

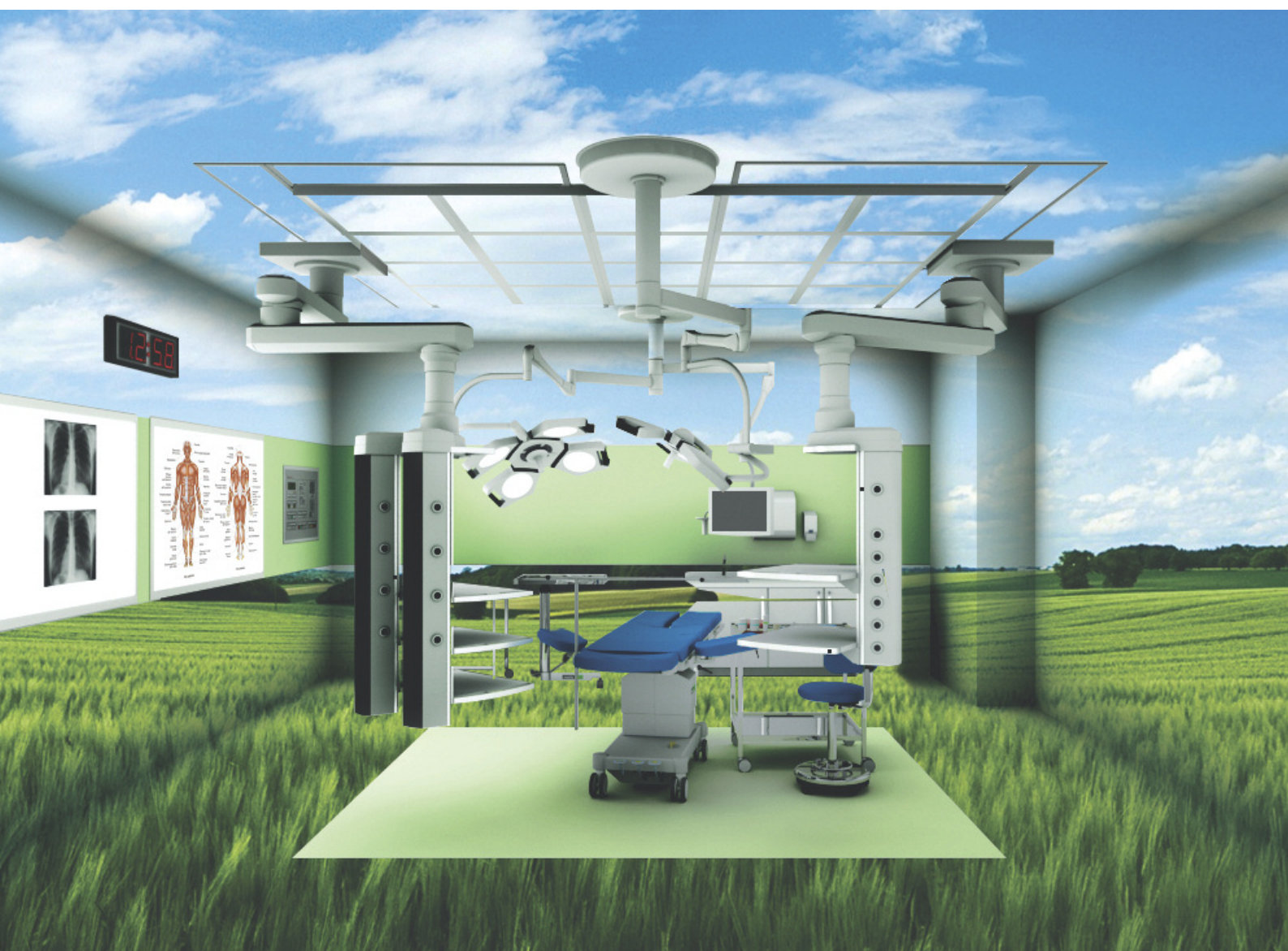
Pure Health[®]

ORION

VIRUS AND BACTERIA SELF-SHIELDING SYSTEM

Sanitize Nature's way

TECHNICAL-SCIENTIFIC GUIDE



TECHNICAL-SCIENTIFIC GUIDE

Introduction

This guide has two purposes:

- *to illustrate the scientific and technical aspects that form the foundation of the Pure-Health system and its operating principle;*
- *to be the basic tool with which to formulate scientifically-correct answers to any questions that a client might regarding the issue of disinfection.*

Definitions

The terms used to describe the processes used to reduce the number of microorganisms are open to variable definitions. This guide will use the definitions that are currently considered the most common.

