Photo ACTIVE®

COVID 19 - H1N1 - BACTERIAS

Analysis (BS) ISO EN 14476:2019
Analysis (BS) ISO EN 27447:2019
Photocatalytic coating, self-cleaning, antibacterial, anti-mold, anti-virus.
Artificial aging test.

Premise

This report describes the results of a study conducted by 3A Laboratories on glass-ceramic substrates coated with PhotoACTIVE® Ag, Code PA-Q07-H2O-Ag, Lot 200827, produced on 27/08/2020, expiry 27/08/2022, firm with the management of the Quality System, in compliance with the requirements of the UNI CEI EN ISO / IEC 17025: 2018 standard, Laboratory with management system certified UNI EN ISO 9001: 2015 by CSQA with n ° 14270, accredited ACCREDIA since 2011 with accreditation n ° 1165.

Normal antibacterial and antiviral disinfectants perform an immediate disinfection action but are labile over time or lose their effectiveness after a few hours.

In this study it will be shown that coating a substrate with PhotoACTIVE® Ag will have a benefit lasting more than one year.

Analyzes performed according to BS EN 1276/19

As established by the BS EN 1276/19 tests performed on PhotoACTIVE® Ag has had an excellent performance in the reduction of bacteriological loads.

The results are reported:

Test Method	Test Parameters	Test Suspension (lg)	Final Count (lg)	Bactericidal Effect (Log Reduction)	Specification Limit (lg)	Bactericidal Efficacy (%)
Quantitative suspension test for the evaluation of bactericidal activity of chemical disinfectants and antiseptics (BS EN 1276:2019)	*Staphylococcus aureus ATCC 6538*	7.26	120	5.18	≥5	99.999
	Escherichia coli ATCC 10536	7.23	160	5.03		99.999
	Pseudomonas aeruginosa ATCC15442	7.27	1.0	6.27		99.999
	Enterococcus hirae ATCC 10541	7.25	140	5.10		99.999

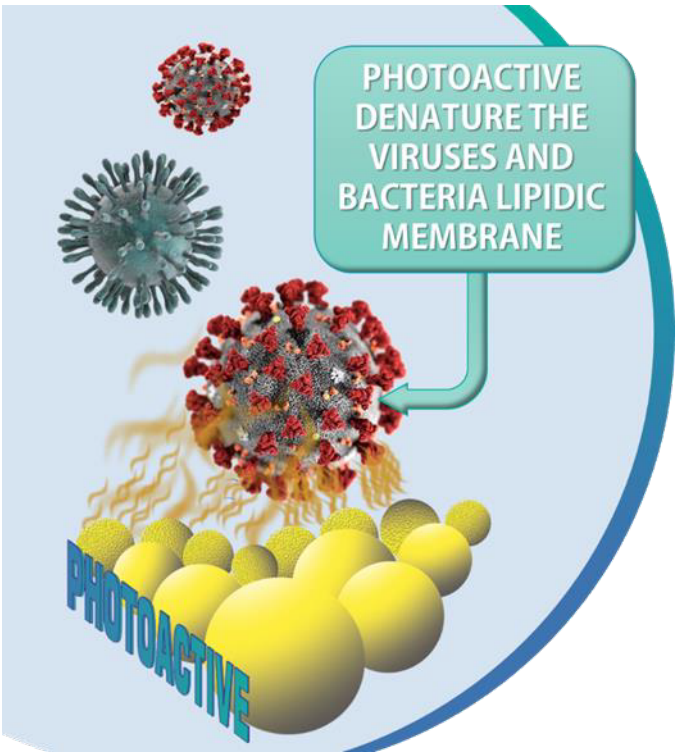
This methodology identifies whether a bactericide is able to remove bacterial loads starting from a product analysis.

Results:
PhotoACTIVE® Ag has an antibacterial efficacy of 99.999% on the strains analyzed.

ABSTRACT

In addition to being a strong bactericide, PhotoACTIVE® Ag also has a photocatalytic function.

HOW DOES IT WORK:



PhotoACTIVE® Ag through the photochemistry of the product performs an antimicrobial action, very effective anti-mold and antiviral, unlike other antibacterial agents do not kill bacteria, viruses or mold, but through reactions of reduction of oxidation decomposes them into gaseous substances dispersed in the environment surrounding without consuming the catalyst.

The decomposition of bacteria occurs for means of highly reactive hydroxyl radicals (OH•) and superoxide anions (O2-) generated from the photocatalytic process that attack the lipid membrane of bacteria decomposing it and preventing the phase of aerobic respiration of bacteria.

