

Thoughts about Far UVC 222nm applications in response to IUVA guiding document July 2020

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IUVA recently published a document “Far UV-C in the 200-225nm range, and its potential for disinfection applications” [1] assessing the status of 222nm applications and giving guidelines “based on a review by a diverse committee of IUVA members and a fair representations of general consensus”. “The objective of this work is to provide an impartial presentation of the available facts on the technology commonly referred to as ‘far UV-C’ and an analysis based on expert interpretation and knowledge of the field of UV disinfection, safety, and public health. “ Studying the paper one has to come to the conclusion that the paper fails in various aspects to achieve the above goals, gives misleading, biased, incomplete information and comes to conclusions that are neither scientifically valid nor represent a consensus of IUVA.

1. “Analysis based on expert interpretation”

The status as of the day of publication is, that NONE of the recognized experts in the field of 222nm have been contacted, asked for input or interpretation, for insight into ongoing research or upcoming publications. None of the manufacturers of 222nm light sources have been contacted for further information, comments or inside knowledge, or collaboration. That includes the IES and ACGIH photobiological committees, the leading researchers at Columbia University or any of the leading researchers in Japan. As the leading manufacturer and expert in 222nm technology, Ushio can say with confidence that it has not been in contact with the lead authors of this paper about the content, and also has not provided 222nm light sources to the authors that would have been dedicated or used for direct exposure of humans.

It should be noted that the authors, according to their biographies and publications are well known experts in UVGI related to microbial inactivation with UVC and most have made significant contributions to the field. However, it should also be noted that none appear to be experts or have done any research in the photobiological (human or animal) research. And, it appears that all authors have focused all their research and work on the use of UVC for water treatment. The lead author is employed by a reputable UV company that specifically focuses on the application of UVC LED.

2. “fair representations of general consensus”

The authors describe the key knowledge of the disinfection by UVC and far UVC accurately and sufficiently and note the general accepted disinfection mechanism of far UVC correctly in that DNA/RNA damage and potential protein damage are the key mechanisms creating microbial reduction. It is true that the amount of reliable research and inactivation data available for 222nm is significantly lower than for 254nm sources. It should be noted that the same applies for UVC LED (with wavelengths of typically 260-280nm).

However, it must be noted that not one publication exists that even indicates that 222nm would not work as a UVC germicidal source. It is indisputable that results by different researcher vary, and that results depend on the environmental and test conditions. The authors miss to note that this applies to all germicidal, especially UVC, applications. It is therefore very surprising to read “validation of its performance in application is generally lacking”, that “device- and case-specific protocols must be defined to assess manufacturers’ claims” and implying that the currently used experimental validation protocols for UVGI do not apply to the 222nm and further imply that existing research on 222nm is therefore basically useless.

The authors refer to the (in)famous Woods 2015 study [2](using unfiltered(!) KrCl lamps) as “moderate” irradiation levels (40-104mJ/cm²). Not only do they reference dose (mJ/cm²) as irradiation levels (mW/cm²), but they also “forget” to mention that those levels are 2-5 times higher than the currently established ACGIH/ IEC62471 levels. They also omit to mention ALL research done with filtered(!) 222nm sources [3] [4] [5] [6] [7] [8] [9] [10] [11] [12] [13]. At the same time they ignore or downplay EVERY other research result indicating the eye and skin safety of filtered 222nm light within ACGIH limits (and well beyond). Again, if the authors would have contacted anyone leading the research or has deeper knowledge about the subject than the authors themselves, this could be a much more balanced review.

The authors also claim that current guidelines for maximum exposure “are for maximum unintentional exposure and are not intended to define repeated exposure guideline”. It seems like here the authors draw a last straw to discredit 222nm technology. Since there is no better guideline available, every application and device refers to standards to establish a safe application. The authors go even further, without evidence, indicating contrary to anyone’s knowledge that “far UV-C remains widely considered to represent a skin and eye damage hazard ..” (beyond ACGIH guidelines?). Again, if the authors would have contacted people that are involved and knowledgeable in these matters, they would have known that soon to be published human studies [13] [7] [8] with filtered 222nm (again) show safe exposure at rates that are 20-300 times higher than current standards and in some cases have been performed over extended times This would have prevented them from wrong statements like “studies have not extended to the exposure of human individuals and so conclusive evidence on acute and chronic exposure is lacking.”