Disinfection: a process through which, by reducing the number of microorganisms present on a given element, the potential of the element itself being a cause of infections is annulled. This procedure may not necessarily eliminate all the microorganisms but it can reduce them to a level at which they are no longer able to cause infection. The number of bacterial spores does not essentially need to be reduced.

Sanitization: a process that removes large amounts of material that are not part of an element, including dust, a large number of microorganisms and the organic matter that protects them. Sanitization refers to the simultaneous implementation or, rather, the two distinct phases of cleaning and disinfection of any surface. Since the infection process is the result of a combination of factors, any disinfection process must take into account the context in which it is used.

Sterile: this term indicates the total absence of living organisms, as regards microbes, or their inability to replicate, in the case of viruses. The process of making an object sterile is called sterilization.

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THE PURE-HEALTH SYSTEM

The Pure-Health concept is a true innovation in the field of sanitization. It arises from the need to fit out hygienically safe environments that ensure continuous protection.

The Pure-Health system consists of coverings and flooring in PVC, resin and fibreglass.

A molecule, Titanium Dioxide, has been inserted into these materials and, thanks to the action of a light, it is able to eliminate over 99% of viruses, bacteria and mould present in the environment in which it is used. Photocatalysis, i.e. the process that is the foundation of the Pure-Health system, is based on the oxidation reaction produced by irradiation of a photocatalyst using fluorescent lamps in a variety of combinations. When this occurs indoors, in the presence of air humidity it produces hydroxyl radicals and superoxide ions that are effective against bacteria, fungi and VOCs (Volatile Organic Compounds).

The Pure-Health system is active 24 hours a day, 7 days a week, even when people are present.

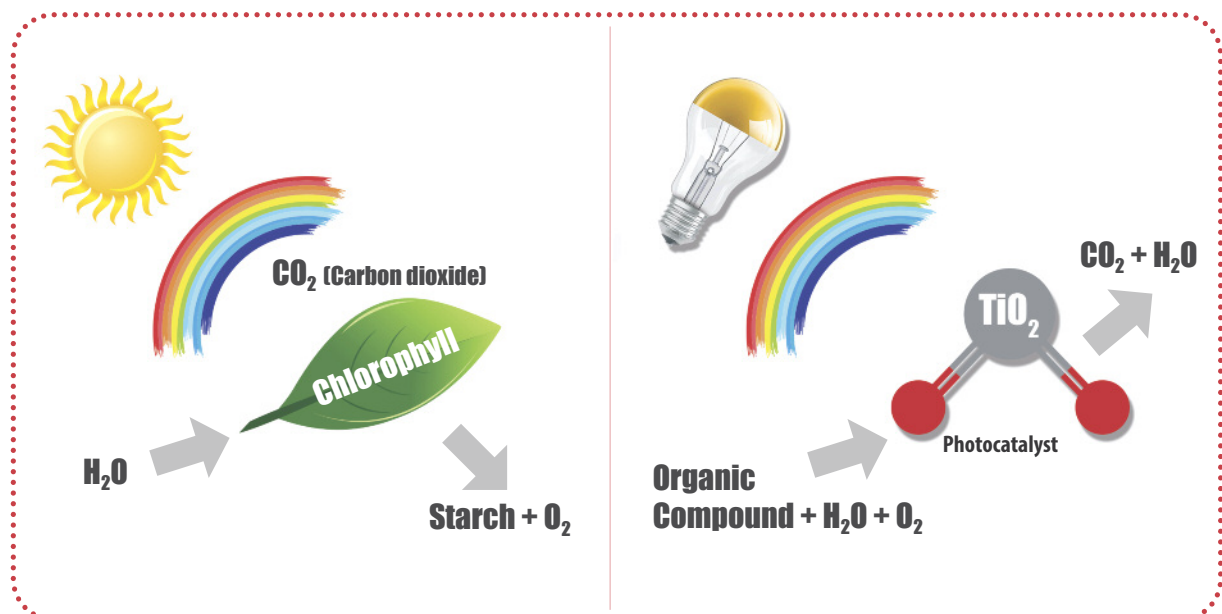
What is photocatalysis?

