maclean [1], K McKenzie [2], J G Anderson [2], G Gettinby [3], S J MacGregor [2]

Affiliations + expand

PMID: 25066049 DOI: 10.1016/j.jhin.2014.06.004

Free article

Abstract

Background: Although the germicidal properties of ultraviolet (UV) light have long been known, it is only comparatively recently that the antimicrobial properties of visible violet-blue 405 nm light have been discovered and used for environmental disinfection and infection control applications.

Aim: To review the antimicrobial properties of 405 nm light and to describe its application as an environmental decontamination technology with particular reference to disinfection of the hospital environment.

Methods: Extensive literature searches for relevant scientific papers and reports.

Findings: A large body of scientific evidence is now available that provides underpinning knowledge of the 405 nm light-induced photodynamic inactivation process involved in the destruction of a wide range of prokaryotic and eukaryotic microbial species, including resistant forms such as bacterial and fungal spores. For practical application, a high-intensity narrow-spectrum light environmental disinfection system (HINS-light EDS) has been developed and tested in hospital isolation rooms. The trial results have demonstrated that this 405 nm light system can provide continuous disinfection of air and exposed surfaces in occupied areas of the hospital, thereby substantially enhancing standard cleaning and infection control procedures.

Conclusion: Violet-blue light, particularly 405 nm light, has significant antimicrobial properties against a wide range of bacterial and fungal pathogens and, although germicidal efficacy is lower than UV light, this limitation is offset by its facility for safe, continuous use in occupied environments. Promising results on disinfection efficacy have been obtained in hospital trials but the full impact of this technology on reduction of healthcare-associated infection has yet to be determined.

Keywords: Disinfection; Environment; Hospital-acquired infection; Infection control; Pathogens; Violet–blue 405nm light.

https://pubmed.ncbi.nlm.nih.gov/25066049/

‘405nm light, has significant antimicrobial properties against a wide range of bacterial and fungal pathogens and, although germicidal efficacy is lower than UV light, this limitation is offset by its facility for safe continuous use in occupied environments.’

405nm reduction on BACTERIA: neisseria gonorrhoeae

https://ui.adsabs.harvard.edu/abs/2018SPIE10479E..0OW/abstract

‘405nm reduced the bacteria CFU by 7.16-log10’ (+99.99%)

Antimicrobial blue light inactivation of Neisseria gonorrhoeae

Show affiliations

Wang, Ying ; Gu, Ying ; Dai, Tianhong

Neisseria gonorrhoeae is a human-adapted, gram-negative diplococcus that infects human reproductive tracts and causes gonorrhea, a sexually transmitted disease, resulting in discharge and inflammation at the urethra, cervix, pharynx, or rectum. Over the years, N. gonorrhoeae has developed resistance to nearly every drug ever used to treat it, including sulfonamides, penicillin, tetracycline, and fluoroquinolones. Drug-resistant N. gonorrhoeae is now considered by the Centers for Disease Control and Prevention (CDC) as an urgent threat. The present study aimed to evaluate the efficacy of antimicrobial blue light (aBL) at 405 and 470 nm for inactivating N. gonorrhoeae and reveal the mechanism of action. Our results showed that an exposure of 45 J/cm^2 aBL at 405 nm reduced the bacterial CFU by 7.16-log$_{10}$. When the aBL exposure was increased to 54 J/cm^2, eradication of bacterial CFU was achieved. When the bacteria were exposed to aBL at 470 nm, 3-log$_{10}$ reduction of CFU was observed at an aBL exposure of higher than 126 J/cm^2. Absorption and fluorescence spectroscopic analyses revealed the presence of endogenous porphyrins and flavins in N. gonorrhoeae cells. The present study indicated that aBL is a potential strategy to control N. gonorrhoeae infections. Endogenous porphyrins play a vital role in the killing effects of aBL. In vivo experiments are ongoing in our laboratory to treat genital tract infections in mice using aBL and explore the potential clinical applications.

Publication: Proceedings of the SPIE, Volume 10479, id. 104790O 6 pp. (2018).

