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# Illumination and Simultaneous Germ Reduction with Light

by Thomas WALENTOWSKI, Dipl.-Ing.(FH); AURORA Lichtwerke

**Light creates emotions and since the introduction of LED technology, it has become easier to realize these emotions, e.g., with infinitely variable color control, color temperatures from cold to warm that can be adapted to the mood, and the integration of lighting into smart home and building management systems. However, light also has biological aspects, such as health, well-being and human performance, which have been pursued for years with the Human Centric Lighting approach, for example.**



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Mr. Walentowski studied Precision Engineering at the University of Applied Sciences in Munich. He is Head of Business Unit Light & Sanitization at AURORA Lichtwerke and has been intensively working on the new disinfective technology with the combination of purple and white light in close cooperation with the Italian partner NextSense S.r.l. Formerly Mr. Walentowski had held various management, sales, marketing and product management functions in the European lighting industry. From 2013 to 2016 he was a Board member of LightingEurope.

## Illumination and Sanitization

With the new sanitizing technology, which sounds almost too fantastic to be true, an important health aspect is now added: The dual function illumination with integrated preventive germ reduction by combining white with purple (blue-violet) light. Light, mind you, not UV-C radiation. It is based on the invention of the Italian company Nextsense S.r.l. (European patent applications EP3442603 and EP3491290) [1].

It involves the combination of different wavelengths with varying intensity in the purple range between 400 nm and 430 nm and white light up to 700 nm, i.e. within the visible range of the electromagnetic spectrum. When the light is switched on, the germ reducing effect also begins, and it is completely harmless for both people and animals that are present in the room without any time limit.

By combining different purple wavelengths (Figure 1), the effectiveness is significantly increased compared to solution approaches that work with only one wavelength, and at the same time the range of action is extended, i.e. many types of bacteria and viruses can be combated with the new sanitizing light technology. A ratio of approximately 1 W of sanitizing purple light and 800 lm luminous flux has proven to be particularly effective. The germ reduction starts when the light is switched on and increases continuously with the exposition time, and the risk of infection decreases accordingly. The microbicidal effect of the sanitizing light is due to so-called photosensitizers, which occur naturally in microorganisms, absorb the purple wavelengths of light and subsequently produce oxygen radicals in the cells, which then destroy membranes, proteins and DNA, killing the cells from inside [2] (Figure 2). The mechanism is not reversible, so that no resistance can develop.

## Microbiocidal Efficiency and Evidences

The effectiveness of the new sanitizing technology against bacteria and the SARS-CoV-2 virus has been confirmed in several studies, e.g. by the Finnish research institute VTT<sup>1</sup>, the French CEA (Département Médicaments et technologies pour la Santé)<sup>2</sup>, and studies by La Sapienza University in Rome, as well as the University of Salerno<sup>3</sup>. Another multicentric study within the European Bio-Defense Laboratory Network, involving the Italian Celio military scientific department, the Swedish military research institute and the microbiological institute of the German Armed Forces, is to be published soon. In the CEA study, conducted in a BSL3 laboratory, the concentration of SARS-CoV2 viruses was reduced by over 99% in one hour.

## Photobiological Safety According to IEC 62471, Harmless for Humans and Animals

Since sanitization is always active when the light is on, photobiological safety according to IEC 62471 is of crucial importance in addition to effective germ reduction. In tests performed by TÜV Rheinland, for example, the BIOVITAE A-60 household lamp was classified in the lowest risk group 0, i.e. the light is completely harmless to both humans and animals even when switched on for long periods of time.

<sup>1</sup>Mr. Satu Salo, Mrs. Hanna-Leena Alakomi, VTT Technical Research Centre of Finland Ltd.: Field study on the microbicidal efficacy of the BIOVITAE® lights installed in the first aid of the Leonardo da Vinci airport, Rome.

<sup>2</sup>Mr. Laurent Bellanger, CEA France, Direction de la Recherche Fondamentale, Département Médicaments et technologies pour la Santé, Service de Pharmacocinétique et d'Immunoanalyse, Laboratoire Innovations Technologiques pour la Détection et le Diagnostic: Study report assessment of the inactivation of the SARS-CoV2 by the BIOVITAE® lamp.

<sup>3</sup>Prof. Anna Angela Barba, Università degli Studi di Salerno, Impianti & Processi - Difarma Microbiologia - Difarma: Protocolli per l'irraggiamento a LED di alimenti per il prolungamento della conservabilità.



## Differentiation and Differences to UV-C

In contrast to the new purple sanitizing light, the significantly shorter wavelength UV-C radiation (usually 254 nm, less often 222 nm and 273 nm), damages the DNA and RNA of microorganisms in a short time and thus prevents their reproduction, but also harms human cells. Therefore, almost all UV-C disinfection devices available on the market work with disinfection chambers hermetically sealed from the environment, because the open application of UV-C radiation is very dangerous.

Purple sanitizing lamps are absolutely safe, in contrast to open UV-C disinfection lamps with timers and motion sensors. For example, if someone falls asleep while watching TV in the evening under purple sanitizing lights, this is totally harmless; but with UV-C lamps this can be very dangerous if the motion sensor does not respond due to lack of movements and the UV-C lamp therefore does not switch off; the person who fell asleep would then wake up with severe skin burns.

