

# Development of an ultraviolet irradiance meter suitable for measurement of UV-LEDs

K. Miyasaka\*, I. Serizawa\*, S. Kobayashi\*, K. Kinoshita\*\*, K. Godo\*\*

\* ORC Manufacturing, Co., Ltd., 4896 Tamagawa, Chino, Nagano, 391-0011, Japan

\*\* NMIJ, AIST, 1-1-1 Umezono, Tsukuba, Ibaraki, 305-8560, Japan

*Abstract*-- Many ultraviolet (UV) irradiance meters are designed and calibrated to measure the irradiance of mercury lamps; however, this kind of meters arise a spectral mismatch error of several tens of percent in measuring the irradiance of UV-LEDs. This error was difficult to correct in many situations because of the variety of UV-LEDs spectra, resulting in low measurement accuracy. We developed an irradiance meter with a flat spectral responsivity suitable for UV-LEDs measurement, and improved a calibration method to minimize spectral mismatch error. Our UV irradiance meter had succeeded in minimize the error from the difference in UV-LEDs spectra, and thus enable more accurate UV-LEDs irradiance measurements.

## I. INTRODUCTION

In irradiance measurements of mercury lamps with little variation in spectral shape, irradiance meters are designed and calibrated to measure irradiance of mercury-emission lines limited by bandpass filters. On the other hand, central wavelength and spectral shape of UV-LEDs vary among individuals and do not match catalog values. To avoid large spectral mismatch error, it is desirable for UV-LED irradiance meters to have a flat spectral responsivity within wavelength range of UV-LEDs. In this study, to minimize spectral mismatch error in UV-LED measurements, we developed an irradiance meter with flat spectral responsivity in UVA range and its calibration method.

## II. DEVELOPMENT OF UV-LED IRRADIANCE METER

Figure 1 shows a developed UV-LED irradiance meter. The irradiance meter is constructed from an indicator and an irradiance-sensor head.

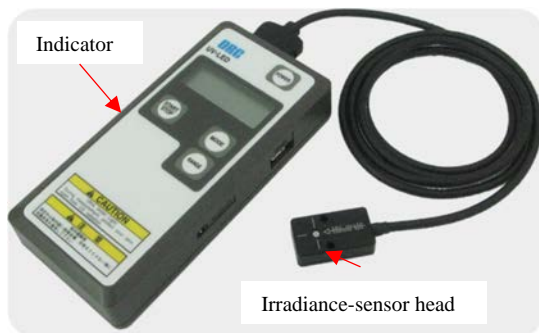


Fig. 1. UV-LED irradiance meter

In general, spectral responsivity in an irradiance meter is determined by transmittance of optical components, e.g. optical filters, and spectral responsivity of a photodiode. To get a flat spectral responsivity in the irradiance meter, optical filters with relative spectral transmittance inverse to spectral responsivity of the photodiode were integrated in the sensor head. The black dash line in figure 2 shows relative spectral responsivity of the sensor head. The

relative spectral responsivity was successfully obtained to be almost flat characteristic in UVA range.

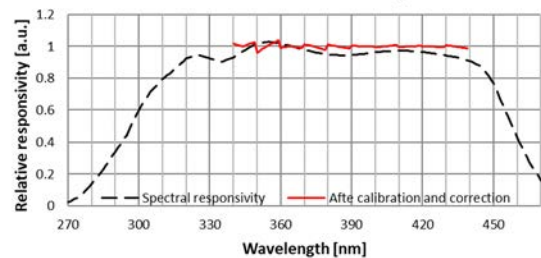


Fig. 2. Spectral responsivity of the irradiance-sensor head.

## III. CALIBRATION AND CORRECTION

To further reduce the spectral mismatch error caused by the non-flat component of spectral responsivity, a monochromatic light source consisting of a xenon lamp and a monochromator was developed as a calibration light source. By adjusting slit width and wavelength position of the monochromator, the light source can generate a monochromatic light with both a full width at half maximum (FWHM) of 10 nm, which match to the FWHM of typical UV-LEDs, and arbitrary center wavelengths. Using the light source like a UV-LED spectrum, i.e., using a similar spectral to a test light source in calibration, reduce the spectral mismatch error in UV-LEDs measurement. The calibration results for each central wavelength were stored within the indicator, and the measurement results are corrected for each time measurement. The red line in figure 2 shows relative spectral responsivity of the irradiance-sensor head after calibration and correction. The spectral mismatch error in each measurement of UV-LEDs at 365 nm, 385 nm, and 405 nm was better than 0.5 % after calibration and correction, that this meter has sufficient accuracy.

## IV. CONCLUSION

Our UV irradiance meter had succeeded in minimize spectral mismatch error by integrating the special designed optical filter and improving calibration method, thus enable more accurate UV-LEDs irradiance measurements.