Microorganisms die or come denatured and gradually decomposed obtaining in carbon dioxide, salts and vapors of water.

The destruction of mold, bacteria, viruses and other microorganisms allows the elimination of bad smells associated with their presence and allows them to maintain the substrate on which the dioxide is applied under high hygiene conditions.

The photocatalysis reaction will be more effective the longer the contact time between the surface and substance to attack, and therefore it will be more effective when the substance is deposited on the surface, rather than when the substance itself circulates in the surrounding atmosphere below form of gas, suspended particle or aerosol (solid-gas reaction).

ANALYSIS CARRIED OUT ACCORDING TO (BS) ISO 27447: 2019

1) **TEST REPORT 20LA13619 (BS) ISO 27447:2019**

- ***TIME ZERO***

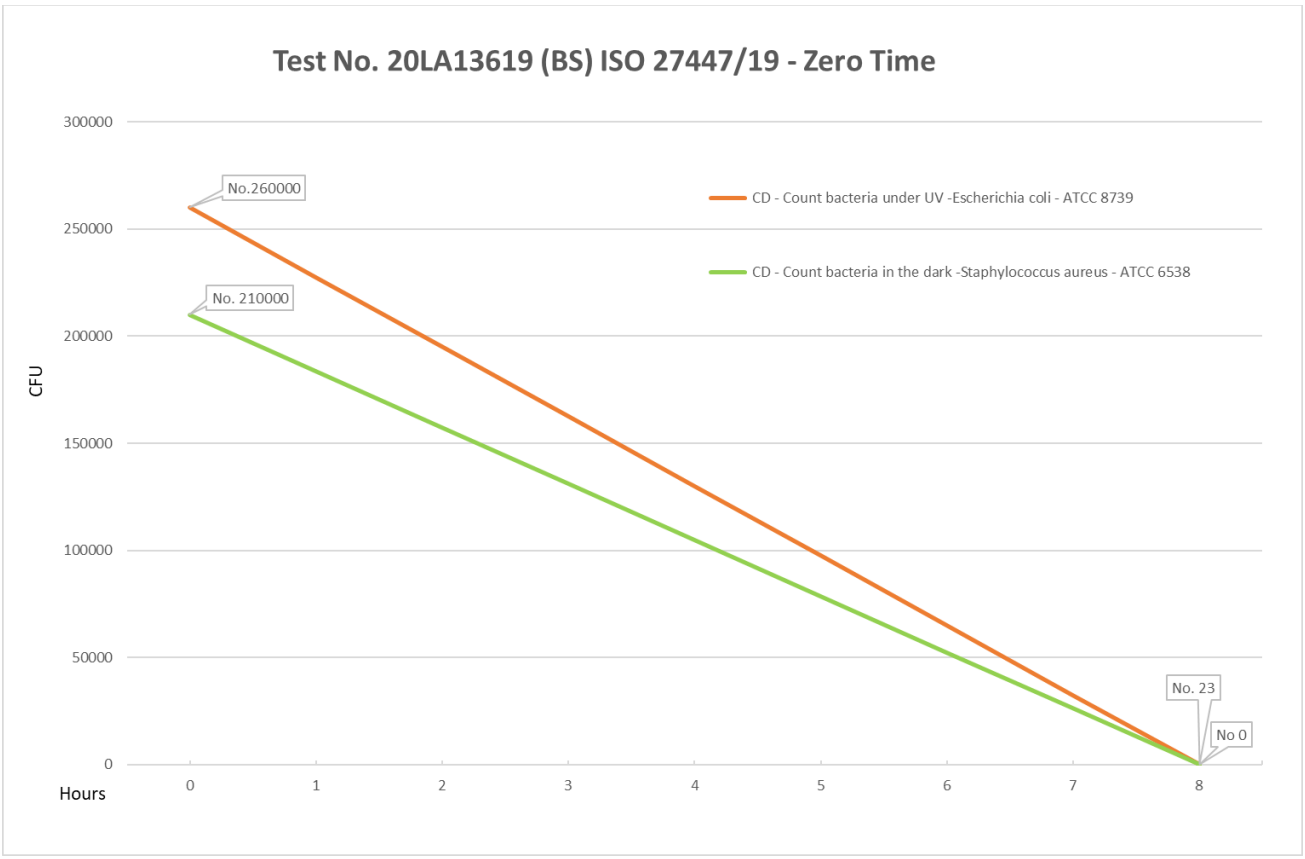
In this test report, according to the standard (BS) ISO 27447:2019, two bacterial loads are used, Escherichia coli - ATCC 8739 and Staphylococcus aureus - ATCC 6538. They are analyzes performed in Zero time. The purpose of the analysis is to verify:

1) Possible antibacterial action in the dark;
2) Photocatalytic function following the antibacterial action in the dark.