Pub Date: February 2018

DOI: 10.1117/12.2291545

Bibcode: 2018SPIE10479E..0OW

405nm reduction on BACTERIA: S.aureus

https://www.frontiersin.org/articles/10.3389/fmed.2019.00331/full

'all light irradiances used, successful reduction of the bacterial contamination was achieved'

Non-ionizing 405 nm Light as a Potential Bactericidal Technology for Platelet Safety: Evaluation of *in vitro* Bacterial Inactivation and *in vivo* Platelet Recovery

Results

Figure 2 demonstrates the efficacy of 405 nm light for decontamination of PLT bags seeded with low density *S. aureus*, using the 4 fixed irradiance levels, over time. It can be seen that at all light irradiances used, successful reduction of the bacterial contamination was achieved. By 8 h exposure <0.5% contamination was detected with all irradiances used. Analysis of the inactivation kinetics of each of the 4 irradiances, demonstrated that inactivation was most effective with the highest, 10 $mWcm^{-2}$, irradiance: contamination levels decreased in a constant downward trend from 1 h, with 0.3% remaining by 8 h. With the other 3 irradiances used, contamination levels remained consistent over the first 4 h, with the majority of the inactivation (>92.5%) achieved by 6 h exposure—similar to the 10 $mWcm^{-2}$ treatment. Statistical analysis demonstrated that, at most exposure times (1–4, 6, and 8 h), the levels of bacterial inactivation achieved were statistically similar despite the use of different irradiance levels ($P > 0.05$). The sample-to-sample variation in PLT transmissibility (Figure 1A) is likely a contributing factor to the degree of deviation observed in some of the inactivation data, and consequently impacting statistical analysis. Regardless, significant differences in the degree of inactivation achieved at fixed time periods were detected at 5 h ($P = 0.001$), and 7 h ($P = 0.006$) (Figure 2). Bacterial contamination in non-treated control samples, showed no decrease over the 8 h period.

What testing has been conducted on Clean Edge

Clean Edge has been successfully tested to reduce bacteria, virus and germs across 5 accredited labs globally.

Test Laboratory	Test Organisms	Test Conditions	Test Result
Eurofins ams Laboratories Pty Ltd	MHV-1 (Surrogate virus for coronavirus as per TGA guidelines for disinfectant efficacy tests on for coronavirus)	- 2 meters from 405nm light - 4hrs, 24hrs exposure	- **99.92% reduction after 4hrs** - **96.20% reduction after 24hrs due to the natural death in control carrier**
Intertek Testing Services Singapore Pte Ltd	Staphylococcus aureus ATCC 6538	- 2 meters from 405nm light - 30min, 3hrs, 9hrs, 24hrs exposure	- **76.7% reduction after 30min** - **89.0% reduction after 3hrs** - **98.7% reduction after 9hrs** - **99.9% reduction after 24hrs**
	Staphylococcus aureus ATCC 6538	- 3 meters from 405nm light - 30min, 3hrs, 9hrs, 24hrs exposure	- **56.4% reduction after 30min** - **67.0% reduction after 3hrs** - **91.7% reduction after 9hrs** - **99.8% reduction after 24hrs**
KR Biotech Co Ltd	Corona virus (SARS-CoV-2)	- 50 cm from405nm light - 60min, 120min exposure	- **97.34% reduction after 60min** - **99.16% reduction after 120min**
Korea Conformity Laboratories	Escherichia coli ATCC 25922 Staphylococcus aureus ATCC 6538 Klebsiella pneumoniae ATCC 4352 MRSA	- 1 meter from 405nm light - 24hrs exposure	- **99.9% reduction for all test organisms**
Korea Testing & Research Institute	Salmonella typhimurium ATCC 13311 Listeria monocytogenes ATCC 19111	- 1 meter from 405nm light - 24hrs exposure	- **+98% reduction for Salmonella** - **+99% reduction for Listeria**

Efficacy Test Result by eurofins | ams

- Test Laboratory: Eurofins ams Laboratories Pty Ltd
- Test Organism: MHV-1 (Surrogate viruses for use in disinfectant efficacy tests to justify claims against COVID-19 ; https://www.tga.gov.au/surrogate-viruses-use-disinfectant-efficacy-tests-justify-claims-against-covid-19)
- Test Duration: 4hrs, 24hrs
- Distance: **2 meters from 405nm light**
- Test Result:

Virus log ^{10}	Control (t=0)	Control (t=4)	Control (t=24)	Test (t=4 hours)	Test (t=24 hours)
Log^{10}	8.33	8.33	4.75	5.25	3.33
Log reduction	n/a	n/a	n/a	3.08	1.42
% reduction	n/a	n/a	n/a	99.92	96.20

99.92%

Efficacy Test Result by intertek

Total Quality. Assured.

