WO3*-BASED PHOTOCATALYTIC TECHNOLOGY: SAFETY, ROS** RELEASE IN THE ENVIRONMENT, BPR CLASSIFICATION

**** Tungsten Trioxide***
***** Reactive Oxygen Species***

Photocatalytic Technology and Release of Reactive Species: Efficacy and Safety

Vitesy's indoor air purifiers use photocatalytic technology, which allow to reduce and degrade in an efficient and safe way gaseous pollutants and airborne microorganisms.

Photocatalytic filters clean the air through the **creation of Reactive Oxygen Species (ROS) and Radicals, in the immediate proximity of the filter surface**, as already widely demonstrated by the scientific literature, see for example [1-4] in Bibliography.
The reactive species, thanks to their **very powerful oxidizing action, degrade microorganisms and pollutants** in an extremely short timespan and with very high conversion yields [3, 4].

The peculiarity of the photocatalytic technology is precisely the **ability to create a layer of ROS on the filter surface** (a few mm thick) **without releasing the same ROS and Radicals in the purified air** and thus **preventing their diffusion** in the environment
In this sense, the photocatalytic technology differs from other air purification technologies such as:

- HEPA filters *(effective mainly against dust and other solid particles)*
- UV-C rays *(which produce ozone as a byproduct -irritating for lungs- and require long exposition times, making them unsuitable for occupied spaces)* [5]
- Ozonizers *(which produce great quantities of ozone - irritating for lungs)* [1]
- Ionizers *(effective in retaining dust but producing ozone as a byproduct -irritating for lungs)* [1, 6]
- Cold Plasma *(which has to create a large amount of ROS in order to be effective)* [1].

As proof of its safety, many studies in the literature confirm that **the purified air released by photocatalytic filtering machines**, has **negligible quantities/concentration of active**

substances such as ROS (ozone, peroxides, radicals and ions): **so low**, indeed, that they **can not even be measured** with dedicated, professional instruments[1].

Last but not least, on the website of the *California Air Resources Board* (CARB) [2], which has become one of the most strict regulators of Air Quality in the world, **none of the appliances identified as potential emitters of ozone uses photocatalytic technology.**

Tungsten Trioxide (WO3)-based Photocatalytic Technology: the New Frontier, Even Safer and More Sustainable

Following our Continuous Evolution mantra, **at Vitesy** we've decided to use the **most advanced and innovative version of the photocatalytic technology.**

In the first version of Natede we've used the more classic implementation of the photocatalytic technology, with a Titanium Dioxide (TiO2) filter coating that requires a UltraViolet (UV) light source for activating the photocatalytic reaction.
In the **product evolution *Natede Smart*** (www.vitesy.com/natede-smart - launched August 2021) and in our newest product **personal air purifier *Eteria*** (www.vitesy.com/eteria - available from January 2022) we're using instead a **filter with a Tungsten Trioxide (WO3)-based coating.**

The move to such coating allowed us to **employ visible light LEDs for the activation of the photocatalytic reaction** in place of UV light sources, which is instead needed in the case of TiO2-based coatings.
This **entails great advantages** both **in terms of energy consumption (much lower)** and **lifespan (much higher) of the visible light LEDs** that activate the photocatalytic process, compared to UV light LEDs, which perform worse in both respects.

The switch to visible light LEDs, in addition, **eliminates all risk factors linked to the use of UV light,** that is:

- **Ozone emission** *(which was anyway negligible even in the 1st version of Natede)* - ozone is a lung irritant;
- Potentially **dangerous for the eyes** *(only if observed directly and for a long time)*.

WO3-based Photocatalysts: Safe and Non-Toxic

Speaking of the potential dangerousness (toxicity) of the **substances used as photocatalysts**, it is important to note that they are positioned **within the device**, in the form of **hard coating (anodization) of the photocatalytic filter** which is hit with visible light and therefore it is **not in direct contact** nor with people or pets during use.

In addition, the hard **coating won't release particles in the environment**, since it's **applied** through an **anodization process** (creating a very tight bond with the carrier) and, just as important, is **NOT subject to any form of mechanical attrition or impact/shock** but only to the flow of pre-filtered air.

Therefore, the filter position within the device and the strong bond of the coating to the carrier are a **guarantee of the safety of the photocatalyst even for the use in occupied rooms.**
This means that the core purification technologies used by Vitesy Air Purifers are safe and present no risks for the people staying in the rooms and environments where the devices are placed.

Photocatalytic Devices & "Biocidal" Classification: State of the Art

Turning specifically to the topic of the biocidal product, which are regulated in the EU area by the BPR - *Biocidal Products Regulation* (EU Regulation nr. 528/2012 and following modifications), **the application of such regulation on devices emitting Reactive Species, such as those using Photocatalytic technology, is still not fully defined** and thus **not yet implementable**, even though the analysis in this sense is underway.

At present, the BPR regulation defines biocidal substances as follows (Article 3.1.a): *" [...]*

- *any substance or mixture, in the form in which it is supplied to the user, consisting of, containing or generating one or more active substances, with the intention of destroying, deterring, rendering harmless, preventing the action of, or otherwise exerting a controlling effect on, any harmful organism by any means other than mere physical or mechanical action;*
- *any substance or mixture, generated from substances or mixtures which do not themselves fall under the first indent, to be used with the intention of destroying, deterring, rendering harmless, preventing the action of, or otherwise exerting a controlling effect on, any harmful organism by any means other than mere physical or mechanical action.*

A treated article that has a primary biocidal function shall be considered a biocidal product.".

AT THE REVISION DATE OF THIS DOCUMENT, **only some guidelines have been defined on the information requirements** about free radicals generated *in situ* and for the approval of related substances used as biocides in a document of the *Health and Food Safety Directorate General* of the European Commission [7].
In such document, treating the **topic of product authorization**, it is expressly required to **take as reference the mixture** *(in the case of Vitesy filters, the photocatalytic elements)* which, **applied as coating** on a carrier, is **able to generate free radicals** (also through the use of light) **.**

At present, however, it is still unclear how and what information is required to classify these products as biocidal products and to authorise their use.

Bibliography

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