RESULTS FROM SIMPLE AVERAGE OF THE TWO BACTERIAL LOADS:

Zero-time analysis: 20LA13619
Only antibacterial: Δ% Reduction without light: **99.783%**
Photocatalytic: Δ% Reduction: **100%**

Below is the graph representing the results:


Test No. 20LA13619 (BS) ISO 27447/19 - Zero Time
300000
250000
200000
150000
100000
50000
0
CFU
Hours
0
1
2
3
4
5
6
7
8
No.260000
No. 210000
No. 23
No 0
CD - Count bacteria under UV -Escherichia coli - ATCC 8739
CD - Count bacteria in the dark -Staphylococcus aureus - ATCC 6538

2) TEST REPORT 20LA13620 (BS) ISO 27447:2019

- ***AFTER 100 HOURS OF ARTIFICIAL AGING ACCORDING TO ASTM G154/12a.***

INTRODUCTION

The purpose of the experimentation is to simulate accelerated aging both on specimens treated with PhotoACTIVE® and on specimens as it is. This operation is performed inside the accelerated aging chamber. The aging chamber simulates the environmental conditions of light and temperature, one of the main causes of aging of materials, with an irradiance range between 5 ± 1 W/m^2 and 45 ± 1 W/m^2. Two U.V.A. lamps with alternating operation, they simulate the action of sunlight in the UVA spectrum and an infrared lamp allows the set temperature to be reached and maintained constant with a tolerance of ± 0.5°C. The chamber is equipped with a mobile support which, thanks to a telescopic support, allows the samples to be positioned at a correct distance from the ultraviolet source, a distance that can be modified to set the desired irradiance on the specimen. It is equipped with a black panel to control the heating temperature up to 80°C. The spectrum of UVA radiation inside the Inve'96 chamber measured by photo radiometer with a spectral range 315-400 nm with a peak at 360nm.

METHODS AND LEGISLATION

We have taken into consideration the ASTM G154/12a standard to set the operational functional parameters. Accelerated tests were performed on 14 specimens treated with PhotoACTIVE® Ag and 20 untreated specimens. The specimens of both types have been marked on the bottom.
Since the unit of measurement used for solar radiation is MJ / m2 (mega joule per square meter), we will have:

$$W/m^2 \text{ x time (seconds)} = J/m^2$$
$$1\ J/m^2 = 0.001\ kJ/m^2$$

The 340nm radiation recorded in the aging chamber must however be converted into a UVA range similar to that measured outdoors with natural radiation. In general, the energy contained in 340 nm is about 1% of that contained in UVA. The conversion is therefore:

$$10\ kJ/m^2 \text{ a } 340\ nm = 1\ MJ/m^2\ (295\text{-}385\ nm)$$

Aging tests are measured temporally in hours: 3,600 seconds = 1 hours
These conversions can be combined in the equation:

$$kJ/m^2 = W/m^2 \text{ x } 3.6 \text{ x hours}$$

One year of exposure to the Florida sun corresponds to 2800 kJ at 340nm, so we will have by setting the data shown in table 1) radiation cycles.

Table 1) RADIATION CYCLES:	ASTM G154/12
Irradiance Watt/m^2	10,8
Conversion into hours	3,6
Hours of irradiation per day	24
Hours per day of condensation	0
Intensity per day obtained (kJ/m^2)	933,12
One-year intensity in Florida TUV (kJ/m^2)	2.800

Table 2) Days needed to do the required cycles

Hours	Days	Date	Hours	Energy given (kJ/m^2)
0	0	31/08/2020	Start 09:00	0
24	1	01/09/2020		933
48	2	02/09/2020		1,867
72	3	03/09/2020		2,800
96	4	04/09/2020		3,733
100	4+4h	04/09/2020	End 13:00	3,889

Below is the formula applied:

2800 kJ/m^2 a 340 nm = 10,8 W/m^2 to 340 nm x 3.6 x hours
That is Intensity for day (kJ/m2) of 933,12 x hours

Below are the data set in the aging chamber:

