光無線給電用のデザイン性を高める太陽電池のカバー構成探索

Investigation of cover configuration of solar cells that enhances appearance of OWPT

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1. Research Background

Optical wireless power transmission (OWPT) system is an attractive photonic system using light source and solar cell. Nowadays most of solar cells are designed for sunlight. In order to absorb various wavelengths of light, the surface of solar cells becomes black. Such surface property of solar cells can cause lack of design possibilities of equipment appearance used in our daily life. In the practical application of OWPT, this characteristic will become an obstacle.

In OWPT system, the light source is not sunlight, but monochromatic light of lasers or LEDs. The wavelength will be selected considering power transmission characteristics. At current, infrared range is the best wavelength for matured Si and GaAs solar cells. Therefore, although there are many different conditions and restrictions, it is theoretically possible to change the appearance of the solar cell through color filters. And at the same time, it will not reduce the efficiency of the solar cell.

In this research, we are investigating the possibility of controlling appearance of solar cell surface used for OWPT considering maintaining power transmission efficiency. In this time, color and power transmission performance of three types of wavelength filters made by functions of absorption or reflection are investigated.

2. Filter Design for Various Color

The kinds of filters considered are (a) visible dichroic mirror (DIM), (b) visible dichroic filter (DIF), and (c) sharp wavelength cut filter (SCF) based on absorption. The transmission spectra and color (surface side) of examples are shown in Figs. 1 and 2. The photos were taken under room light. The DIM and DIF are designed for angled-reflection and transmission of target visible wavelengths using multilayer structure and it has no absorption. The colors displayed by multilayers are different depending on the angle of the incident light. The color of these filters are changed also by the reflection from backside material, although it will be black solar cell in the case of OWPT. Therefore, when absorbable SCF stacks with DIM or DIF, the surface color is different from DIM/DIF itself.

3. Experimental Setup and Results of OWPT

The light source is an 850nm-VCSEL array whose output power is 1W, and the solar cell module (6cm×7cm) is 2-series connected polycrystalline-Si type (~10%@1sun). The filters whose size is 5cm×5cm are set on the solar cell with 5cm×5cm aperture. The transmission distance is set at 22.5cm in order to irradiate the entire filter area.

The I-V characteristic and output power of the solar cell are measured and results are shown in Fig. 3. Since the transmittance of the filter to the light is not 100%, the efficiency of solar cell which is under a filter is little lower than that of solar cell without filter. One of reasons is considered to be due to no-AR coating on the backside of filter substrate glass.

4. Summary

Under the OWPT light source, it is possible to change the surface appearance of solar cells to some extent without large deterioration of performance.

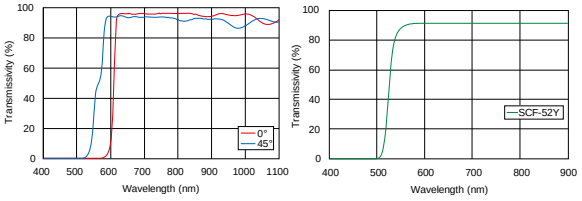
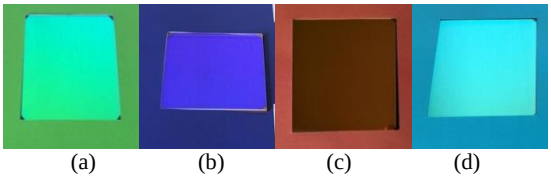


Fig. 1. Spectrum of (left) DIF-RED and (right) SCF-52Y. The data is referred from speck sheet of SIGMAKOKI CO., LTD.



(a) (b) (c) (d)

Fig. 2. Color of (a) DIF-MAG, (b) DIF-YEL+SCF-52Y, (c) DIM-GRE+SCF-52Y, (d) DIF-RED+SCF-52Y. The center is a filter installed on black matter and the outside is the color of printed matter.

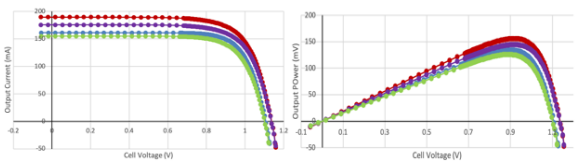


Fig. 3. Output (left) I-V and (right) power of solar cell using different filters. Red: No filter. Purple: SCF-52Y. Blue: DIF-RED. Green: DIF-RED+SCF-52Y.