- Test Laboratory: Intertek Testing Services Singapore Pte Ltd
- Test Organism: Staphylococcus aureus ATCC 6538
- Test Duration: 30mins, 3hrs, 9hrs, 24hrs
- Distance: **2 meters from 405nm light**
- Test Result:

Test Duration (2m from light source)	Results		
	Control Sample	Test Sample	Reduction rate
0 min	1.2 x 10^4 cfu/ml	1.2 x 10^4 cfu/ml	0%
30 minutes	1.2 x 10^4 cfu/ml	2.8 x 10^3 cfu/ml	76.7%
3 hours	1.0 x 10^4 cfu/ml	1.1 x 10^3 cfu/ml	89.0%
9 hours	9.3 x 10^3 cfu/ml	1.2 x 10^2 cfu/ml	98.7%
24 hours	8.2 x 10^3 cfu/ml	<10 cfu/ml	99.9%

99.9%

- Test Laboratory: Intertek Testing Services Singapore Pte Ltd
- Test Organism: Staphylococcus aureus ATCC 6538
- Test Duration: 30mins, 3hrs, 9hrs, 24hrs
- Distance: **3 meters from 405nm light**
- Test Result:

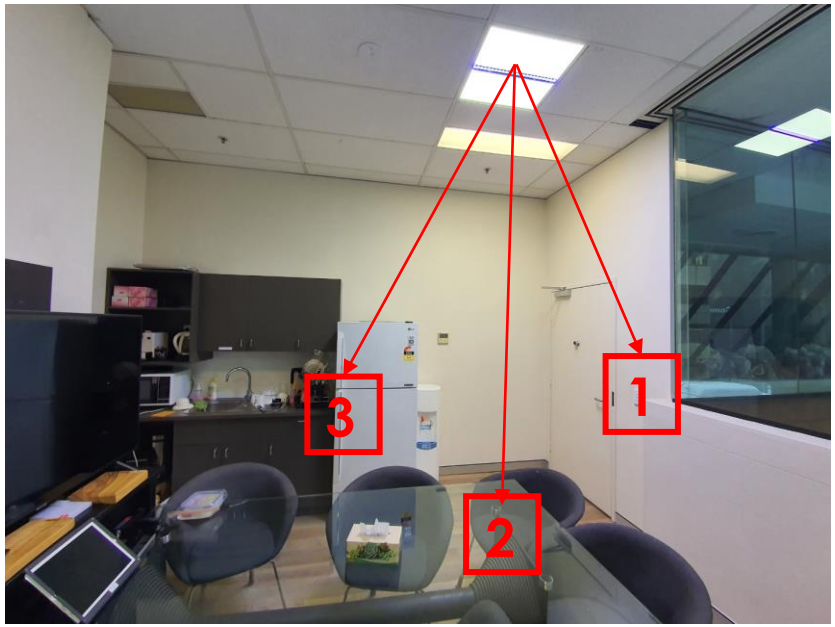
Test Duration (3m from light source)	Results		
	Control Sample	Test Sample	Reduction rate
0 min	1.1 x 10^4 cfu/ml	1.1x 10^4 cfu/ml	0%
30 minutes	1.1 x 10^4 cfu/ml	4.8x 10^3 cfu/ml	56.4%
3 hours	1.0 x 10^4 cfu/ml	3.3 x 10^3 cfu/ml	67.0%
9 hours	9.0 x 10^3 cfu/ml	7.5 x 10^2 cfu/ml	91.7%
24 hours	6.1 x 10^3 cfu/ml	10 cfu/ml	99.8%

99.8%

Proof of Concept Testing
Clean Edge - Retail Staff Room

Real-world test was conducted at an installation in a staff/kitchen room at Sydney Duty Free where a swap test via an ATP tester was conducted for 24hrs before and after on high-touch surfaces, within a real life environment e.g. doors being opened, external wind from outside coming in, causing potential germs to repopulate and spread while the light continued to disinfect.

This was another breakthrough result, as it highlighted the ability for the Clean Edge lights to not only reduce but to **MAINTAIN** a low germ environment in real life settings. This is possible because it's a continuous solution, as opposed to manual cleaning which quickly removes germs, however lacks a continuous cleaning solution, where at times hundreds or thousands of people can repopulate germs between cleans.



Light Switch
Distance – 2.3m
Before count – 4173
After count– 426

1.
90%

Table
Distance – 2.2M
Before count – 5445
After count – 444

2.
92%

Refrigerator Handle
Distance – 2.6M
Before count – 5224
After count – 246

3.
95%

Certificate and Approval Summary for Clean Edge

Certificates	Standards	Mark
CE Marking	- LVD Directive 2014/35/EU - EMC Directive 2014/30/EU - RoHS Directive 2011/65/EU recasting 2002/95/EC - Directive 2015/863/EU	
IECEE CB Scheme	- IEC 60598-1:2014/AMD1:2017 - IEC 60598-2-2:2011	
IEC62471A	- IEC 62471:2006	
EMC Test	- CISPR 15:2013+AMD1:2015 - AS/NZS CISPR 15:2017 - IEC 61647:2009 - IEC 61000-3-2:2018 - IEC 61000-3-3:2013+AMD1:2017	
Australian Approbation	- Electrical Safety as Level 1 based on CB Test Report, Photobiological Safety Test Report, PAHS Chemical Testing Report - Electrical Equipment Safety System (EESS) and Regulatory Compliance Mark (RCM) - Electromagnetic Compatibility (EMC)	