- Start test: 31/08/2020
- End test: 04/09/2020
- Temperature black panel: 60°C ±3°C.
- Light source: 2 Lamps UVA 500 Watt.
- Filter used: Daylight
- Irradiance a 340nm: 10.8 Watt/m^2
- Exposure cycle: 24 hours
- Total test duration time: 100 hours
- Nr. processed samples: 34

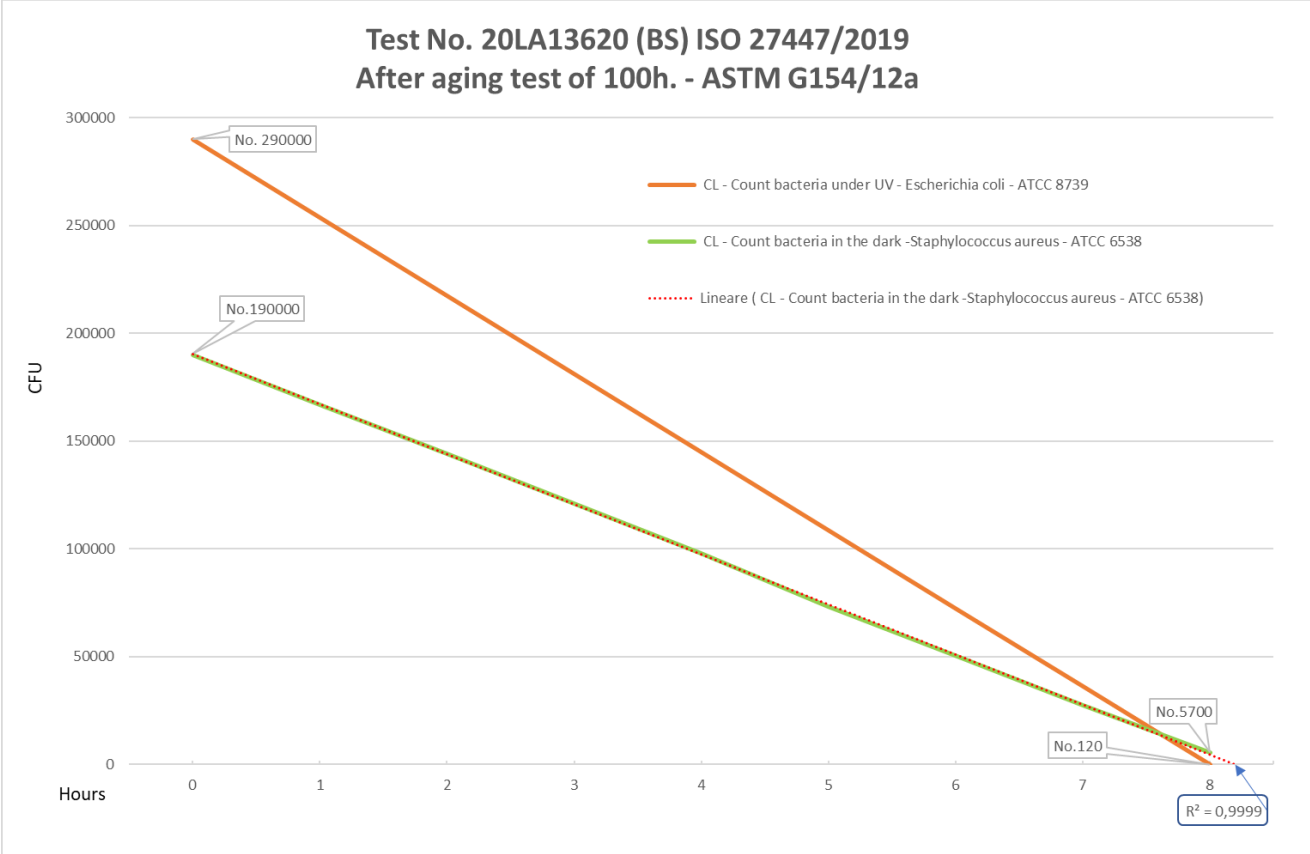
In this test report, according to the (BS) ISO 27447:2019 standard, two bacterial loads are used, Escherichia coli -ATCC 8739 and Staphylococcus aureus - ATCC 6538. They are analyzes performed after 100 hours of artificial aging. The purpose of the analysis is to verify:

1) Possible antibacterial action in the dark;
2) Photocatalytic function following the antibacterial action in the dark;
3) Coating efficiency after 100 hours of artificial aging according to ASTM 154G-12a.

