Reference UVC LED Source

S.V. Nikanenka, A.V. Danilchyk, E.V. Lutsenko

B. I. Stepanov Institute of Physics National Academy of Sciences of Belarus, Minsk, Belarus
s.nikonenko@dragon.bas-net.by

A compact reference UVC source based on state-of-the-art commercially available LED has been developed at B.I. Stepanov Institute of Physics NAS of Belarus. The paper presents the design and results of the study of the optical characteristics of the radiation of the reference UVC LED source.

INTRODUCTION

UV radiation is widely used to solve various engineering and scientific problems. Efficiency, quality and safety of work performed using UV radiation, is largely determined by the quality of the preliminary metrological support of these works.

There are a number of problems in metrological insurance in the UV spectral region. First of all, it is a significant reduction in the accuracy of the transfer of measured units size from national standards of the corresponding optical quantities to working units in the CIE UV ranges. Second, when measuring in the UV CIE ranges, it is necessary to use a power meter with constant spectral sensitivity inside these ranges and zero outside it, which is very problematic due to the lack of high-quality UV filters. Third, the accuracy of the results of measuring optical characteristics of UV radiation is reduced significantly due to the difference in spectral distributions of the radiation intensity of the test and reference radiation sources.

One of the promising ways to improve the accuracy of measurements in the UV spectral region is the use of reference radiation sources created on the basis of LEDs, due to their stability and long lifetime. Earlier, the Institute of Physics of the NAS of Belarus has developed a number of reference radiation sources for the CIE UV ranges based on LEDs [1 - 3]. In the article the design of the created new reference CIE UVC LED source describes.

DESIGN UVC LED SOURCE

A reference UVC LED source (RUVCS) based on state-of-the-art commercially available one LED emitting at wavelength of 265 nm.

The source operates as follows: the injection current is supplied to the LED chip 1, the temperature of which is regulated by the Peltier element 4 based on the resistance value of the thermistor 5. The heat generated by the Peltier element is removed through the base 6 and is additionally cooled by a radiator of water or air cooling 11. A temperature controller Arroyo TECSource 5305 were used to stabilize temperature of the RUVCS.

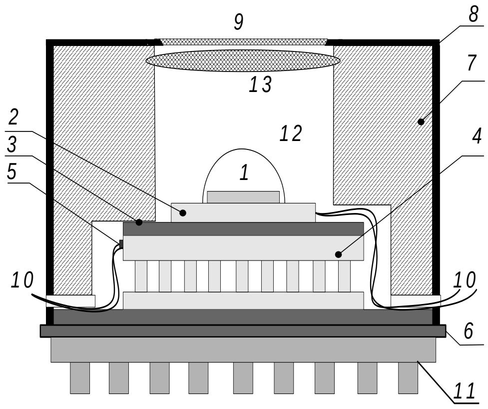

Figure 1. Picture of reference UVC LED source

OPTICAL CHARACTERISTICS OF THE SOURCE

The measurement of optical characteristics of LEDs and RUVCS was carried out using setup for the measurement of optical characteristics of UV-NIR SSL sources emission [4]. The measurements of the were performed at 25ºC stabilized temperature.

The inset in figure 2 shows the angular distribution of the radiation intensity of the LED chip. As can be seen from the far field, the radiation intensity is approximately the same within the cone 20º. The observed jumps in the radiation intensity are due to the fact that the LED lens projects an image of the chip to infinity. The radiation intensity jump corresponds to the electrode of the LED chip. To reduce the intensity heterogeneity in this angle, we used a 5° holographic diffuser (inset on Fig. 2).

However, the obtained radiation intensity levels of the RUVCS are insufficient for calibrating UV radiometers. Therefore, a correcting lens 13 and a holographic diffuser 9 are included in the design of the reference source (Fig. 1).

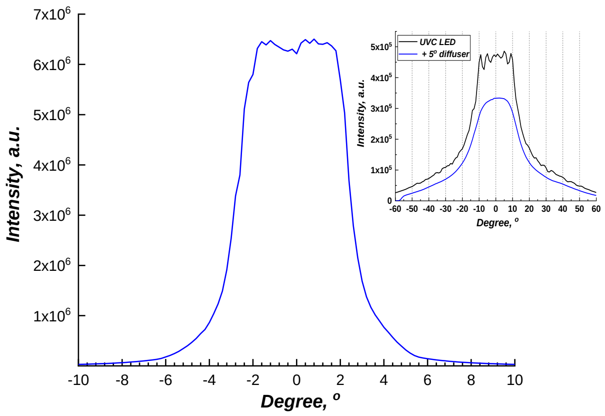

Figure 2 Radiation intensity of reference UVC LED source as a function of angle. Inset shows radiation intensity of UVC LED and UVC LED at 5° diffuser

As can be seen from Fig. 2, only the use of the correcting lens made it possible to increase the power density of the RUVCS by an order of magnitude and significantly reducing the inhomogeneity of radiation intensity in the far field. Fig. 3 shows the dependence of the power density on the injection current at measurement distance 0.5 m from RUVCS and the LED chip.

