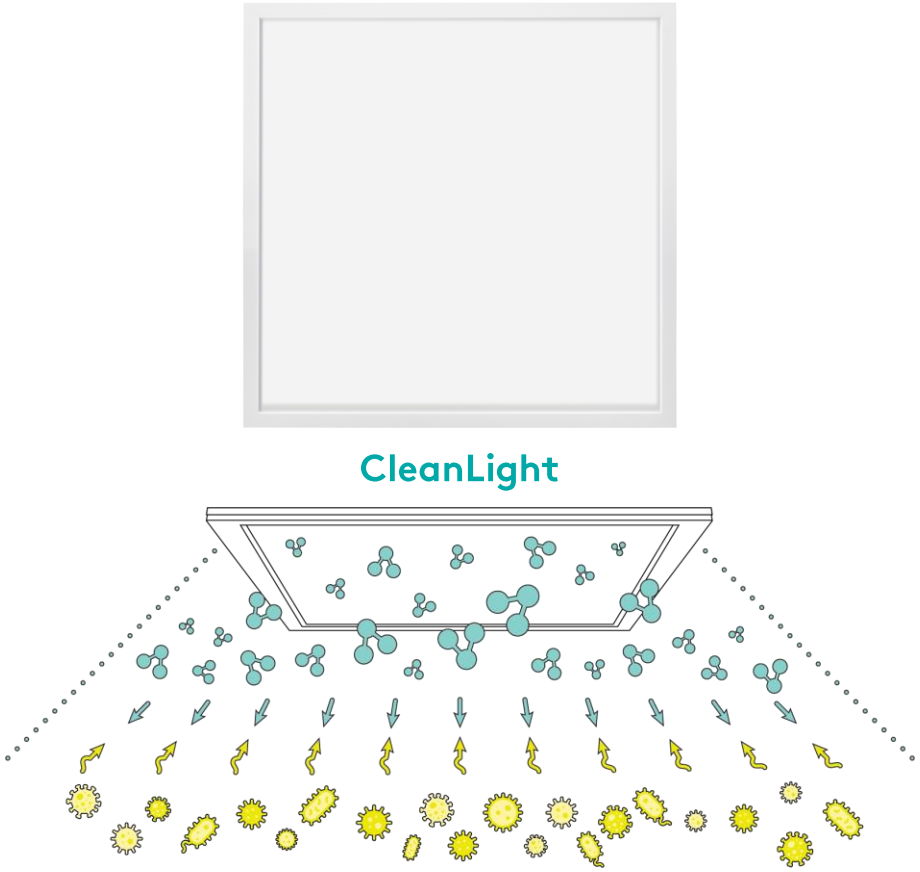
LIGHTICO

The science of infection control with TiO_2



CleanLight

CleanLight uses Titanium dioxide (TiO_2) as a photocatalyst to generate an area of Photocatalytic Oxidation that is able to inactivate pathogens (like bacteria and viruses).

Titanium dioxide (TiO_2) has been widely used as a photocatalyst in many environmental and energy applications due to its efficient photoactivity, high stability, low cost, and safety to the environment and humans.

Photocatalysis is the activity occurring **when a light source interacts with the surface of semiconductor materials**, the so called photocatalysts. CleanLight uses TiO_2 as a photocatalyst.