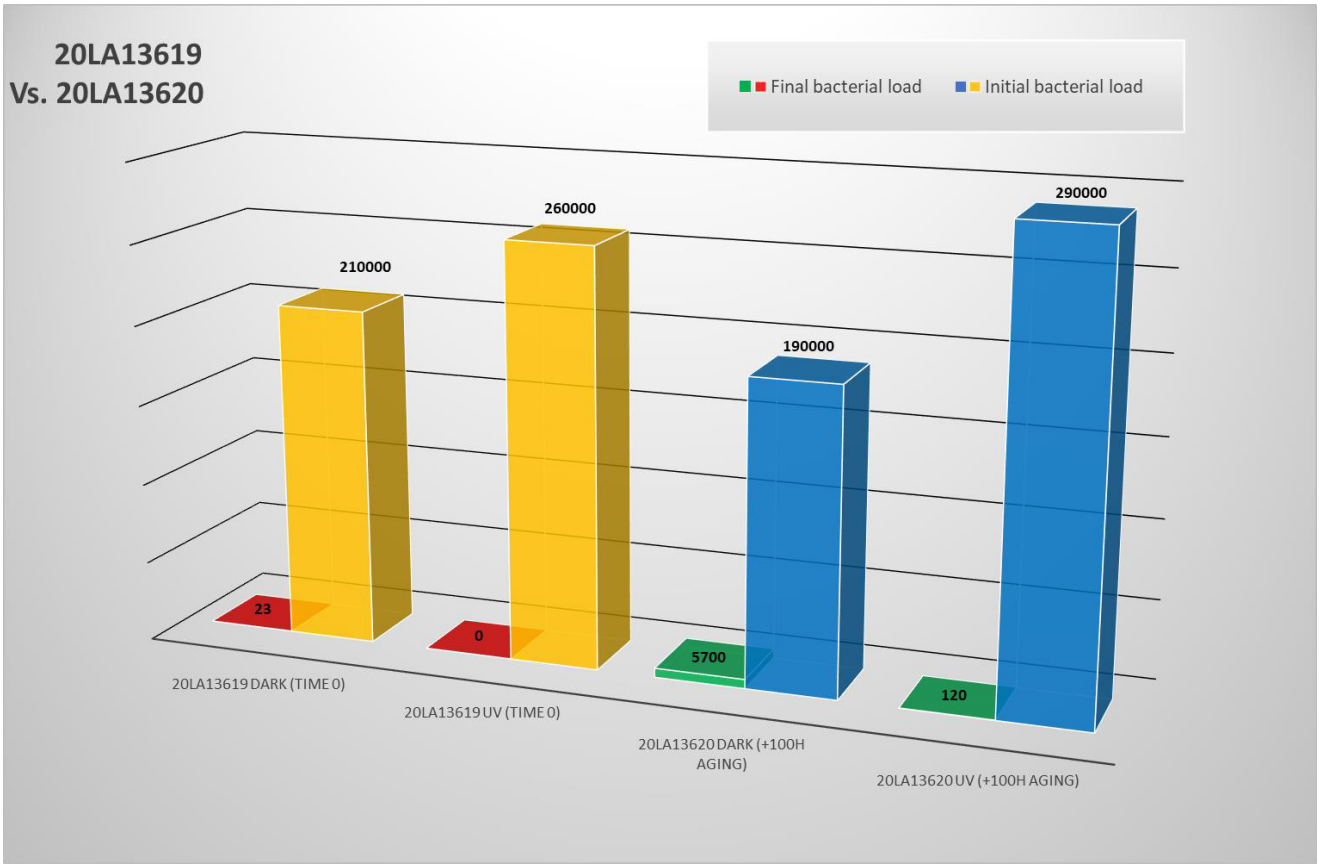
RESULTS FROM SIMPLE AVERAGE OF THE TWO BACTERIAL LOADS:

Aging analysis. ASTM G154 100h. - 20LA13620
Only antibacterial: Δ% Reduction without light: **97.362%**
Photocatalytic: Δ% Reduction: **99.71%**

Below is the graph representing the results:



The two graphs in comparison



EXECUTIVE SUMMARY

The efficacy tests, conducted on the PhotoACTIVE® Ag product by independent laboratories with international ILAC-MRA accreditation, both in contact with liquid suspension after 5 'according to the BS EN 1276/19 standard and in contact with coating on a glass ceramic support according to BS ISO 27447/19, demonstrate the absolute efficacy of the product, which guarantees a bactericidal action far superior to the standards prescribed by the EPA for sanitizing products by 99.9%, after 5' of contact time, and which even reaches 100% effectiveness after 8 hours of exposure to light.