Photocatalysis is defined as "the acceleration of the speed of a photoreaction in the presence of a catalyst".

A catalyst is neither modified nor consumed by a chemical reaction.

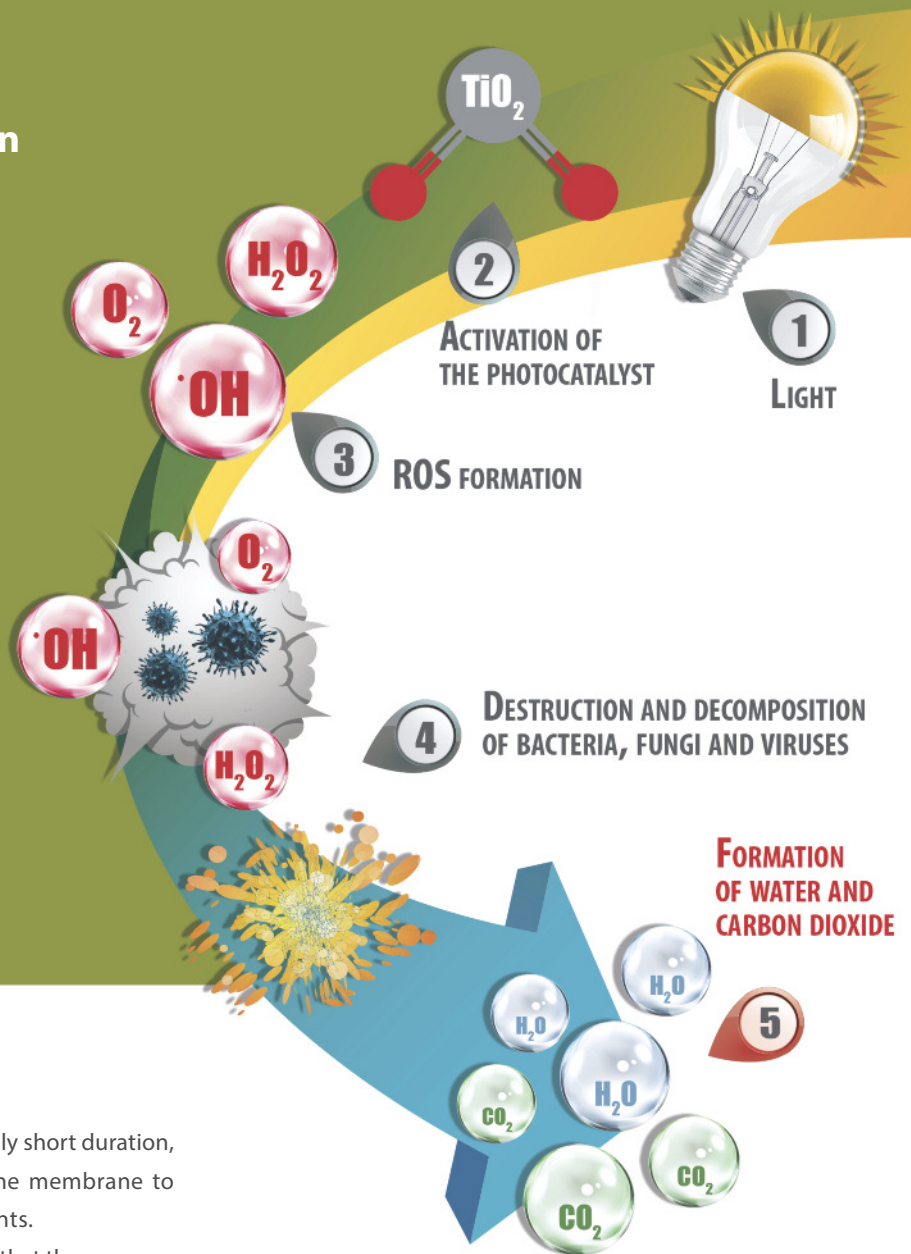
This definition includes photosensitization, a process in which a molecular species undergoes photochemical alteration as a result of an initial absorption of light energy by another molecular species called a photocatalyst.

Chlorophyll in plants is a type of photocatalyst. Compared to photosynthesis, in which chlorophyll captures sunlight to convert water and carbon dioxide into oxygen and glucose, photocatalysis (in the presence of a photocatalyst, light and water) generates a strong oxidizing agent able to transform organic substances into carbon dioxide and water.



