Characterisation of high irradiance level 254 nm UV sources for UVmeter calibration

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UVC light around 254 nm is used in many applications that requires high irradiance levels up to 150 W/m². We have investigated several types of sources to determine their ability to produce such level of irradiance for the purpose of the calibration of UVC radiometer. Low-pressure mercury lamps with amalgam as well as newly developed UVC LED show good performances. We present the results of the characterisation in irradiance level and spatial uniformity for both sources.

INTRODUCTION

UVC light is use in many applications and particularly for the disinfection of water, air and surfaces, but also for sterilisation in the medical field. For all these application high irradiance levels are used on the order of 150 W/m² and there is a need for calibration of UV meters on this level range.

However today calibration laboratories have limited irradiance range less than 20 W/m² at 254 nm due to the type of sources used.

We have investigated several UVC sources in order to determine their suitability to produce the required irradiance levels. In this paper we present the results of the characterisation performed on two parameter: irradiance level and spatial uniformity.

SOURCE PARAMETERS

The sources investigated will be used for UVC meter calibration. Therefore they have to comply with some characteristics that are :

- Irradiance level that should be about 150 W/m²
- The spatial uniformity should be limited to 5% on a circular area of 3 cm²
- A temporal stability less than 1% over one hour

The focus was made on the first two parameters but a rough estimation of the temporal stability was evaluated. In complement to these physical parameters, the cost of the source was also taken into account.

We have investigated four types of sources:

- Laser and laser diodes
- Laser driven light source (LDLS)
- Mercury lamps with almalgam
- UV LED

SOURCE CHARACTERISATION RESULTS

UVC laser can reach the required irradiance levels. However such source is not cost effective. UVC laser diode s are not available yet on the market.

LDLS needs a UV filter and a lot of light is wasted limiting the UVC output level.

Low pressure mercury lamps with amalgam [1] exhibit high UVC throughput with about 85% of 254 nm light.

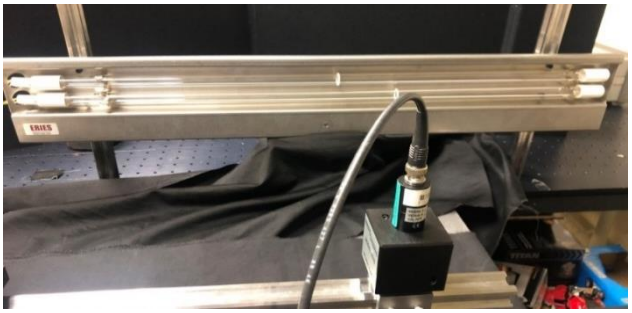

Figure 1. Amalgam UVC source.

Using the set-up shown on figure 1 with two 1m long lamps an irradiance level > 200 W/m² was reached at a distance of 10 cm from the lamp. The spatial uniformity was better than ±2% over a disc of one inch in diameter.

A new device like the one shown on figure 1 is under development and will integrate shorter lamps: 4x57 W with 36 cm in length. The beam profile based on simulation is shown on figure 2.

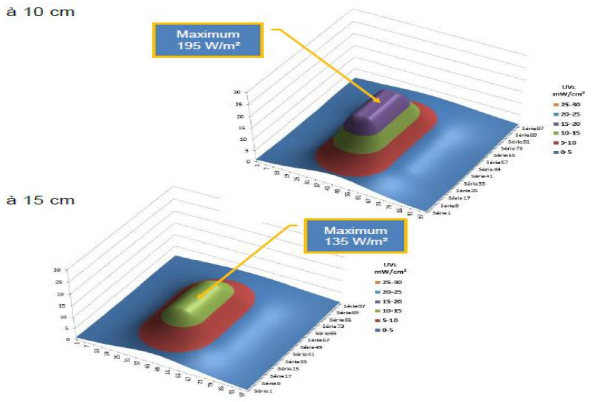

Figure 2. Beam profile of the new Amalgam UVC source.

UV LED are developing rapidely and recently 5W are made available for UVC applications. These LED have a 10 nm spectral bandwidth and can have a angular distribution of 7°, 35°, 120°. Figure 3 shows the angular distribution of the 35° wide LED.

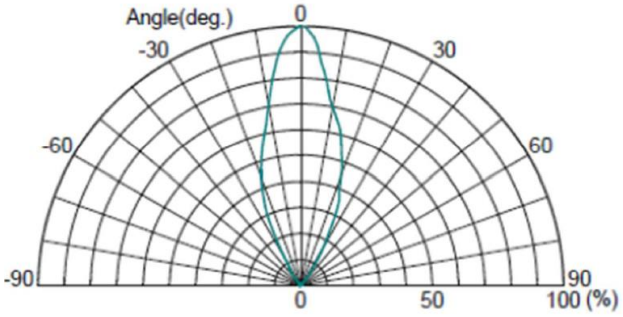

Figure 3. Angular distribution of the UVC LED.

In order to obtain the required irradiance level the LED should be set in an array and an optic should be added. Optical simulation based on the following parameters has been made:

- Data from figure 3
- Radiometric specifications from the manufacturer
- A 5x5 array with 32 mm x and y dimensions
- A focusing lens in the 2f optical configuration

The results of the simulation is show on figure 4. At a distance of 90 mm from the source, the irradiance level is about 290 W/m² and the spatial uniformity is ±2.2% over a disc of 1 inch in diameter.

The UVC LED were delivered by mid of January 2020. By the time of the conference experimental results will be available

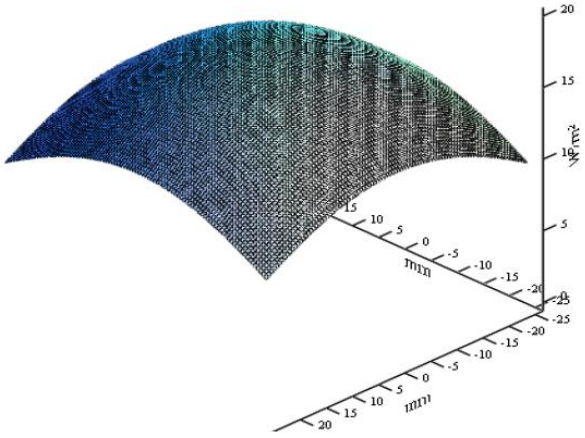

Figure 4. Simulation of the beam profile of the 35° wide UVC LED source.

CONCLUSION

Low pressure mercury lamps with amalgam and newly developed UVC LED show good performance to allow high irradiance level and can be used in calibration set-ups for UV radiometer.

REFERENCES

1. Ultraviolet Light in Food Technology: Principles and Applications, Larry J. Forney, Carmen I. Moraru à ISBN10 1281993689 à ISBN13 9781281993687.