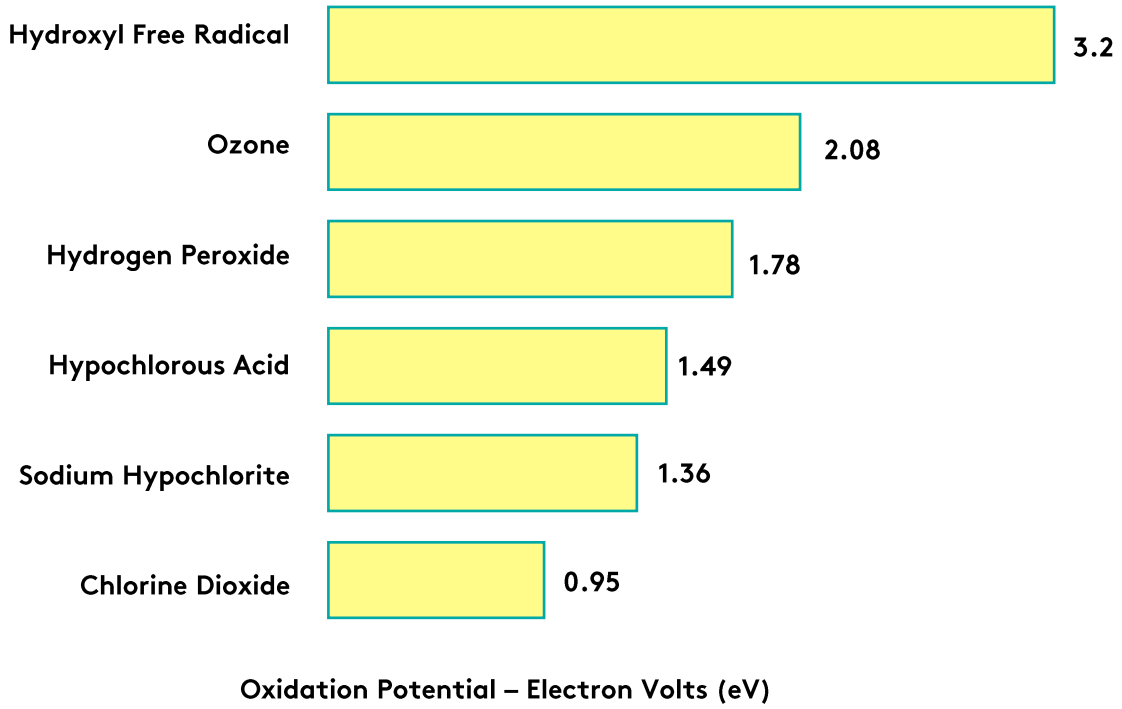
This technology was first identified by AKIRA FUJISHIMA & KENICHI HONDA in 1972 and was quickly utilised in the reduction of cyanide in water.

UV radiation of 320-380 nm has been previously used to excite the photocatalyst (TiO_2). However long term exposure of the skin to this level of radiation can be harmful to human skin.

CleanLight does not use UV light

CleanLight uses light on the visible spectrum to excite the photocatalyst (TiO_2) and generate Photocatalytic Oxidation (PCO), oxidising pathogens that come into range. By using light on the visible spectrum this process is created safely by replacing existing LED lights already in use in most environments.

PCO is proven to safely kill viruses & bacteria



Oxidation Potential

The differing oxidation potential, or disinfection ability of similar types of disinfection is measured in Electron Volts and provide an Oxidation Potential.

By exciting the TiO_2 CleanLight photocatalytic oxidation is generated which releases Hydroxyl Free Radicals. It is there free radicals that attached micro organisms, changing their structure and destroying the bonds that link the carbon and oxygen atoms.

Other methods and substances that use a similar process are things like Ozone and Hydrogen Peroxide. However there are risks to humans and animals while these materials are being used meaning that spaces need to be sealed during their application.

With an oxidation potential of 3.2 eV, Hydroxyl Free Radicals generated by TiO_2 PCO are significantly more efficient at deactivating pathogens that bleach (Hydrogen Peroxide)

The excited photocatalyst (TiO_2) on the surface of CleanLight generates Photocatalytic Oxidation (PCO) with more efficiency and with less risk to humans and animals than similar methods currently being used to deep clean environments.

CleanLight is the safest and most efficient cleaning solution

Independent Validation by Dr Carl Edwards

All the data presented in the pack has been independently inspected and validated my Dr Carl Edwards of the University of Leicester.

Dr Edwards, a commercial manager at Leicester University with over 35 years commercial and academic experience in clinical science and microbiology reviewed the data as part of his work with the Leicester Life Sciences Accelerator.

He provided written confirmation to Lightico as to our interpretation of the data confirming its validity and also provided his own summary as to the efficacy of the product.

An extract of the letter he provided is supplied here...

I would like to comment that the data provided confirms a good performance as an anti-bacterial and anti-fungal product against an internationally recognised range of organisms used for assessing disinfectant properties.

The CleanLight product produced significant reductions in E. coli, S. aureus, K. pneumoniae and C. albicans; that would be appropriate with it being regarded as a disinfectant product.

