Area: 4 Organic and Dye-Sensitized Solar Cells

PV FOR INDOOR USE AND ITS STANDARDIZATION

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While sunlight changes with weather and time, humans usually operate in bright places, so their living areas are filled with light. The power density of outdoor direct sunlight is on the order of 1 kW / m^2, whereas in indoor light, the indoor lighting intensity is 1000 lx, which is bright, the power density is about 3 W / m^2. Energy harvesting is to utilize energy that is weak but abundant in the environment. Such an autonomous power source should be useful though the generated power is not comparable to a commercial power source but can be used wherever there exists illumination. So far, PV energy harvesting technology has been used in limited items such as calculators and watches. In recent years IoT (Internet of Things) technology that everything is connected to the network has been attracting much interest. In such systems, sensor networks that collect information from objects is used to produce so-called big data and trilion sensors will be installed in the future [1]. To disseminate such many sensors, it will be enevitable to use a wireless network and an autonomous power supply using energy harvesting.

Though crystalline Si (c-Si) solar cells are superior to other solar cells in terms of efficiency, durability for out-door use, it is not the best in indoor applications. In recent years, several companies have announced the practical application of organic solar cells (DSC and OPV) for indoor use. Organic solar cells show high conversion efficiency for indoor light with less anxiety for durability and can utilize other features such as flexibility, color, and/or transparency, and can expect future markets. However, there is no standard light source or measurement method for evaluation and its standardization is desired.

Thus the JEITA-ET-9101 standard [2] has been created and published as such solar cell evaluation method for indoor use. After the style of IEC 60904, the standard indoor light source are is decided. Furthermore, detailed method of evaluating solar cell with indoor light such as classification of light source, measurement method of illuminance, reference solar cell, IV measurement method, etc. are described in the standard. Among them, we decided the standard indoor light spectrum for three kinds of light sources: sunlight (indirect light from outside, D50), fluorescent lamp(F), LED lamp(L), which are shown in Fig as well as the illuminosity function. They are based on the lamps that are readily available from the market and thery all have a color temperature of 5000 K. As a method of setting the illuminance, a reference cell method composed of reference indoor light, a method of calculating using spectral sensitivity and spectral irradiance (PRISM method), and a luminometer method are specified. In the reference cell method, one needs an indoor reference cell that is calibrated for the standard indoor light. The indoor spectral matching factor of a light source is defined in the standard, and it is recommended that light sources with good spectral matching factor should be used for the illuminometer method. For accurate adjustment without a calibrated reference cell, the PRISM method is recommended.

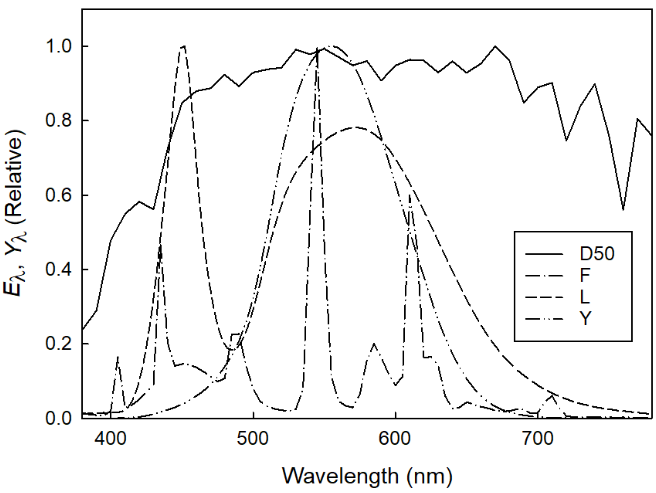

Fig. Spectral irradiance of standard indoor lights (D50, F, L) and luminosity function (Y).

Acknowledgment

This work is based on the discussion in the OPV Standardization Group in JEITA.

References

[1] J. Bryzek, Sensor Magazine, **5**, 6 (2014).

[2] JEITA ET-9101, “Photovoltaic device evaluation method for indoor light”, http://www.jeita.or.jp/japanese/public_standard/