More precisely, PhotoACTIVE® Ag guarantees an instant bactericidal action that guarantees its classification as a "Disinfectant" according to 1276/19, which give an antibacterial efficacy of 99.999% after 5' of contact time, and the tests according to BS ISO 274447: 2019 which even give an antibacterial efficacy of 100 % to light after 8 hours of exposure.

The product also maintains a bactericidal action of the highest level that lasts substantially unchanged over time. Both in the dark and in the light, for periods of more than one year from the application. Artificial aging tests according to ASTM G154/12a, also carried out by independent laboratories with international ILAC-MRA accreditation, show that, after a period of exposure of the surfaces treated with PhotoACTIVE® Ag to meteorological conditions (temperature, irradiation UV and relative humidity) of Florida for an equivalent duration of 365 days), the product still performs, with a decline in performance, one year after application, of 2.43% in the dark (bactericidal action only) and 0.29% in presence of light (combined bactericidal/photocatalytic action). It should be noted that this decay, after one year of aging, does not mean that the product eliminates fewer bacteria in absolute terms, but that it still eliminates more than 99.99% in a slightly longer time than the measurable times immediately after application. Finally, it should be noted that the aging tests simulate extremely severe weather and climatic conditions and that in the case of indoor application the performance decline can understandably be expected as substantially lower.

The results of the tests described so far show that PhotoACTIVE® Ag, applied by spray coating as a surface sanitizer, guarantees comparable or superior performance standards, in terms of immediate bactericidal efficacy, compared to a conventional disinfectant, but the degree of surface hygiene is incomparably superior in terms of continuity over time compared to a conventional disinfectant, since the antibacterial/photocatalytic action is continuous and uninterrupted for 24 hours and does not end a few seconds or minutes after application.
Normal disinfectants do NOT perform this very strong disinfection action.
PhotoACTIVE® Ag is effective for a time 10,000 times higher than a normal disinfectant available on the market today.

CONCLUSIONS:

In light of the results obtained, the surface treatment of substrates with coatings based on PhotoACTIVE® Ag can be recommended as a REPLACEMENT treatment of conventional sanitization by ordinary products, which ensure 99.9% effectiveness only at the time of application but have no effectiveness over time.
Based on the tests carried out, the effectiveness of this REPLACEMENT sanitization is demonstrated for a period of at least 12 months after application both outdoors and indoors.

PhotoACTIVE® Ag is certified according to the following standards:

EN 14476:2019	Virucidal activity as chemical disinfectant (tests on A/H1N1)
BS EN 1276:2009	Bactericidal activity as chemical disinfectant
BS ISO 27447:2019	Antibacterial activity on ceramics
EN ISO 20645:2004	Antibacterial activity on textiles
EN ISO 20645:2004	Antibacterial activity on paints/varnishes
BS EN 15457:2014	Antifungal activity
UNI 11247:2010	Degradation of nitrogen oxides in air
BS ISO 27447:2019	Antibacterial activity on ceramics after weathering / aging (*)
ISO 6330:2012	Wet scrub resistance
ISO 695:1991	Alkaline attack on glass

(*) tests for antibacterial activity on samples subject to ageing according to ASTM G 154/12a.

UNISI - H1N1 - REPORT OF THE VIRUCIDAL ACTIVITY ACCORDING TO UNI EN 14476: 2019

REALIZED BY: University of Siena - Microbiology and Virology Laboratory, Department of Medical Biotechnologies, Polyclinic le Scotte, Lot 5, Floor 2, 53100 Siena

INTRODUCTION

This study aims to demonstrate the virucidal activity of PhotoACTIVE® (TiO2) Vs. PhotoACTIVE® Ag (TiO2 + Ag) against **influenza A virus** (A/PR/8 H1N1). The Photo Active and Photo Active Ag samples were placed in contact at different dilutions with the influenza virus (A/PR/8 H1N1) at a known concentration for 15 and 30 minutes at room temperature.