Another great advantage of the new purple light technology compared to central UV-C disinfection devices, and also room ventilators, is the decentralized arrangement of the lights in the room (for example above the desks, or at home in the floor lamp next to the sofa): germ reduction takes place exactly where people are.

And finally, commercially available UV-C lamps usually have to be replaced after 8000 hours to 12 000 hours, while BIOVITAE lamps and luminaires have lifetimes of between 20 000 hours and 50 000 hours.

## Applications and Reduction of the Risk of Infections

Therefore, the purple sanitizing light is predestined for simple, efficient germ reduction and at the same time completely harmless for humans and animals in all indoor spaces with many people. Thus, germ reduction with purple light as an integrated part of normal room lighting covers a very wide range of applications; like school classrooms, kindergartens, hospitals, doctors' and dentists' offices, hairdressers' salons (Figure 3), government offices (e.g. registration office, vehicle registration office) and last but not least in family homes.

The use as a pure purple supplementary light would also significantly reduce the

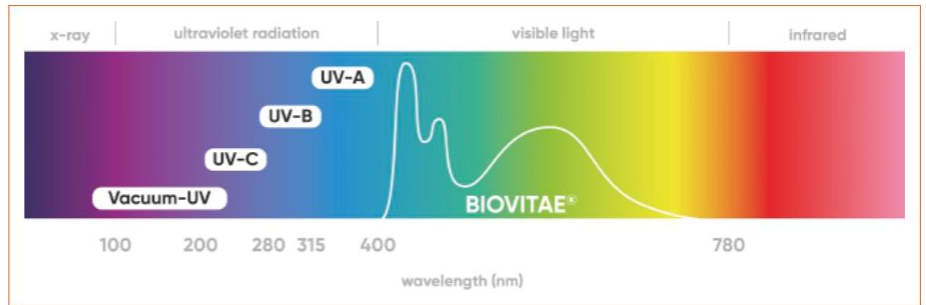


Figure 1: Sanitizing spectrum (BIOVITAE), Source: Nextsense S.r.l.

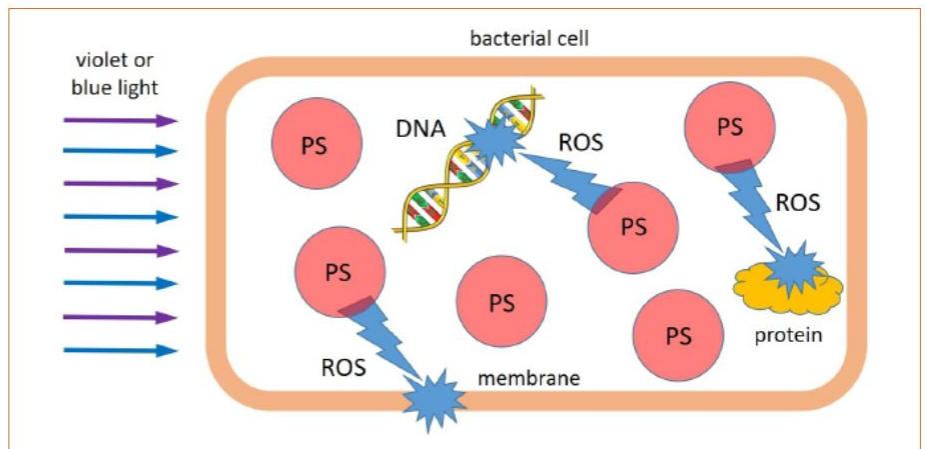


Figure 2: Scheme of the disinfection mechanism of blue and violet (purple) light for bacteria [2] (PS: Photosensitizer, ROS: Reactive Oxygen Species, DNA: Deoxyribonucleic acid).



Figure 3: Barbershop by Kardasch Berlin, Grunewald. Photo: Why-5, M. Wurzer.

risk of infection in public means of transportation (for example, buses, trains, cabs). All these applications can be perfectly addressed because the new sanitizing technology is already commercially available in different lamps and luminaires. For example in LED tubes, linear fixtures and LED panels 600x600.

A pilot installation at St. Walburg School, Eichstätt, Germany, has just been finalized; and another school project in Baden-Württemberg will be scientifically accompanied by the Institute of Medical Engineering and Mechatronics, Ulm University of Applied Sciences, Ulm, Germany. Therefore, a logical approach worth considering would be to include lamps and luminaires based on germ reduction with purple light saniti-

zation technology as an alternative to room ventilators and UV-C disinfection devices in corresponding public support programs aimed at reducing indoor infections. ■

## References

- [1] European patent applications EP 3442603 and EP 3491290 Nextsense S.r.l., Carmelo R. Cartiere, Rosario Valles.
- [2] Buehler, J., Sommerfeld, F., Meurle, T., Hoenes, K. and Hessler, M., "Disinfection Properties of Conventional White LED Illumination and Their Potential Increase by Violet LEDs for Applications in Medical and Domestic Environments." *Advances in Science and Technology Research Journal* 2021(15 (2)) (2021).