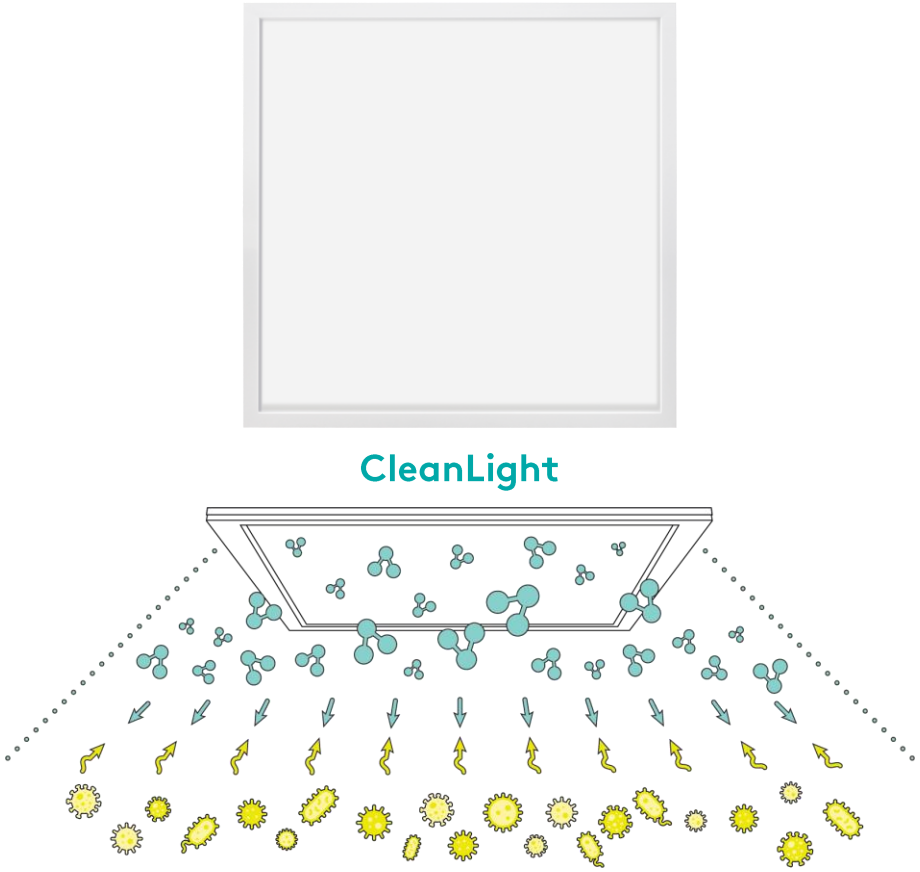
LIGHTICO

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.

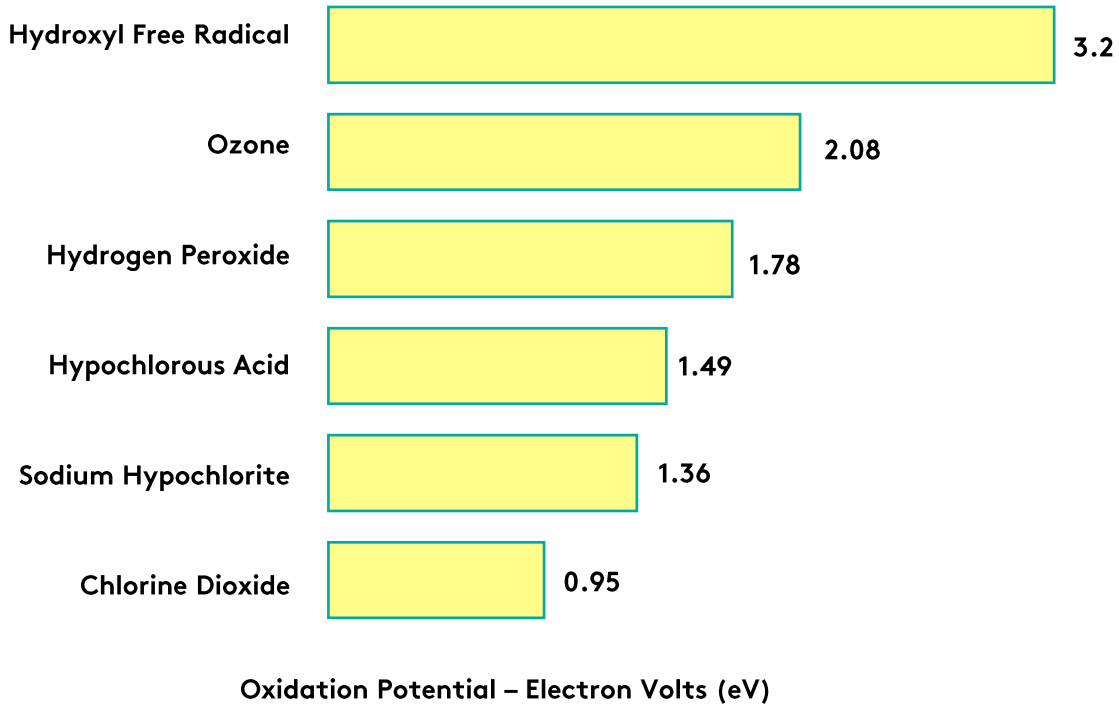
This technology was first identified by AKIRA FUJISHIMA & KENICHI HONDA in 1972 and was quickly utilised in the reduction of cyanide in water.

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 no risk to humans and animals compared to 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.