Photocatalytic oxidation

Photocatalytic oxidation is a type of technology used for the purification of air and surfaces that possesses the ability to destroy both microorganisms and microbial volatile organic compounds. The bactericidal and virucidal effect due to the photocatalytic action of TiO_2 is due to the formation of reactive oxygen species (ROS), such as O_2^- , H_2O_2 and $\cdot\text{OH}$ (hydroxyl), generated by the synergistic TiO_2 – light system, elements capable of transforming harmful organic substances into harmless inorganic molecules (such as H_2O and CO_2). Most studies have led to the conclusion that the hydroxyl $\cdot\text{OH}$ radical is the main species involved in the bactericidal and virucidal action of photocatalysis.



Hydroxyl radicals, which have an extremely short duration, must be generated in the vicinity of the membrane to be able to oxidise some of its components.

The extremely short lifespan and the fact that they are produced on a surface make them harmless to people.

Photocatalysis not only kills bacterial cells, it decomposes them. It has been proven that titanium dioxide is more effective than any other antibacterial agent because the photocatalytic reaction occurs even when there are cells covering the surface and there is active bacterial multiplication. In addition, the endotoxin resulting from the death of the cell is decomposed by photocatalytic action.

Titanium dioxide does not degrade and has a long-term antibacterial and virucidal effect.

Photocatalysis is defined as "the acceleration of the speed of a photoreaction in the presence of a catalyst."

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reaction. This definition includes photosensitivity, a process in which a molecular species undergoes photochemical alteration as a result of an initial absorption of light energy by another molecular species called a photocatalyst.

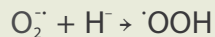
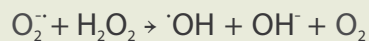
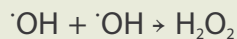
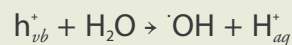
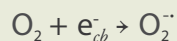
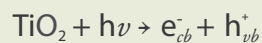
Titanium dioxide, in the form of anatase, is the most common photocatalyst and has the following advantages: low cost, high photocatalytic efficiency and non-toxicity. The product has biocidal characteristics and, if the laws and regulations that govern the fields of application are adhered to, it can be considered a guarantee for definitive sanitization.

HOW IT WORKS

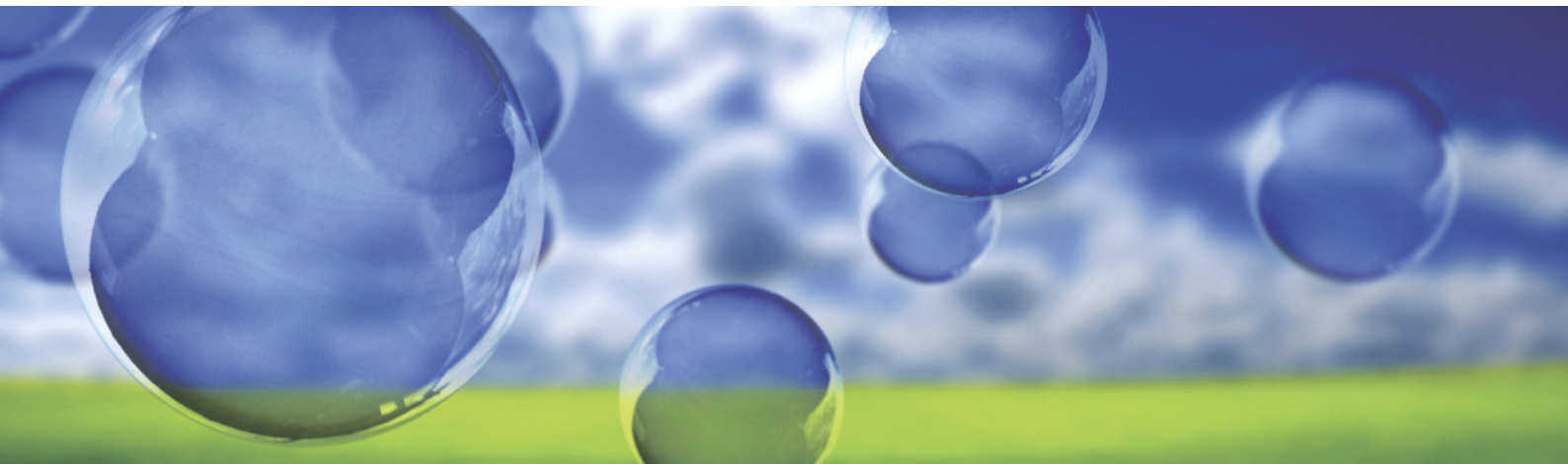
Photocatalysis is a process that is activated by the action of light and air. When titanium dioxide is exposed to sunlight or an artificial light source such as fluorescent lamps, it absorbs ultraviolet (UV) radiation. This phenomenon generates electrons pairs and holes (positively charged species). The absorption of UV radiation excites the electron in the titanium dioxide valence band. The excess energy of this excited electron promotes the electron to the conduction band, giving rise to the electron pair (e^-) and hole (h^+). The hole breaks the molecule of water to form hydrogen gas and a hydroxyl radical.