Sample identification:

Sample 1 (TiO2)
- name: **PhotoACTIVE®**
- Lot nr: 200709
- manufacturing of: L&G Holding srl, Italy
- conservation: room temperature

Sample 2 (TiO2 Ag)
- name: **PhotoACTIVE® Ag**
- Lot nr: 200731
- manufacturing of: L&G Holding srl, Italy
- conservation: room temperature

RESULTS OF CYTOTOXICITY

RESULTS OF THE CYTOTOXICITY OF SAMPLE 1:

SAMPLE 1: PhotoACTIVE®	
TiO2 Diluted to: 80%	**Toxic**
TiO2 Diluted to: 60%	**Toxic**
TiO2 Diluted to: 40%	**Non-Toxic**

RESULTS OF THE CYTOTOXICITY OF SAMPLE 2:

SAMPLE 2: PhotoACTIVE® Ag	
TiO2 Diluted to: 80%	**Toxic**
TiO2 Diluted to: 60%	**Toxic**
TiO2 Diluted to: 40%	**Non-Toxic**

The tables indicate that only **40% of PhotoACTIVE®** and **PhotoACTIVE® Ag** are enough to be effective against the cytotoxicity of the virus. 80% and 60% of the virus is 100% denatured, meaning the product is toxic to the **influenza A virus.**

RESULTS OF VIRUCIDAL ACTIVITIES

The product is considered virucidal when, after the contact time, a 4 log10 reduction in $TCID_{50}$ titre is observed in the treated sample compared to that found in the virus control.

The K Virus that measures product functionality after 15 minutes is as follows: 1.1×10^6.
The K Virus that measures product functionality after 30 minutes is as follows: 6.3×10^6.

CONCLUSIONS UNIVERSITY OF SIENA

The PhotoACTIVE® Ag product appears to be more effective than PhotoACTIVE® in virucidal activity against the influenza virus, as can be seen in the table. The presence of the virus in the order of 25% in the sample is however highlighted even after a 15-minute treatment with PhotoACTIVE®. On the contrary, the PhotoACTIVE® Ag product appears 100% virucidal after 15 minutes of contact.

UNISI - COVID 19 - REPORT OF THE VIRUCIDAL ACTIVITY ACCORDING TO UNI EN 14476: 2019

REALIZED BY: University of Siena - Microbiology and Virology Laboratory, Department of Medical Biotechnologies, Polyclinic le Scotte, Lot 5, Floor 2, 53100 Siena

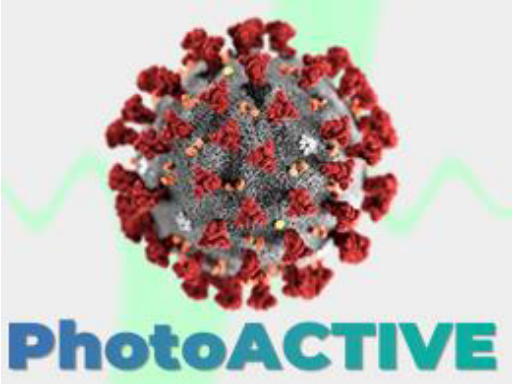
INTRODUCTION

This study aims to demonstrate the virucidal activity of PhotoACTIVE® (TiO2) Vs. PhotoACTIVE® Ag (TiO2 + Ag) against **SARS-Cov-2 (COVID-19).** PhotoACTIVE® and PhotoACTIVE® Ag samples were placed in contact at different dilutions with the influenza virus **SARS-Cov-2** at a known concentration for 30 minutes at room temperature.

Sample identification:

Sample 1 (TiO2)
- name: **PhotoACTIVE®**
- Lot nr: 200709
- manufacturing of: L&G Holding srl, Italy
- conservation: room temperature

Sample 2 (TiO2 Ag)
- name: **PhotoACTIVE® Ag**
- Lot nr: 200731
- manufacturing of: L&G Holding srl, Italy
- conservation: room temperature



RESULTS OF CYTOTOXICITY

RESULTS OF THE CYTOTOXICITY OF SAMPLE 1:

SAMPLE 1: PhotoACTIVE®	
TiO2 Diluted to: 40%	**Non-Toxic**

RESULTS OF THE CYTOTOXICITY OF SAMPLE 2:

SAMPLE 2: PhotoACTIVE® Ag	
TiO2 Diluted to: 40%	**Non-Toxic**

The tables indicate that only **40% of PhotoACTIVE®** and **PhotoACTIVE® Ag** are enough to be effective against the cytotoxicity of the virus.

RESULTS OF VIRUCIDAL ACTIVITIES

The product is considered virucidal when, after the contact time, a 4 $\log^{10}$ reduction in $TCID_{50}$ titre is observed in the treated sample compared to that found in the virus control.

