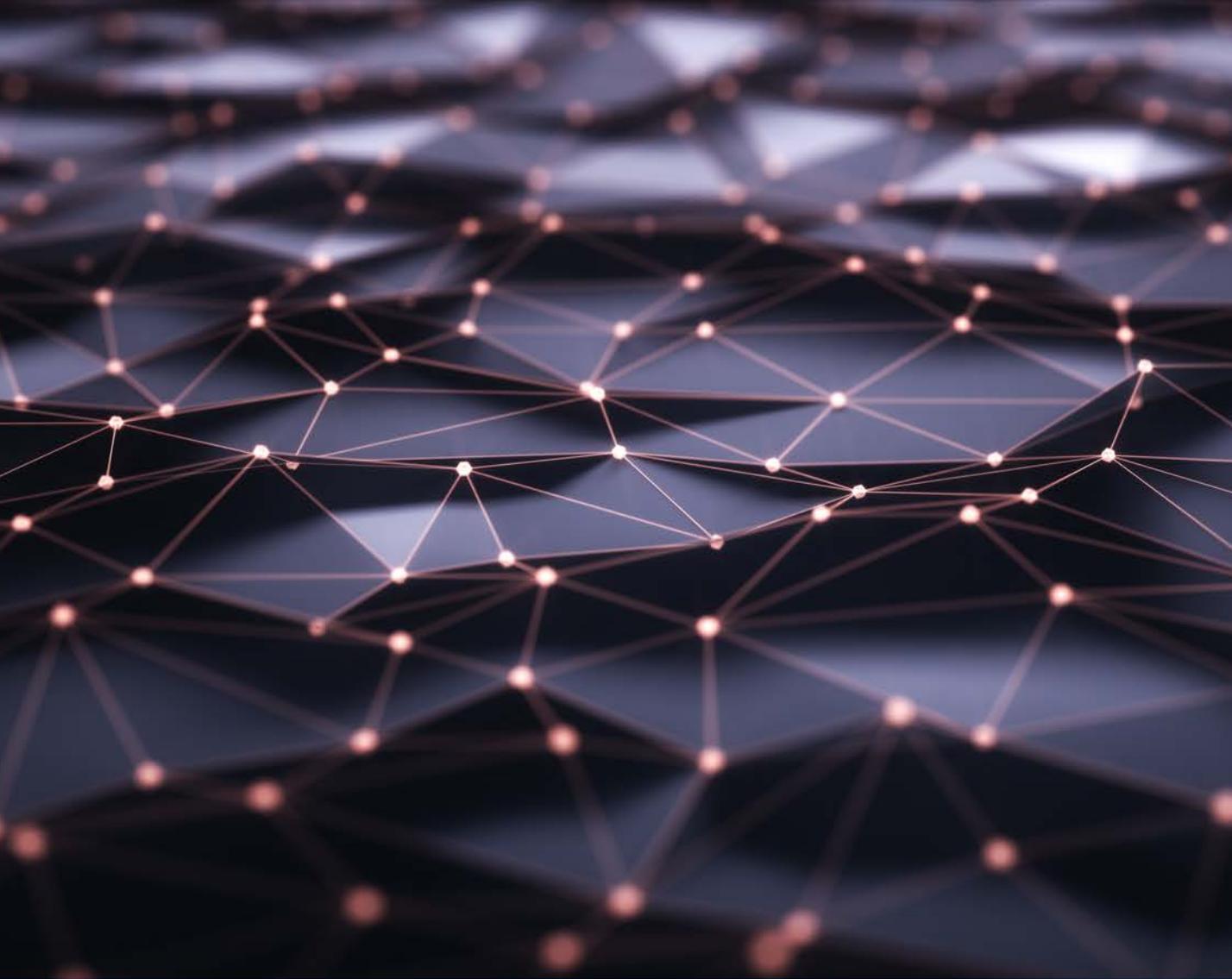


**BIOKKER®**

**Technology**

biosintel



**Performance and Improvement of our Technology**

Biokker is an indoor air cleaning system which is used to remove any compound or organic particle, living or inert, that is dissolved in the air of a any given zone.

The purifying technology employed by Biokker is based on an advanced photo-catalysis process called oxidative, included in the so called AOTs (Advanced Oxidation Technologies), with the ability to remove contaminants in the gas phase by UV. This oxidative activity takes place in the sealed reactor inside each device.