The electron reacts with the oxygen molecule to form superoxide ions. This cycle continues as long as light is available. This process is similar to photosynthesis in which chlorophyll captures sunlight to convert water and carbon dioxide into oxygen and glucose.

Therefore, the strong oxidative effect created by light, water and titanium dioxide, leads to the decomposition and conversion of bacteria, viruses and fungi into harmless substances. The photocatalytic surfaces prevent the growth of microorganisms and do not allow the build-up of the substances on which these microorganisms feed.



It has been shown that after just a few minutes the Pure-Health system is able to eliminate harmful microorganisms, reaching a reduction of 99% after only 90 minutes.



HOW IT WORKS

What is ultraviolet light?

Ultraviolet (UV) light is a region of the electromagnetic spectrum consisting of three sub-regions of frequencies, which are UVA, UVB and UVC.

UVA, commonly referred to as black light - longwave UV (320-400 nm):

- essential for organisms living on the Earth's surface, it is able to convert cholesterol into vitamin D;
- effects on the dermis - 37% penetrates to 0.06 millimetres;
- not blocked by glass;
- minimal photon excitation;
- therapeutic in the presence of a photosensitizer.

UVB, commonly referred to as sunburn-inducing - intermediate length UV (290-320 nm):

- reaches the Earth's surface and is harmful to people and ecosystems;
- effects on the epidermis - 90% is absorbed in the upper 0.03 millimetres;
- blocked by most materials, including glass and plastic;
- photons are highly excited and more biologically active;
- therapeutic effect, although it is 1000 times more erythema-inducing than UVA.

UVC, normally used to sterilize instruments - shortwave UV (200-290 nm):

- absorbed by the ozone layer, does not reach the Earth's surface;
- maximum photon excitation;
- not for therapeutic use;
- germicidal action.

Pure-Health lamps use a type of ultraviolet light that is safe and not harmful. The inactivation of bacteria by heterogeneous photocatalysis using UV-A (315-400 nm) and TiO₂ is considered one of the most effective disinfection technologies because during the process there is no formation of carcinogenic, mutagenic or malodorous compounds.

Fluorescent lamps

Fluorescent lamps are lamps whose emission spectrum is very similar to the complete spectrum of natural light. They were developed in the USA in order to simulate natural light in indoor environments.

The essential features of full-spectrum fluorescent lamps are:

- emission spectrum identical to daylight;
- biologically-stimulating action;
- the best contrast vision;
- reproduction of completely natural light in association with the optimal temperature phase, the colour of daylight (5500 Kelvin);
- the closest colour reproduction characteristics: Ra 96;
- wider and more continuous spectrum compared to other fluorescent lamps;
- harmonious light quality;
- service life when operating with electronic starter (pre-heating): 13000h;
- average lifespan when operating with electronic starter (pre-heating): 24000h;
- flow efficiency up to 71 lm/W.

Fluorescent lamps, due to their characteristic spectrum and low levels of UV-A and UV-B radiation (similar to natural daylight), stimulate the metabolism and glandular functions. They also have a positive effect on the autonomic nervous system.



THE BIOCIDAL ACTION

Microbial cells present a wide range of differences in terms of size, subcellular architecture and biochemical composition, and hence also the sensitivity to external chemical agents. Despite their great variety, all types of microorganisms are sensitive to photodynamic activity.