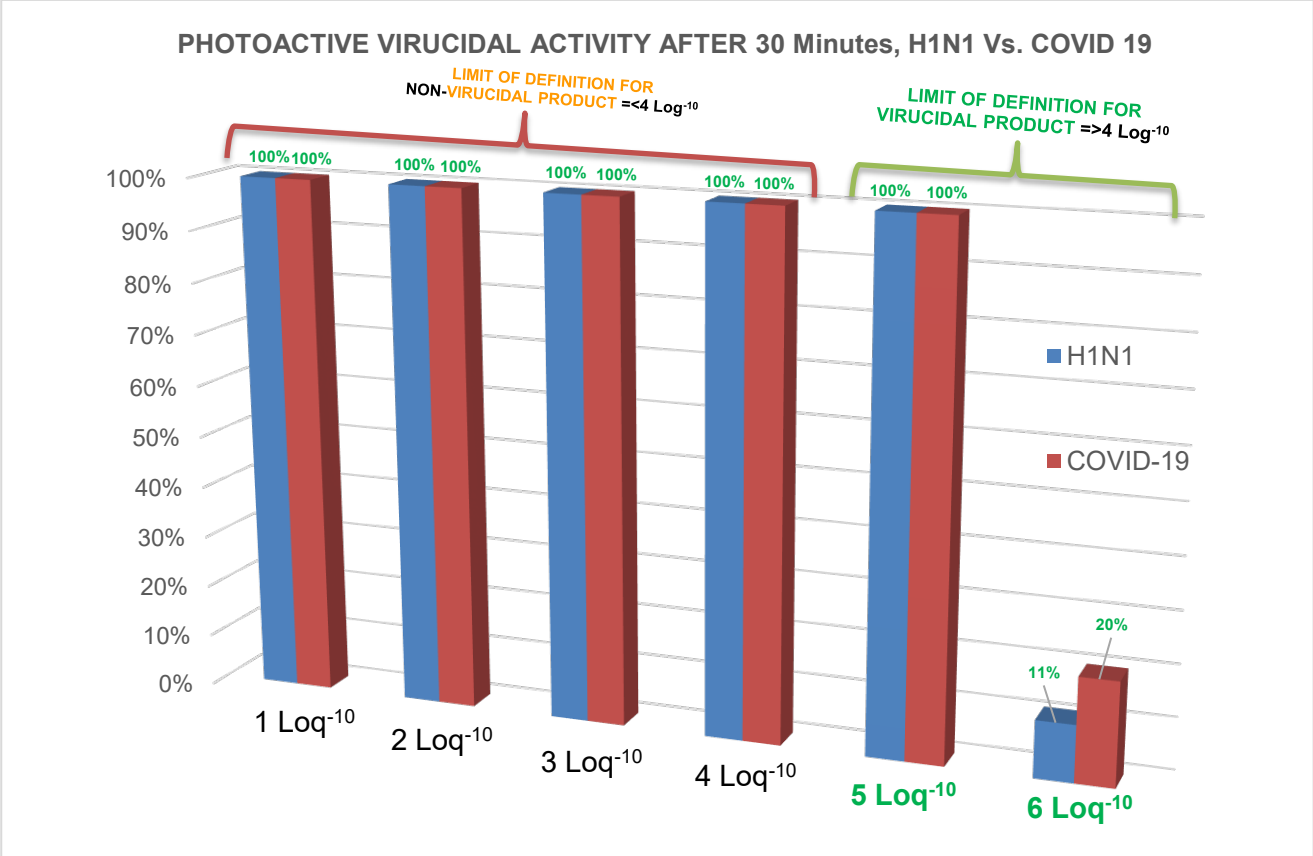
The K Virus that measures product functionality after 15 minutes is as follows: 2 x 10^6.

CONCLUSIONS UNIVERSITY OF SIENA

Both products, PhotoACTIVE® and PhotoACTIVE® Ag exhibit virucidal activity against SARS-Cov-2 viruses. As can be seen from the table. Treatment with both products was effective against the SARS CoV-2 virus starting from dilution 10-1.
The product is considered virucidal when, after the contact time, a 4 $\log^{10}$ reduction in $TCID_{50}$ title observed in the treated sample compared to that found in the virus control.

Original test available upon request.

Below is the summary graph



PhotoACTIVE® has proven its effectiveness against viruses diluted to 40%.

RESULTS: H1N1 after 30 minutes $TCID_{50}$ = 1.1×10^6.
RESULTS: COVID-19 after 30 minutes $TCID_{50}$ = 2.0×10^6.

Report N1H1 and Covid-19 carried out by UNISI, commissioned by: Biomedical Pharma, branch of Power Metal Italia srl

Thanks for your attention