Today, we are still searching the way to enhance the photo-catalytic activity of the nanosized  $\text{TiO}_2$  material through the use of transition metals in order to modify the band-gap energy. The technology used in our devices has been substantially improved by the incorporation of a second semiconductor, zirconium oxide ( $\text{ZrO}_2$ ), with a greater bandwidth to substantially increase photo-catalytic activity.

This way we achieve higher levels of efficiency in pollutants elimination due to a considerable increase in the surface area with respect to the previous use of  $\text{TiO}_2$ .  $\text{ZrO}_2$  in combination with  $\text{TiO}_2$  is not only highly photoactive, it is stable under UV-irradiation, it has very reduced toxicity and still makes it possible to be utilized affordably from a commercial point of view. The result is BLOKKER, the new generation of photo-catalytic oxidation.

Biokker uses two semiconductors as catalysts employing photons in the UV range of the solar spectrum as energy generating free radicals which act by oxidizing the volatile organic compounds and purifying the air.

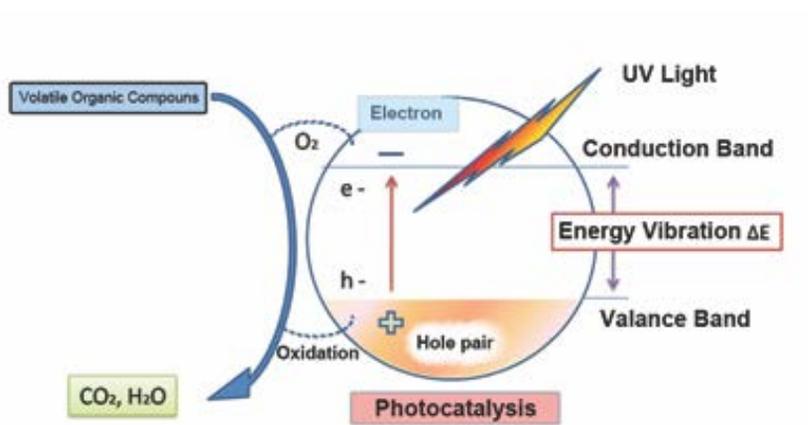
When the photo-catalyst  $\text{TiO}_2$  and  $\text{ZrO}_2$  absorbs ultraviolet light (UV) from the bulbs the absence of an electron occurs in the valence bands, also called electron-hole pair, the electron hole contributes to the passage of electric current through the semiconductors.



The electrons of the valence bands of titanium and zirconia dioxides are energized if incised by a UV light ray of an appropriate wavelength. The energy associated with the light makes the electrons to move up towards the conduction band of both dioxides, creating positive hole pairs and negative electrons in the catalyst. This stage of the action of the photo-catalyst is called semiconductor's "state of photo-stimulation".

The titanium/zirconia dioxide positive gap forms hydrogen gas and hydroxyl radicals. The negative electron reacts with oxygen molecule to form superoxide anion. This cycle goes on indefinitely as far as there is a source of light available.

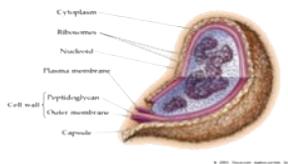
The organic molecules are coupled in the same way with the active sites of the catalyst (negative electron and positive gap) and with the free radicals generated on the surface of the titanium and zirconia dioxides. The result is a complex series of cascade reactions whose end products are CO<sub>2</sub> and H<sub>2</sub>O in trace amounts and zero organic matter.



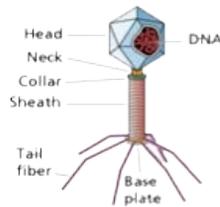
The action mechanism of the catalyst inside the device is designed to remove any organic compound dissolved in the air and passing through the photo-catalyst chamber, from volatile organic compounds (VOCs) to prokaryotes cells provided with cellular walls, therefore reaching all of airborne microorganisms, virus, moulds and yeasts, bacteria, fungi and their products (mycotoxins, allergens...). Furthermore, this technology presents another important application in the removal of toxic compounds that cause bad odours which generally contain N or S (hydrogen sulphide, formaldehyde, mercaptan...).

The airflow passing through the catalyst is calculated so that the performance of the catalyst approaches 99.99%, intervening both, the matrix composition of the two dioxides and the way the supports are placed, which are of crystalline origin, and especially designed to achieve the maximum performance.