Bacteria

Titanium dioxide is a photosensitizer of particular interest for bacterial inactivation.

The photogenerated ROS can attack the microorganism from the outside, initially oxidizing the cell membrane (especially by lipid peroxidation) and then destroying the nucleic acids, the proteins (enzyme deactivation), etc. The cooperative effect of the various oxidizing species (which include hydroxyl radicals, superoxide anions and H₂O₂ produced by photogenerated superoxide anions) explains the inactivation of the bacteria. The attack by these species leads to the destruction of the three layers of the cell wall: the outer membrane, peptidoglycan and the cytoplasmic membrane.

The hydroxyl radicals are the most toxic to microorganisms by promoting the peroxidation of the polyunsaturated phospholipid component of the lipid membrane and inducing disorder in the cell membrane. The damage to the outer membrane increases permeability to the ROS, a process possible due to the significant lifespan of the ROS generated on the TiO₂ surface.

Viruses

In a similar way to bacteria, viruses also have to be destroyed without causing unacceptable damage to the host cells. Enveloped viruses, such as HIV, are generally susceptible to photoinactivation, unlike non-enveloped viruses: this indicates that the viral envelope, rather than the nucleic acids, is the target of the photosensitization.



Fungi

The photodynamic inactivation of fungi can be obtained in the presence of irradiated TiO₂, as has been demonstrated for *Penicillium expansum* and several fungi belonging to the genus *Fusarium*.

	HEPA Filter	Electrostatic	Ozone	UV	Ionizer	Photocatalysis
Mould	Mediocre	Good	Good	Good	Mediocre	Excellent
Bacteria	Mediocre	Mediocre	Good	Good	Mediocre	Excellent
Mites	Mediocre	Mediocre	Mediocre	Good	Mediocre	Excellent
Gas	Mediocre	Mediocre	Good	Good	Mediocre	Excellent
Odours	Mediocre	Good	Good	Good	Good	Excellent
Smoke	Good	Good	Good	Mediocre	Excellent	Good
VOCs	Mediocre	Mediocre	Good	Good	Mediocre	Excellent

THE ADVANTAGES

Microbial cells present a wide range of differences in terms of size, subcellular architecture and biochemical composition, and hence also the sensitivity to external chemical agents. Despite their great variety, all types of microorganisms are sensitive to photodynamic activity.

Economic: the use of Pure-Health does not limit the operational capacity of the environment nor is the production cycle interrupted during sanitization. In addition, there is no need for the intervention of staff.

Low energy-consumption lamps: full solar spectrum lamps have a lower level of energy consumption than those normally installed in various environments.

Durability: the photocatalytic reaction does not consume the catalyst (titanium dioxide), so there is no need to replace the Pure Health unit and this ensures that it has the same lifespan as the medium in which it is inserted.

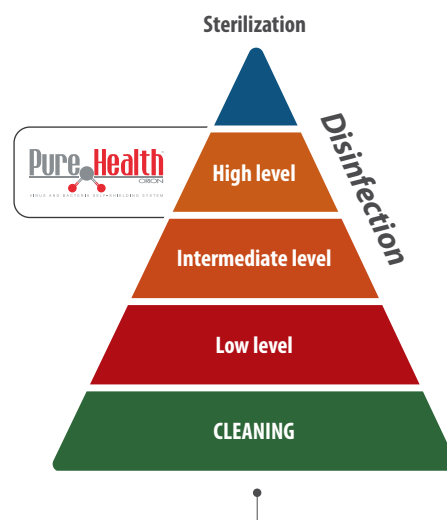
Rapidity: It has been shown that after just a few minutes the Pure-Health system is able to eliminate harmful microorganisms, reaching a reduction of 99% after only 90 minutes.

Effectiveness: the constant sanitizing action is more effective than any other substance with a temporary effect used by the staff. The action against microorganisms occurs not only at the time of sanitization, it continues if contamination occurs. Sanitization with Pure-Health is active 24 hours a day and, therefore, definitive.

Environmentally-friendly: with the Pure-Health system there is no dispersion of pollutant material, so the environmental impact is zero. Pure-Health surfaces are safe to touch and do not release particles. The low energy consumption of the lamps used allows a greater respect for nature.

Safety: Titanium dioxide, approved by the FDA (Food and Drug Administration), is harmless to humans. The surfaces produced by Pure-Health are non-slip and anti-static, they do not need maintenance and ensure the elimination of bacteria and odours.