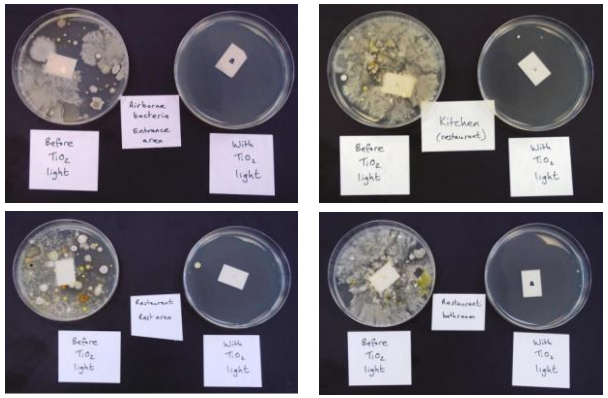
The annual cost of E. coli bacteraemia was estimated to be £14,346,400, with third-generation cephalosporin resistance associated with excess costs per infection of £420*

*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

Supermarket Field Trial

To access the real world application of CleanLight for supermarkets a field trial was designed to address specific staff areas where social distancing or the removal of these areas from use would be impossible.

A locker room and toilet were identified as ideal areas since staff needed to access these regularly during the day and the air handling within the rooms is limited.

Without regular air change within these spaces any pathogen introduced was likely to remain airborne for several hours increasing the risk of transmission/infection and spreading surface contamination throughout the space when they eventually settle.

Prior to installation settle plates were placed in 2 areas within the spaces for 90 minutes with 1 plate removed and sealed every 30 mins. Colony counts were made from bacteria collected.

3 panels were then installed in the locker room and 2 in the toilet. Consideration was given to the size of the room and the range (estimated at 7.5m^2) of the panels. The lights operated alongside the existing light fittings.

Settle plates were again placed in the same areas, on the same day of the week and at the same time of day. The rooms were not sealed and colleagues continued to come and go as normal.

Colony counts were made from the bacteria collected and compared to those previously recorded.

The numbers below refer the number of bacteria colonies counted after 48hr incubation:

	Before Install			After Install		
	30mins	60mins	90mins	30mins	60mins	90mins
Locker Room (small section)	5	8	10	2	3	9
Locker Room (main section)	2	10	13	1	2	6
Toilet (Top of cubicle)	98	163	260	60	109	177
Toilet (Top of Soap Dispenser)	117	164	233	N/A*	122	128

Despite the areas being in continued use throughout sampling, reduced bacteria counts were recorded in all cases.

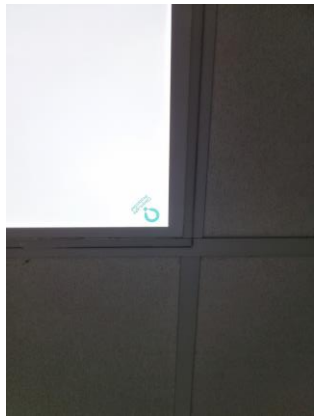
*This sample was contaminated making counting impossible

Hospital Field Trial

Working with the estates team and wholesale partner. 35 lights have been provided FOC for installation to a major NHS hospital. One area of concern was an Intensive Care Ward currently being prepared for the 3rd wave of infection post easing of current lockdown restriction. Consideration was also given to a general ward with COVID positive patients.

Lighting was initially installed in 2 recovery wards for COVID-19 patients. The nurse's work station and connecting corridors has lights installed alongside existing fittings as these areas provided the highest bacterial load during pre-testing. They also represent the greatest risk of transmission given the inability for people to social distance and the time spent in these areas.

Location	Time (mins)	Number of colonies on plate		
		Before Installation	After Installation	% Difference
Corridor	30	12	5	-58.33%
	60	27	10	-62.96%
	90	28	17	-39.29%
Nurses' station	30	11	7	-36.36%
	60	19	6	-68.42%
	90	27	6	-77.78%



In areas where health care workers spend extended amounts of time together and are unable to socially distance a significant difference in background bacteria levels was detected.

Food Factory Field Trial

Working with our wholesale partner CEF Lightico was invited to conduct a proof of concept trail with one of the largest fresh food packing firms in the UK. With a high number of production staff on site the concerns were two-fold. Firstly the current risk of COVID-19 transmission among the workforce presented a new risk for both employee welfare and business productivity. Secondly the ongoing risk of contamination onto the factory floor where fresh food is produced. Any contaminant finding its way into the supply chain could have long lasting health and commercial consequences.

Following a site survey at one of the businesses facilities a locker room was identified as the ideal location for the trial. This was the initial area where anyone (production or administrate staff) had to pass through to get onto the factory floor. This room contained lockers for outside clothing and racks for shoes to be stored as these needed to be removed prior to moving to the next stage of preparation where full protective clothing is worn. Staff are also required to wear hair and beard nets which need to be put on in this space.

This presented a pinch point where social distancing would be almost impossible and all members of staff potentially exposed to viral infection. While the cleaning regime was stringent with the room being clean several times a day. Other than basic mechanical air handling little could be done to supress airborne pathogens.

Before Installation After Installation

Plate label	Time	Colony Count	
		Before	After
A1	30 mins	54	24
A2	60 mins	86	44
A3	90 mins	75	73
B1	30 mins	49	36
B2	60 mins	85	78
B3	90 mins	Uncountable (> 300)	70
C1	30 mins	36	N/A
C2	60 mins	83	N/A
C3	90 mins	68	42

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