Given the nature of the photo-catalytic process, it is important to remember that no bacterial cells are crippled, but completely decomposed into CO<sub>2</sub> and H<sub>2</sub>O also destroying the genetic material (RNA or DNA).

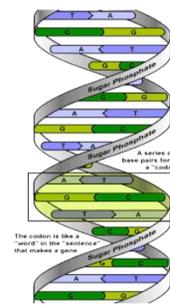


**Bacteria**

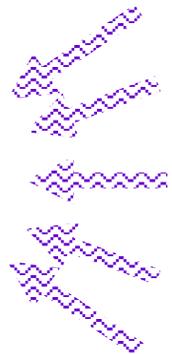


**Virus**

**ADN/ARN**

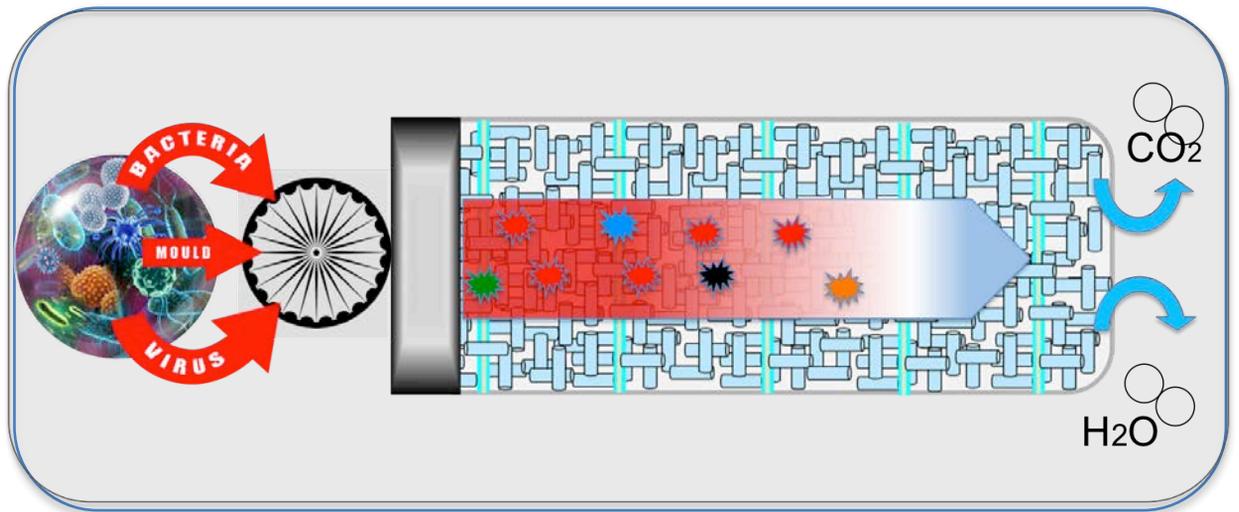


**LUZ-UV**



This fact gives the catalyst indefinite, inexhaustible life, making it a self-cleaning element that requires no maintenance or replacement. The TiO<sub>2</sub>/ZrO<sub>2</sub> do not deteriorate, thus it shows a prolonged antimicrobial effect.

Biokker operates continuously 24 hours a day, it produces no harmful by-products, it does not generate Ozone, and it works during the development of any activity, without interfering with the work performance of people or with any existing disinfection, prevention, AC or ventilation equipment.



### Main advantages when using the technology of photo-catalytic oxidation Biokker

- Great improvement of indoor air quality
- Energy efficient
- Reduces the number of air renewals
- No Ozone emission
- Photonic activation
- Considered green technology
- No harmful by-products or emissions
- One single annual maintenance required
- Contaminants are removed, not modified
- Easily adapting to varying operation conditions
- Operates at room temperature and atmospheric pressure
- Not a filter, it does not collect or keep pathogens or allergens, it eliminates them
- Not a filter, it does not discriminate particles by size
- The only chemicals required are  $\text{TiO}_2$  &  $\text{ZrO}_2$  and the  $\text{O}_2$  present in the air
- No ducts required and can be combined with other air treatments
- High oxidative power & low selectivity, allowing the degrading of multiple compounds & mixtures