Health: Pure-Health can be used safely in the presence of people and food. In addition to activating the sanitizing effect on the surfaces, on which there is no need to use chemicals, the full solar spectrum lamps increase the synthesis of endorphins and serotonin with beneficial effects on the human organism.



Results after using the Pure-Health® system

High level

- All microorganisms

Intermediate level

- Mycobacterium tuberculosis
- Most viruses and fungi

Low level

- All bacteria in the vegetative stage
- Some viruses (lipophilic)
- Some fungi

MATERIALS

The Pure-Health system consists of coverings and floorings made of PVC, resin and fibreglass. A molecule, Titanium Dioxide, has been inserted into these materials and, thanks to the action of a light, it is able to eliminate over 99% of the viruses, bacteria and mould present in the environment in which it is used.

PVC

Polyvinyl chloride, also known by the abbreviation PVC, is the polymer of vinyl chloride and the most important of the series of plastics obtained from vinyl monomers. It is one of the most commonly used plastic materials in the world due to its stability and safety in technological applications at room temperature.

Resin

Synthetic resin is a material similar to plant resin, viscous and with the ability to harden when exposed to heat or cold. It is a wide class of different, complex polymers that can be obtained using a wide variety of processes and raw materials.

Fibreglass

Fibreglass is a type of plastic reinforced with glass, in the form of fabrics or non-woven fabric, felt and randomly oriented fibres. They are impregnated with thermosetting liquid resins made from polyester, vinylester or epoxy that harden after machining in the presence of catalysts and accelerators.

A molecule, nanostructured titanium dioxide, has been inserted into Pure-Health PVC, resin and fibreglass. This causes the material to become a photocatalytic surface. This process is patented (patent no. PVC PCT/IT2012/000219 - brevetto resina e vetroresina PCT/IB2011/0579).

FIELDS OF APPLICATION



Health Care for outpatient, hospital, paramedical and school environments. The Pure Health® system is ideal for:

- waiting rooms
- hospital wards
- communal areas in clinics and hospitals
- veterinary clinics
- emergency areas
- intensive care units
- operating theatres
- schools
- nurseries



Pure Food for the food industry. The Pure Health® system can be used in bars, restaurants and hotels, and installed in:

- manufacturing areas
- storage areas
- warehouses
- cold rooms
- transport vehicles



Wellness Pure-Health® for the health and fitness industry. Pure Health® coatings are suitable for:

- gyms
- fitness centres
- swimming pools
- locker rooms
- spas



FREQUENTLY ASKED QUESTIONS

How long does Pure-Health last?

The photocatalytic reaction does not consume the titanium dioxide (TiO₂) catalyst, so there is no need to replace the Pure-Health unit. This ensures a very long life.

Moreover, not by varying the technical characteristics of the material on which it is grafted, the duration is guaranteed by the manufacturer of that material.

What are the aesthetic differences between a Pure-Health covering and a traditional covering?

There is no difference from the aesthetic point of view between a Pure-Health covering and a normal covering. Despite the fact that titanium dioxide is mainly used as a white pigment because of its high refractive index, the production processes of the Pure-Health system and the purity of the titanium dioxide used allow the creation of support mediums and coatings in a wide range of colours.

Do I have to create a Pure-Health environment or I can limit myself to the floor or walls?

For complete sanitization, it is essential to create both the walls and the floors. If there are evident obstacles to doing this, it is possible to only create the floors.

How do I recognize an environment or a vehicle equipped with the Pure-Health system?

For each installation, a certificate of compliance for projects carried out according to the requirements of the system will be issued by Next Technology, a research organization founded by and with the participation of the Ministry of Education, University and Research (MIUR).

Can I use any type of light?

The activation of the photocatalytic process requires the irradiation of the TiO₂ molecules using full-spectrum lamps. The lamps used in the Pure-Health system guarantee activation of the photocatalytic process with no UV emission harmful to humans.

Does the Pure-Health system only work with the light on?

No. Once the full photocatalytic potential is reached, the system takes an equal amount of time to cease ROS production.

Can the Pure-Health system be a solution to nosocomial outbreaks?

