§17. Evaluation of White-Color LED Flat Panel for an Alternative Light Source for Plasma Visible Spectroscopy

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This work has been conducted as a part of the LHD Project Research Collaboration "Experimental verification of helium line spectroscopy models by intermachine and intermethod comparison".

One of the main objectives in this research is to develop an imaging spectrometry using a liquid crystal-based tunable Lyot filter[1] and apply it for the line-intensity ratio analysis of atomic helium lines based on a collisional-radiative (CR) model [2,3].

The Lyot filter we have been adopted is based on polarization interference between multi-stage optical units. The wavelength tunability is achieved by varying the retardation of the nematic liquid crystals in each unit. The filter (CRi: VariSpec VIS-7-20) has 7 nm FWHM pass band and 12 % transmittance at 550 nm. Tunable range of the Lyot filter we use is 400-720 nm. We have identified the leak-band characteristics, which appears presumably due to the misalignment of the internal optical components, existing at longer than 548 nm at a specific wavelength setting below 455 nm. Therefore, the range of 455-720 nm are usually used.

Proof-of principle experiments in which the Lyot filter imaging spectrometry combined with the CR-model for He I [4] have been conducted in pure helium discharges of the MAP-II(material and plasma) linear divertor simulator in the University of Tokyo [5]. Recently, the field of view has been improved to a considerable degree by modifying the coupling optics including the Lyot filter [6].

In such an imaging diagnostic, *in situ* intensity calibration can be regarded as useful. However, the guaranteed calibrated area for conventional standard lamps is limited. Therefore, we evaluated the applicability of white-color flat LED panel as a standard light source [7].

An intensity-calibrated low dispersion spectrometer (StellarNet inc. EPP2000C) was used to evaluate the LED panel. The wavelength range of the A6 LED panel (140 × 91 mm^2 in light-emission surface area) is 420-750 nm as shown in Fig. 1(a), which covers the ordinal range of our visible Lyot filter.

Emitted light from the LED panel surface is reflected by dot-shaped white inks on the back surface of the acrylic plate forming the non-uniform marble pattern. Therefore, a polyester sheet is used as the diffuser as recommended by the supplier.

The angular dependence of the irradiance of the A6 LED panel was measured. Sweeping the angle between the viewing chord and the normal direction of the panel surface, the irradiance and the wavelength distribution of the center point of the panel are obtained. As can be seen in Fig. 1(b), this observation shows that, at the angle within ±30 degrees, the irradiance is not smaller than 95 % to the irradiance at the 0 degree. It indicates that on the light axis, the bright optical system such as F/1.4-1.7 can be used.

Uniformity of the irradiance was also checked to be acceptable especially for the intensity ratio measurement. Therefore, we concluded that the LED panel is applicable in particular in the visible spectroscopy as a large-area standard lamp.

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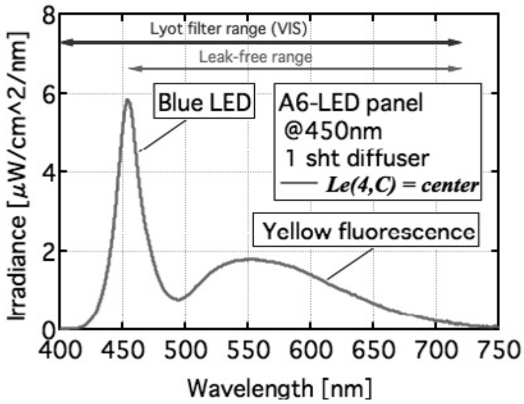
(a)



(b)

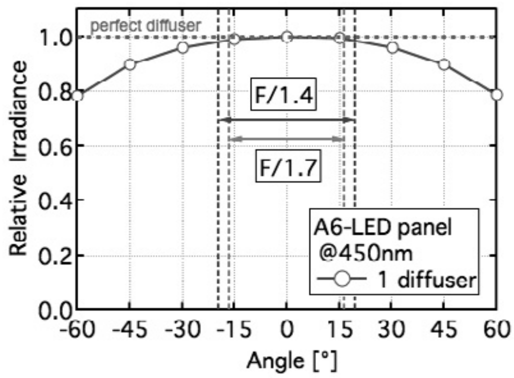


Fig. 1 Optical properties of flat white-color LED panes of A6 size. (a) Spectral irradiance (b) relative angular distribution of the irradiance at 450 nm. Note that the irradiance exhibits unity for perfect diffuse reflector, since radiance shows cosine while the observing area shows reciprocal of the cosine dependence on the observing angle.