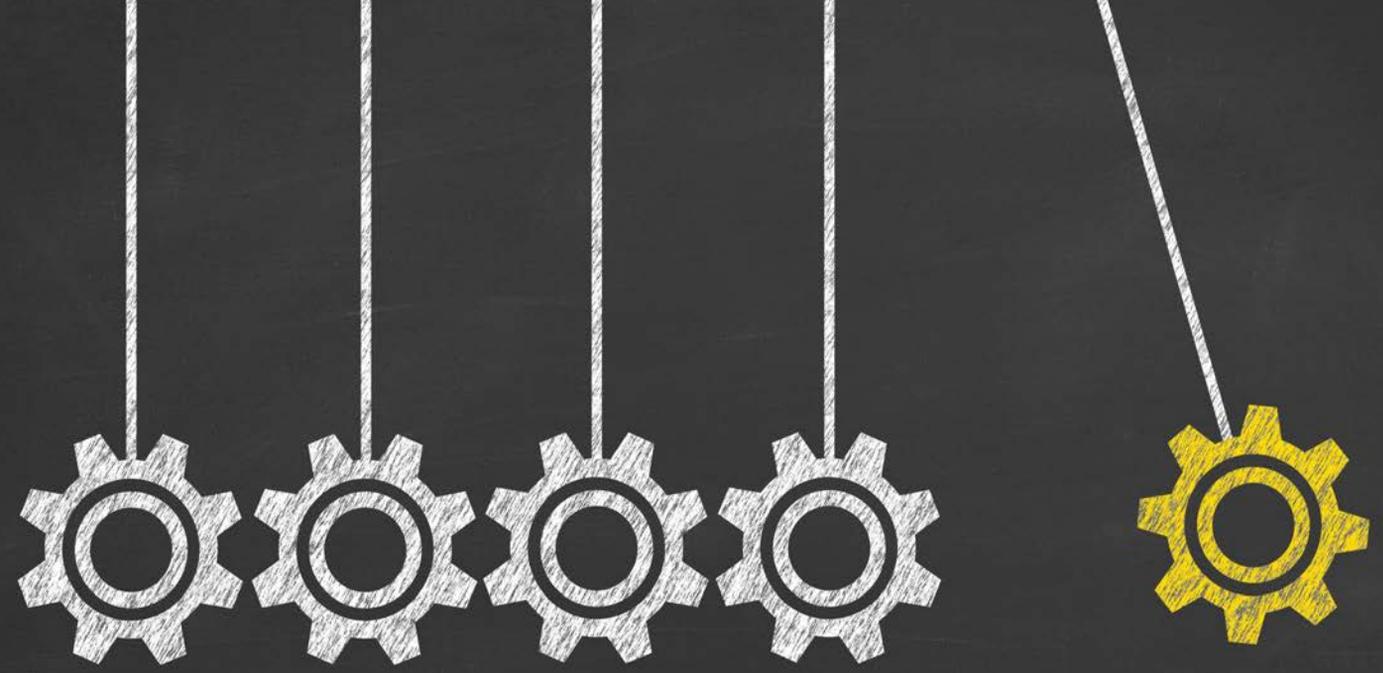
# Airflow

Biokker devices are installed independently in any environment. This autonomous system reinforces its performance due to its independent operation within any single area continuously mixing the treated fresh air with the existing untreated one as well as through the natural air movement and/or the forced air in the room itself. Moreover, its effectiveness is further reinforced by the ducts of the various existing air systems within the same interior environment.

Our device is versatile, it can be installed in any room and its performance also involves adjacent areas because the air travels towards those adjoining areas, especially if they are connected by air conditioning or heating ducts.

Removal of contamination, and therefore, consequent air purification is achieved by forcing the passage of air through the photo-catalytic reactor located inside the system, where a chemical reaction produces clean pure air. This clean air is then mixed with the remaining air present which is still contaminated. This combined action of mixing pure and polluted air is repeated continuously and uninterruptedly resulting in the reduction of solid particles and gaseous contamination within the whole space.

In any given space, usually new pollutants are constantly introduced by opening outside doors, windows, etc., in addition to the internally generated gaseous chemicals and the organic matter carried by people, so air processing must happen continuously. The key to the maximum efficiency of our Biokker device is the continuous operation and its exceptional ability to remove microorganisms in a single pass.