Supply Capability

Company Introduction & History

Maltani Co., Ltd. – the manufacturer

Since 1984, Korea's largest lighting company specialized in lighting production with eco friendly tech & design

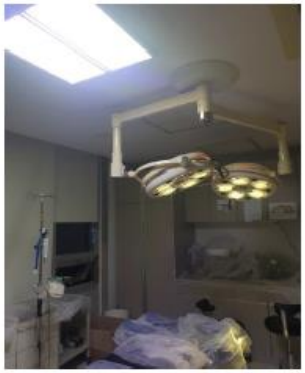
With world-class pioneering & designing skills, the company was acknowledged in the global market for their consistent effort and results in new product development, R&D and quality control processes for the LED light industry.

CLEAN EDGE uses VIOLEDs lighting, a patented technology also used in NASA's space station for sterilization management

VIOLED technology was co-developed by the Korean company Seoul Viosys, the number 1 market share leader for UV LEDs with over 4000 patents and SETi US based company and globally recognised developer of UV LED products.

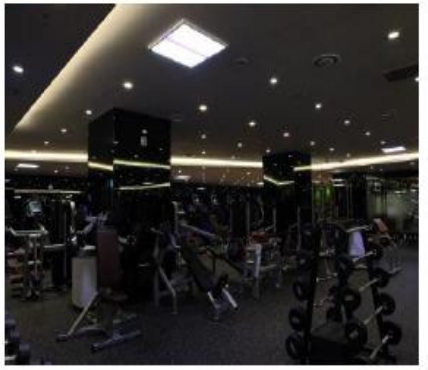
HOSPITAL, HEALTH & ACCOMODATION









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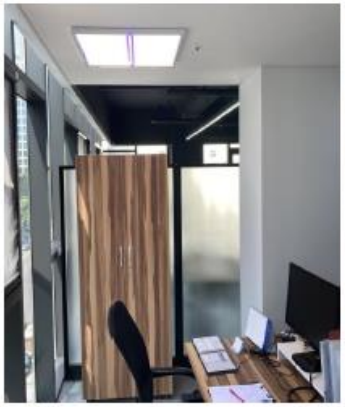
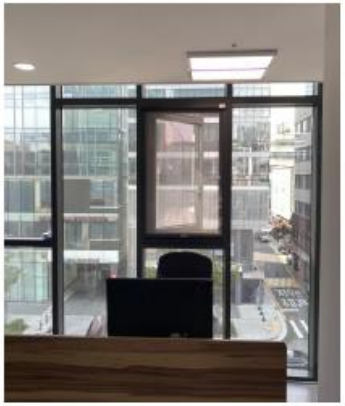



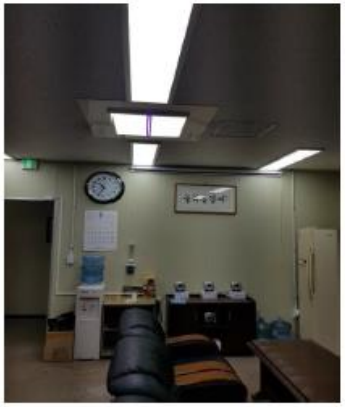






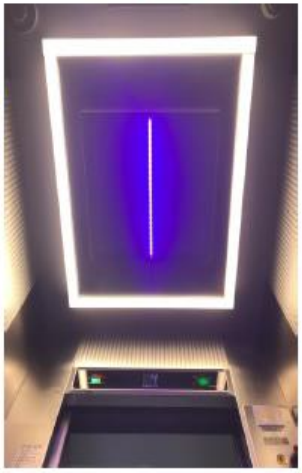
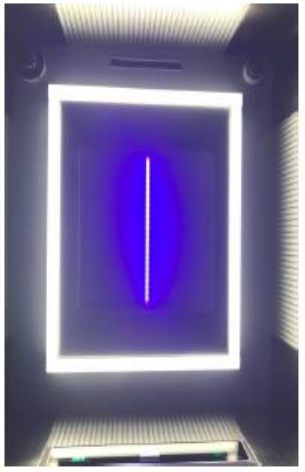

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