The additional research also shows CleanLight has a significant activity against SARS-CoV-2. This would be expected given the results against bacteria and fungi, but the explicit evidence provides additional support for the CleanLight being a generally applicable disinfectant product.

The intended use of CleanLight as part of a whole room hygiene solution is well supported by the data that has been generated. The exposure times of approximately an hour, generating 80-99% decrease in viable organisms, would translate well into reducing the microbial burden of a space illuminated constantly throughout a working day.

Testing for SARS-CoV-2

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the technical name of the virus that causes the coronavirus disease, COVID-19. As of January 2021 over 1.84m people worldwide have died from COVID-19.

Tests were conducted to quantify the effectiveness of CleanLight against airborne SARS-CoV-2.

Active SARS-CoV-2 was placed on a lab plaque, 15 cm below the light panel surface. The light and test sample were placed in a $6m^3$ sterilised chamber. No air movement to applied to the chamber.

The light was switched on and samples taken at specific 15 minute intervals.

Over the course of 60mins exposure to CleanLight the following levels of viral load were recorded:

Time sample taken	Viral Load Reduced
15 mins	0%
30 mins	28%
45 mins	43%
60 mins	72%

In laboratory conditions CleanLight is PROVEN to kill SARS-CoV-2.

Current research identifies the half-life of SARS-CoV-2 when airborne at 3 hours* increasing the risk of transmission and surface contamination significantly.

van Doremalen N, Bushmaker T, Morris DH, et al. Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. *The New England Journal of Medicine*. 2020 Apr;382(16):1564-1567. DOI: 10.1056/NEJMc2004973

Testing for MRSA

Staphylococcus aureus (MRSA) is a type of bacteria that's resistant to several widely used antibiotics. This means infections with MRSA can be harder to treat than other bacterial infections.

The full name of MRSA is meticillin-resistant *Staphylococcus aureus*. Often called a "superbug".

Tests were conducted by the Guang Zhou Institute of Microbiology to quantify the effectiveness of CleanLight against MRSA.

MRSA was released into a $3m^3$ sealed test chamber and samples were taken after 60min exposure to CleanLight. These results were compared to the level of bacteria in the chamber after 60mins without the light turned on.

After 3 x 60mins exposure to CleanLight following bacteria levels were recorded:

	Original Bacteria Count	Bacteria Count after Treatment	Reduction
Test 1	1.17×10^5	1.12×10^4	90.4%
Test 2	1.10×10^5	1.13×10^4	89.7%
Test 3	1.14×10^5	1.16×10^4	89.8%

In laboratory conditions CleanLight is PROVEN to kill 90% of MRSA bacteria.

From over 80,000 cases of bacterial infections in the UK (including MRSA) over 12,000 people die*. MRSA accounts for an extra 1 million extra hospital days at the cost of £380m**

*Thirty-day all-cause mortality following MRSA, MSSA and Gram-negative bacteraemia and C. difficile infections – PHE – 2018/19
**Costs of healthcare-associated methicillin-resistant Staphylococcus aureus and its control - I. M. Gould , J. Reilly , D. Bunyan and A. Walker - 2010

Testing for E. Coli

Escherichia coli (E. coli) are bacteria found in the environment, foods, and intestines of people and animals. The bacterium is found in faeces and can survive in the environment. E. Coli bacteria can cause a range of infections including urinary tract infection, cystitis (infection of the bladder), and intestinal infection. E. Coli bacteraemia (blood stream infection) may be caused by primary infections spreading to the blood.

In the past 12 months there have been 43,990 hospital admissions from E. Coli infection in the UK NHS.

Tests were conducted by the Guangdong Detection Center of Microbiology to quantify the effectiveness of CleanLight against E Coli.

The same method was used to that in the MRSA trials.

After 3 x 60mins exposure to leanLight following percentages of bacteria were eliminated:

Test 1 = 82.31%

Test 2 = 80.77%

Test 3 = 81.67%

Average Kill Rate = 81.58%

In laboratory conditions CleanLight is PROVEN to kill E. Coli to an 81% effectiveness.