## Types of Air Sanitizers

There is a wide range of devices that assure their ability to clean, disinfect or sterilize the air, from devices for personal use to the ones that supposedly clean the air of an entire building as part of the central air conditioning or ventilation system. They are all filtering devices by means of the use one or more HEPA filters, electro-statically charged filters, carbon filters, elite filters, ozone generators, UV lamps, loading plates, working as generators of negative or positive ions, or finally there is photo-catalyst oxides, such as TiO<sub>2</sub>.

Most systems on the market today have documented evidence on particulate removal, usually based on dust removal through a limited performance measuring system called CADR(Clean Air Delivery Rate), which measures only the removal of dust, pollen and smoke.

**HEPA Filters.-** High Efficiency Particulate Air filters are used to reduce the number of indoor air pollutants. A true HEPA filter will retain 99.97% of all particles  $\geq 0.3$  microns, however they have several disadvantages: it is a filter, it can suffer leakage, especially when used in vacuum form, it has a high initial cost and replacement expenses, it requires constant maintenance and filter changing, it has high energy consumption, and it has a variable and diminishing air flow due to constant obstructions. Also these systems do not remove viruses, gases (VOCs) or odours.

**MERV Filters.-** Or pre-filters are common filtering elements in air conditioning systems. Most of these eliminate about 95% of particles of  $\geq 10$  microns but are not efficient on microorganisms or virus, against the VOC's or odours.

**Carbon Filters.-** Also called charcoal filters work from a system of suction, filtration and extraction through microscopic removal sponges, in order to trap odours and some VOC's, which it will eventually release back into the environment when facing the slightest minimum temperature change, contributing to higher concentrations of the same odours and gases originally existing in the air.

**Electrostatic Precipitators.-** These use a process of electrically charged plates to attract dust, so that some microorganisms can be picked up along with it. The biggest drawback is that the collector has to be kept always clean in order to maintain effectiveness. The other big problem is that these devices generate Ozone.

**Ozone Generating Systems.-** Outdoor pollution is composed in most part by Ozone. The competent authorities recommend an Ozone exposure of “zero” and supposedly the standard measure for levels of Ozone exposure should be a maximum of 0.08 ppm. Despite this, Ozone generators are still sold in the market under the mistaken idea of being ions and fresh air generators, plasma and cold plasma creators, negative ions or atomic oxygen developers, etc. These devices produce gaseous hydroxyl radicals by Ozone. The radicals attack randomly any organic matter that encounters, including people. A high concentration of Ozone is required in order to kill microorganisms, so its use is not safe at all near people. The sale and use of Ozone generators is already prohibited in many countries.

**Ultra Violet Light (UV).-** Traditionally, ultraviolet lights are placed within the return air ducts in the air conditioning main systems in order to prevent the entering of microorganisms or to destroy the already stored ones. Currently we know for a fact that this method, in general, does not use enough energy or time for an effective removal of microorganisms.

**Photo-catalytic Oxidation.- BIOKKER.-** It is NOT a filtration method used for trapping and storing pollutants, reason why the particle size or its composition are irrelevant since Biokker fragments the chemical bonds of the organic material and neither the gas particles nor the gas (VOCs) are kept within or stored.

The Biokker devices do not use ionic charge technology to trap pollutants on any kind of plates. Also unlike gaseous hydroxyl radicals generated by the Ozone generators, hydroxyl radicals created during the photo-catalysis inside the unit remain entirely contained within the device.

Biokker utilizes UV light basically to energize the catalyst and to activate the hydroxyl radicals which will chemically react with the COVs. Our air sanitation technology uses a nano-particle science to create a membrane of dioxides (titanium & zirconia) that is photo-catalytically active without delaminating.

Biokker is easily installed, requires no special ducts, it is energy efficient because it is low consumption, it contributes to energy saving in general as it reduces the number of air renewals needed to achieve the optimum air quality required by current environmental regulations, and it needs only one single annual maintenance for the replacement of the UV bulbs.

**Conclusion.-** Numerous “air filtering” devices on the market assure to clean the air. Some are partially effective, but each and every one of them has disadvantages and limitations in comparison with the Biokker technology. Some filtration technologies, such as HEPA filters, have become obsolete and therefore they would no longer be up to the current air sanitizing needs. In fact, when considering that most of the suspended particles in the air are not even filterable, these technologies are not even reliable. Biokker does not filter nor store pollutants, it effectively removes particles in suspension: bacteria, virus, mould, fungi, spores, allergens, mites, odours and volatile organic compounds that pass through the device.



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