

## Application News

# No. A497

### Spectrophotometric Analysis

## Measurement of Emission Spectra of LED Light Bulbs

Light sources that emit visible light, such as fluorescent lamps and LED light bulbs, have specific emission spectra. The hue of the light emitted by these light sources is determined by what extent to which different wavelengths of light are emitted. When a light source such as a light bulb is developed, measuring the emission spectra of the light source is very important for examining what kind of light the light source emits.

Emission spectra are usually measured with a UV-visible spectrophotometer (UV) or a spectrofluorophotometer (RF). When a UV instrument is used, the emission spectra that are measured incorporate some characteristics of the measurement instrument (instrument function), and are different spectra to those actually observed by a person. Shimadzu's RF-6000 spectrofluorophotometer system includes a function that automatically removes this instrument function (an automatic spectrum correction function). Therefore, using the RF-6000 allows for acquisition of accurate emission spectra that are not affected by the instrument function.

In this article, we present measurements of emission spectra of LED light bulbs using the RF-6000.

### ■ LED Light Bulbs

We measured commercially available LED light bulbs. We obtained eight bulbs in total, four different warm white color bulbs (A to D) and four different daylight white color bulbs (E to H), with each bulb in each group being from a different manufacturer. Warm white bulb A and daylight white bulb E are shown in Fig. 1, for example. The warm white color bulb has a yellowish hue, and the daylight white color bulb is white without any hue.

Fig. 2 shows the sample compartment of the RF-6000. LED light bulbs were fixed in place in a light bulb socket, connected to an external power source by routing the power cord through a hole in the lid of the sample compartment. Seven layers of mesh filter (wire mesh) were placed in front of the spectrofluorophotometer inlet port to reduce the intensity of the light from the LED bulbs. A blackout cloth was laid on top of the instrument as shown in Fig. 3 to ensure no external light entered the instrument during measurement.

There was no need to illuminate the sample with excitation light since the sample itself was the light emitter. For this reason, the shutter on the excitation light side was shut so no excitation light could incident onto the light bulb, and so only light emitted by the LED bulb was measured by the spectrofluorophotometer. The RF-6000 has a large sample compartment that allowed light bulbs to be installed inside the compartment without other adjustments.

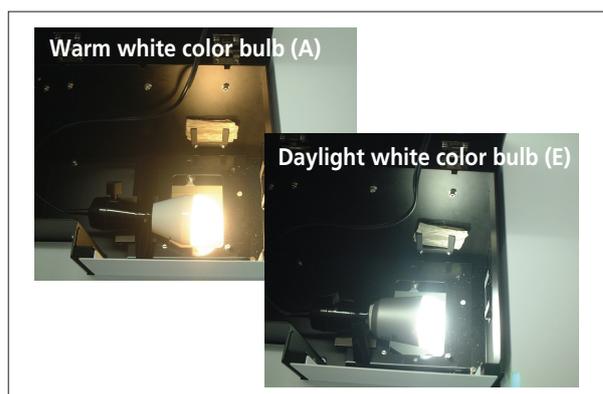


Fig. 1 LED Light Bulbs

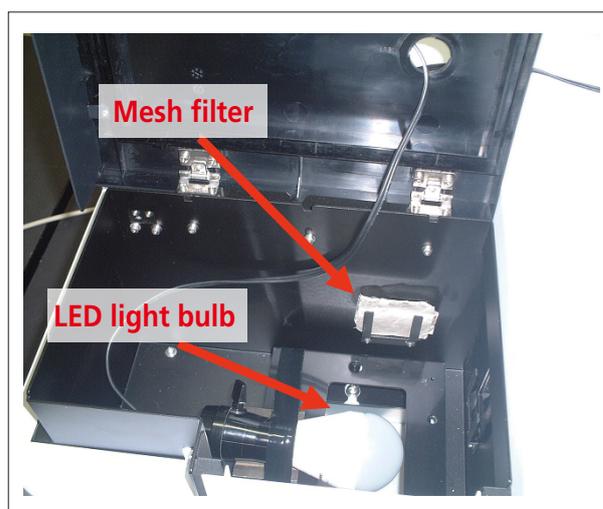


Fig. 2 LED Light Bulb Installed in the Sample Compartment



Fig. 3 Measurements with Sample Compartment Covered with Blackout Cloth

### Measurement of Emission Spectra of LED Light Bulbs

The emission spectra of the warm white color bulbs and daylight white color bulbs measured under the conditions described in Table 1 are shown in Fig. 4 and Fig. 5, respectively. Measurements were taken twice while leaving the sample installed in the sample compartment. Fig. 4 shows that the high intensity of visible light emitted from the warm white color LED bulbs occurred in the green band (500 to 600 nm) and the red band (600 to 700 nm), showing that the yellowish hue emitted from the warm white bulbs was a mixture of light in these green and red bands. Fig. 5 shows that for the daylight white color LED bulbs the area under the graph is approximately equal across blue (400 to 500 nm), green, and red bands of light, and the hueless white light emitted from the daylight white bulb was a mixture of these bands. Fig. 4 and Fig. 5 also show that there are differences in peak wavelength and peak profile even between the LED light bulbs of the same color type. This demonstrates that different LED light bulb products of the same color type emit slightly different colors.

