REFERENCE LAMP AND DIRECTIONAL RADIATION SOURCE WITH LED SPECTRUM

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For assuring the traceability of luminous flux measurements for "white" LEDs, NSC "Institute of Metrology" (Ukraine) has developed prototypes of a reference lamp and a directional radiation source that uses an incandescent lamp with correction filters. The spectrum of the developed sources corresponds to the LED spectrum.

INTRODUCTION

The transition to energy efficient LED light sources causes certain problems with the accuracy of measurements of their luminous flux. These problems are associated with two components: reproducing the luminous flux for LED sources and transferring the unit to the working measuring instruments. The first component is related to the fact that the reproduction of the luminous flux of reference lamps in most measurement standards in the world is carried out using integrating sphere photometers. As a rule, they are spheres with a diameter of 1.5 meters or more (Figure 1).

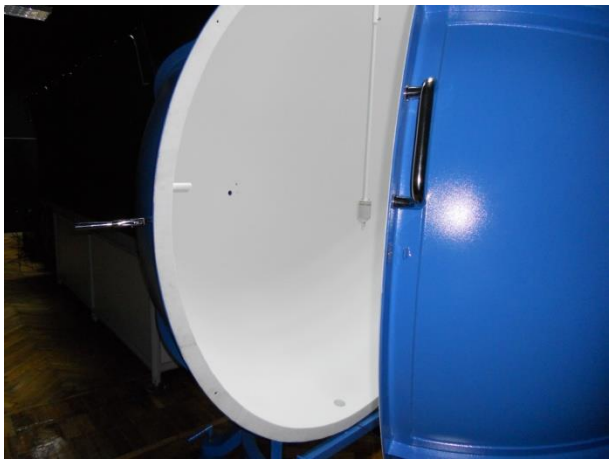

Figure 1. $BaSO_4$ coated sphere

The result of measuring the luminous flux of a LED source using a calibrated directional luminous flux from a reference lamp (type A) will contain significant type B uncertainty (up to 5% [1]). This may be due primarily to the difference in the relative spectral sensitivity of the integrating sphere photometer from the visibility function V(λ), since the emission spectra of the reference incandescent lamp and the "white" LED source are significantly different.

The method for reproducing and transferring the luminous flux for LED sources developed at NSC "Institute of Metrology" (NSC IM) allows to eliminate this problem [2].

To test this method, a prototype of a reference lamp of the unit of luminous flux was developed at NSC IM in order to assure the measurement traceability of LED radiation sources. A prototype of a directional radiation source was also developed for calibrating reference integrating sphere photometers.

Both of these prototypes are based on incandescent lamps with correction filters to obtain the spectrum of a standard "white" LED lamp.

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For a halogen lamp, a bulb with correction filters was developed. A cooling system is provided inside the bulb. Figure 2 shows the photo of a lamp prototype.

Figure 2. A prototype of a reference lamp with correction filters developed at NSC "Institute of Metrology"

The relative spectral characteristic of the lamp was measured on a integrating sphere spectrometer.

The integrating sphere spectrometer was calibrated with a reference tungsten halogen lamps of the FEL type with known characteristics. The result of the relative spectral characteristics of the luminous flux is shown in Figure 3.

The results obtained indicate good repeatability of experimental studies with the theoretical model

within the difference between the real spectral transmission of filters from tabulated values and the difficulty of taking into account all parameters in the theoretical model.

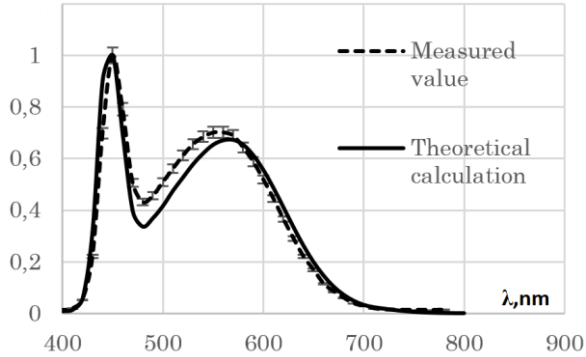

Figure 3. Relative spectral characteristics of the luminous flux of the lamp prototype – theoretical model and measured values

REFERENCE RADIATION SOURCE WITH LED SPECTRUM

For calibrating a reference integrating sphere photometer according to the scheme shown in Figure 4, a prototype of a reference radiation source based on an incandescent lamp with a radiation correction filter for the spectrum of a LED source was developed.

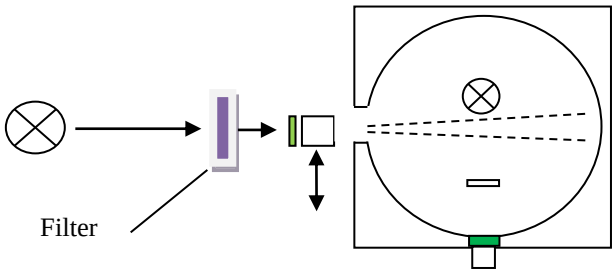

Figure 4. Functional scheme of the installation for reproducing and transferring the unit of luminous flux to LED sources

The results of studies of the relative spectral characteristics of the radiation of directional source by a spectrometer (developed by NSC IM) are presented in Figure 5.

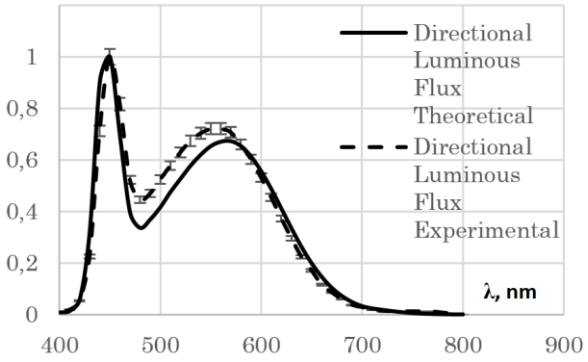

Figure 5. Relative spectral characteristics of the luminous flux of the directional source prototype – theoretical model and measured values

The obtained study results demonstrate a good repeatability.

CONCLUSIONS

The study results of the developed prototypes of the reference lamp and the directional radiation source demonstrate the possibility of realization of theoretical models for LED sources with different emission spectra. Due to the high long-term stability of the reference incandescent lamps compared to LED lamps, the creation of highly stable reference lamps for LED calibrations is possible. Due to the synthesis of the spectrum of the reference lamp prototype, which is close to the spectrum of the standard "white" LED, the difference in the sensitivity of the integrating sphere photometer to LED and the developed prototype does not exceed 0.26% (for a integrating sphere photometer with a difference from $V(\lambda)$ $f' = 6\%$).

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