Nosocomial outbreaks represent a constant and increasing risk to the health of operators and users, in addition to a real economic damage to facilities. The Pure-Health system, making use of the photocatalytic properties of TiO₂, allows the proliferation of the viral and bacterial elements that cause such outbreaks to be avoided, thanks to the constant killing exerted by the combination of ROS with our lighting system.

Does the Pure-Health system work even at temperatures below 0°?

Yes, thanks to the attention paid to the client's needs. In environments at temperatures below 0°, traditional fluorescent lamps suffer a physiological loss of efficiency, whereas the fluorescent lamps used in the Pure-Health Food division are designed to guarantee exceptional light output at temperatures as low as -20 °.

FREQUENTLY ASKED QUESTIONS

Does the light have to be kept on 24 hours a day?

No. The use of intermittent lighting also helps to eliminate bacteria, mould, fungi and viruses. An independent study on the loss of *E. coli* cell viability through photocatalytic reaction with TiO_2 (titanium dioxide) showed that after 15 minutes of illumination almost all the cells were still viable. However, it has been shown that after just a few minutes, the Pure-Health system is able to eliminate harmful microorganisms, reaching a reduction of 99% after only 90 minutes.

What factors affect the efficiency of TiO_2 ?

Light and airflow have a strong influence on the reaction of the TiO_2 catalyst in that both provide the necessary elements for it. Suitable lighting, especially from fluorescent lamps, is effective. Direct sunlight, UV radiation and black light (UVA) create the most powerful oxidizing species.

Is titanium dioxide safe?

Approved by the FDA, TiO_2 is harmless to humans. It is widely used as a food additive as well as in paints, toothpastes and a wide range of further applications. Pure-Health surfaces are safe to touch and there is no risk of release of particles because the TiO_2 is nanostructured with the other chemical compounds that constitute the PVC, resins and fibreglass used.

How effective is TiO_2 as a disinfectant?

The hydroxyl radicals produced by the TiO_2 catalyst are among the strongest oxidizing agents, even stronger than chlorine (3 times), ozone (1.5 times) and hydrogen peroxide (1.5 times). They are, therefore, very powerful oxidizing agents capable of killing a wide variety of microorganisms.

Why does TiO_2 have an antimicrobial effect?

The old standard for killing microorganisms was the use of strong UVC radiation (over 20,000 μW of UVGI per second). Germicidal UVC radiation eliminates microbes by destroying their DNA. However, some microorganisms, particularly anthrax, have very strong DNA coatings and can withstand even 30,000 μW of UVGI.

The Pure-Health covering works differently because TiO_2 decomposes and destroys the cell membrane, not the DNA. Most microbes are unicellular organisms that die quickly when any part of them comes into contact with a treated surface. Consequently, the titanium dioxide also kills MRSA (Methicillin Resistant *Staphylococcus Aureus*), a major cause of hospital infections. In addition, TiO_2 has also been tested to fight microbes resistant to antibiotics. Due to its oxidation mechanism, the titanium dioxide also decomposes the toxins that are emitted when the microbes die (Verotoxins, Enterotoxins), reducing them to harmless vapours.



ABOUT US

Founded in 1997 with the aim of designing and producing ambulances and special vehicles, Orion s.r.l. is constantly engaged in the search for innovative, functional solutions, aimed at improving the standards of safety and quality of its vehicles. The DOMINO project in boat fibreglass is behind the success of the company, which in a few years has established itself as a true benchmark in the market for special vehicles. To date, Orion has developed and marketed in Italy and abroad about 2,000 special vehicles including ambulances, medical cars, police cars, firefighting vehicles, off-road vehicles and Quads. Thanks to its more than 3000 square metres, the Orion factory serves about 200 vehicles a year. Orion is ISO 9001 certified and has authorization from the Ministry of Transport for the mass production of special vehicles.

CERTIFICATION

Recognition of the technological validity of titanium dioxide by decree of the Ministry of Environment and Land Protection, published in the Official Journal n° 84/2004.

Next Technology, a laboratory of the Ministry of Education, University and Research, issues certification of an environment sanitized by Pure Health® once installation is complete.



BIOCHEMIE lab

NEXT
TECHNOLOGY
SOCIETÀ A RESPONSABILITÀ LIMITATA
SISTEMI A INALZAMENTO DI PISERGA S. L.



ISTITUTO
GIORDANO
Qualità al Plurale.

**INTERNATIONAL
PATENTS:**
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