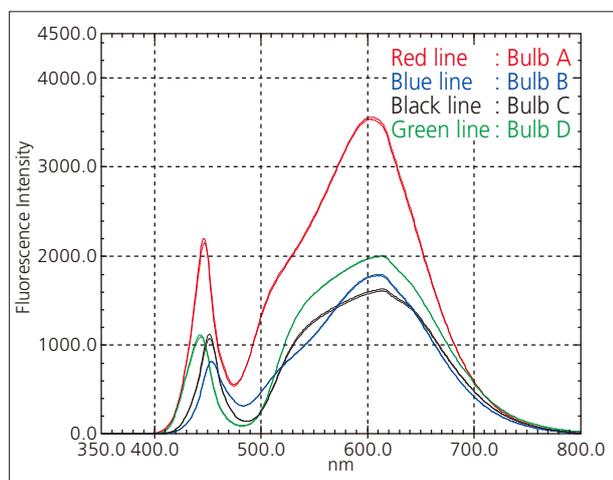


Fig. 4 Emission Spectra of Warm White Color Bulbs

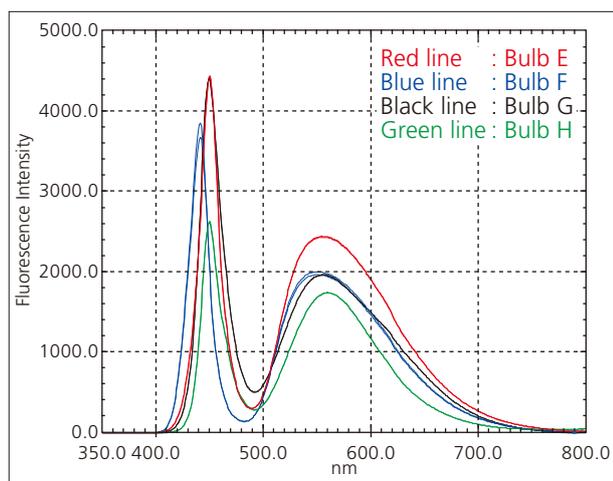


Fig. 5 Emission Spectra of Daylight White Color Bulbs

Table 1 Analytical Conditions

Measuring Instrument	: RF-6000 spectrofluorophotometer
Spectrum Type	: Emission spectrum
Excitation Wavelength	: 350 nm
Measured Wavelength Range	: 350 nm to 800 nm
Data Interval	: 1.0 nm
Scanning Speed	: 600 nm/min
Bandwidth	: Ex 5 nm, Em 5 nm
Sensitivity	: Auto

### Comparison of Corrected Spectrum and Uncorrected Spectrum

The RF-6000 records the corrected spectrum after removing the instrument function as well as the uncorrected spectrum without the instrument function removed. Fig. 6 shows a comparison of the corrected spectrum and the uncorrected spectrum measured from a warm white color light bulb (sample A). This comparison shows the large discrepancy between the corrected spectrum and the uncorrected spectrum. A corrected spectrum is needed to be able to understand the correct status of light emission.

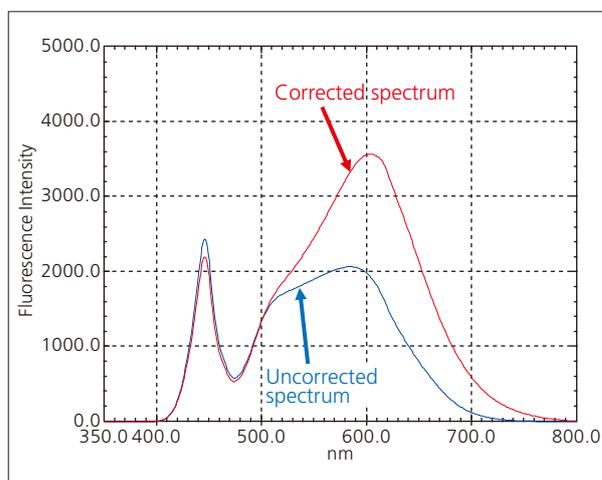


Fig. 6 Corrected Spectrum and Uncorrected Spectrum of Warm White Color Bulb (Sample A)

### Conclusion

The RF-6000 has a large sample compartment that allows large samples such as light sources to be installed inside the compartment without other adjustments. The RF-6000 also has an automatic spectrum correction function that allows for automatic acquisition of measured spectra with the instrument function removed. The RF-6000 enables the collection of accurate emission spectra from light sources including LED light bulbs.