In addition the authors come to the conclusion without evidence and proof that “In summary, the fluence required to achieve common disinfection targets often exceeds these limits, and where the limit is higher, it is not by more than an order of magnitude. Thus, a broad ‘safe disinfection window’ does not exist and any application must be carefully reviewed.” It is somewhat true that an “order of magnitude .. safe disinfection window” may not exist yet. However, it should be considered that the current ACGIH limits for filtered 222nm is 22mJ/cm². Many viruses and bacteria have D99 dose values of less than 15mJ/cm² (Corona viruses typically less than 2mJ/cm²). Admittedly, there are several microbials, specifically spores, that need significantly higher doses (e.g. 20-40mJ/cm²). However, that does not mean that the technology can or should be discounted.

Further on the authors feel competent to elaborate about ozone production by far UVC. Again, would the authors have contacted anyone knowledgeable of 222nm excimer lamps (like Ushio), the facts could have been explained quickly. Instead, a 90 year old publication is referenced to substantiate their misleading claims. The fact is that 222nm radiation from KrCl lamps does not produce ozone in any measurable amount! However, it must be mentioned that certain designs of excimer lamps will produce ozone. That is mostly related to the wire mesh structure of the outer electrode where corona discharges will occur which create ozone. Through sophisticated technical design the ozone generation can be

eliminated or reduced to insignificant levels. So, the statement of the authors that “systems designed to apply far UV-C radiation either to or through air will generate some ozone during their operation” is wrong. However, I agree that the ozone production of far UVC devices should be evaluated (similar to UVC (254nm) air cleaners) under existing guidelines and standards.

3. Summary

It is laudable that IUVA attempted to explain far UVC (222nm) technology to the public. However, by ignoring all experts in the field, including the manufacturers and users of the technology, the authors failed to inform the public in a balanced way, and make it sound like their opinion is the opinion of IUVA. Instead the authors come to the conclusion that “Far UV-C is a promising technology that demands further investigation, though it is the opinion of the IUVA that this burden of proof has not yet been met.”

4. Statement

It is without doubt that the enhanced eye and skin safety of filtered 222nm has only been discovered recently and the results of more research are only coming in slowly. Within the 7 years of the first discovery there has not been ONE research result that would even give a sliver of an indication that the application of filtered 222nm light within ACGIH limits has any negative effect on humans. In fact, ALL research indicates that the current limits are by magnitudes too conservative.

Top researchers around the world continue their efforts to contribute more findings, not as an effort to “whitewash” the technology, but to deepen our understanding and give a much better understanding of the risks and benefits.

Filtered 222nm light is a somewhat special technology since suddenly different science and technology branches meet, that had previously rare reason to talk- Photobiological (looking at the effects of photons on humans etc.) and antimicrobial science (germicidal effects on microbials). Moreover, the major current germicidal equipment market is water treatment, with some lesser amount in (forced) air and surface (HVAC) and minor application in upper air treatment. None of the main applications even consider human exposure to UVC.

That brings us to the term “risk”. Filtered 222nm cannot, does not and will not eliminate risk (presence of microbial burden, or some interaction with humans or the environment). However, all the existing evidence, together with the theoretical models substantiates that humans are rather safe while microbials are not (aka will be reduced). ALL current models and measurements and findings support this, not one research result contradicts this.

It should be noted that manufacturers of 222nm light sources cannot and should not ever make “claims” regarding predicting “disinfection rates” in final applications. Ushio and its customer provide a 222nm light source that will provide a more or less defined amount of 222nm radiation with a more or less defined light pattern and spectrum.

Ushio also provides an overview of microbial reduction results by various researchers, however we expect that these laboratory results will likely not be achievable (or measurable) in practical applications, especially in air.

So, should filtered 222nm be applied today, or shall humanity wait until all risks are eliminated (as the authors suggest- complete all clinical studies and eliminate all “risk factors across a broad range of characteristics such as age, gender, race, and medical conditions”)? The current Covid crisis clearly indicates that new approaches to microbial control and reduction have to be taken, especially when it comes to occupied spaces and air. Care 222 is currently one of the very few options to improve the situation, in combination with existing cleaning, disinfecting and social behavior measures. Discounting this exciting option and stating “The IUVA recommends that far UV-C not be implemented as an unshielded disinfection technology” by the authors is neither helpful to humanity nor does it support the goal of IUVA to support the enhancement and application of UV light.

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