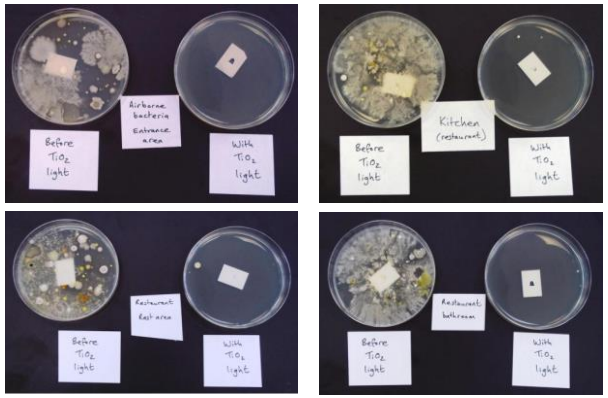
The annual cost of E. coli bacteraemia was estimated to be £14,346,400, with third-generation cephalosporin resistance associated with excess costs per infection of £420*

*The health and cost burden of antibiotic resistant and susceptible Escherichia coli bacteraemia in the English hospital setting: A national retrospective cohort study - 2019 National Institute of Health Research

Real World Testing in UK Restaurant

In March 2020 a field trial was conducted in a UK restaurant to ascertain the effectiveness of the CleanLight in a real world environment.

Petri dishes of Tryptone Soy Agar (TSA) were positioned throughout the restaurant and airborne bacteria were collected. After collection of samples, TSA plates were returned to the Test laboratory for incubation at 30° for 48h, producing the bacterial colonies shown here:



Samples were taken in the following locations and a kill rate identified:

Entrance = 100%

Kitchen = 95.7%

Bathroom = 99.06%

Waiting Area = 98.83%

In a real world setting CleanLight is PROVEN to kill 98.40% of airborne bacteria

A newly published scientific review by the Food Standards Agency (FSA) has estimated that around 2.4 million cases of foodborne illness occur every year in the UK.*

*Foodborne Disease Estimates for the United Kingdom in 2018 = FSA Jan 2020

Surface Anti-Bacterial Testing

As well as acting as a photocatalyst TiO_2 has antimicrobial properties that deactivate virus and bacteria when coming into surface contact.

These properties were investigated by the Guang Zhou Institute of Microbiology by applying certain bacteria to the surface of the Clean light Panel and a control panel without the TiO_2 treatment.

Samples were taken 24 hours after applying the bacteria and compared to the control.

After 24 hours the following kill rates were calculated:

Escherichia coli (E coli) = 99.9%

Staphylococcus aureus (MRSA) = 99.9%

Klebsiella pneumoniae = 99.8%

Candida albicans = 88.2%

In laboratory conditions the CleanLight surface is PROVEN to kill E. Coli to a 99.9% effectiveness.

E. coli bacteraemia places a substantial cost burden on NHS hospitals, being associated with an excess length of stay of almost four days per infection and an annual cost of over £14 million*

*The health and cost burden of antibiotic resistant and susceptible Escherichia co/ibacteraemia in the English hospital setting: A national retrospective cohort study - 2019

Room tests for NO_2 and CO

A recent test conducted at Lightico's own testing facility was designed to quantify the effectiveness of CleanLight in dealing with potential toxins in the air.

The toxins identified were Nitrogen dioxide (NO_2) and Carbon Monoxide (CO). Both toxins, generated by vehicle engines, are significant contributors to urban pollution.

Testing apparatus were established in an enclosed room, approximately $3m^2$ with a suspended ceiling 2.5m high. 2 CleanLight LED panels were installed in the ceiling and wired into the existing lighting circuit.

Damp wood was burnt inside the room, allowing smoke to fill the room increasing the CO and NO_2 levels, well beyond background norms.

The lights were switch on and a timer started to measure the reduction of the respective levels of CO and NO_2 over time.

The results are detailed here.

NO2 – 100% of the NO_2 detected in the room was removed within 1min 26 seconds.

CO – 67.39% of CO was removed from the room in 6mins. A 25% reduction was achieved within 3 minutes making the room safe to occupy.

In an enclosed room all NO_2 was removed in less than 1.5 minutes and safe levels of CO archived in 3 mins.

Two million Londoners – including more than 400,000 children – are living in areas which exceed legal limits for air pollution*

*Updates to the London Atmospheric Emission Inventory (LAEI) – April 2019

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