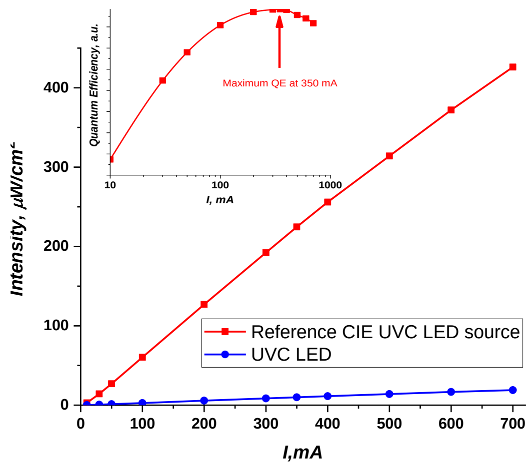

Figure 3 Intensity of reference UVC LED source as a function of injection current. Inset shows radiation intensity of UVC LED and UVC LED at ± 5° diffuser

As can be seen in the inset in Fig. 3, the maximum quantum efficiency is achieved at an injection current of 350 mA. This corresponds to a power density of >200 μW/cm², which provides a fine level for calibrating UV radiometers. Therefore, we recommend this injection current level for source operation. At this level, the radiation spectrum is independent of the viewing angle within the essential radiation intensity levels (±5º).

As can be seen from Fig. 4, the radiation intensity of RUVCS are about 5% at the boundary between UVC and UVB ranges.

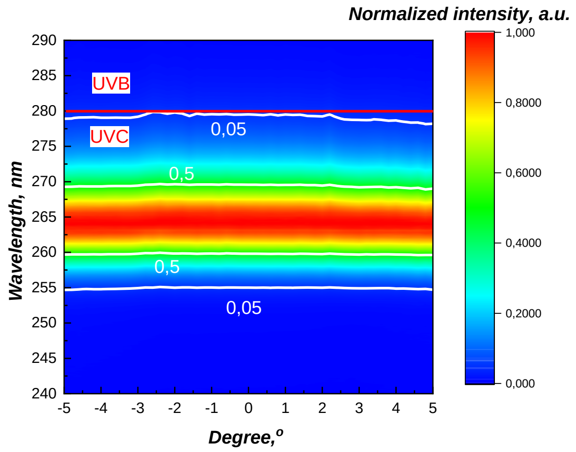

Figure 4 2D color mapping of reference UVC LED source normalized spectra as a function of angle

Fig. 5 show the distribution (±2%) of the radiation intensity of RUVCS without holographic diffuser in the working area at distance 0.5m. The additional use of 1º holographic diffuser in the source leads to an improvement in the uniformity of the distribution of the radiation intensity density up to ±1%.

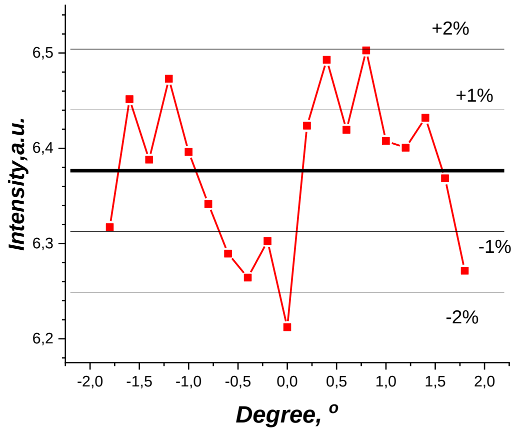

Figure 5 Intensity of reference UVC LED source in the working area

REFERENCES

1. S.V. Nikanenka, *et al.*, A practical method for determination of averaged spectral radiance of UV LED, in Proceedings of 28th CIE session, CIE 216:2015, Vol. 1, Part 2, 1396–1400, 2015.
2. S.V. Nikanenka, *et al.*, Reference UV LED Sources, in Smart Lightning for Better Life: Proc. of the Conf. at the CIE Midterm Meeting 2017, 984–989, 2017.
3. S.V. Nikanenka, A.V. Danilchyk, E.V. Lutsenko, Compact reference UV-LEDs sources with conical diffuse reflectors, in Proceedings of 29th CIE session, CIE x046:2019, Vol. 1, Part 2, 1193–1194/4, 2019.
4. S.V. Nikanenka, *et al.*, Setup for measurement of the optical characteristics of UV-NIR solid-state light sources emission, Proceedings of NEWRAD 2014, ed. S.Park et al., 350-351, 2014.