LED-based Optical Wireless Power Transmission System for Long Distance Operation

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1. Introduction

The optical wireless power transmission (OWPT) is a potential candidate of remotely power transmission technologies. Due to sever regulation of laser for eye-safety reason, LED-based OWPT system is the promising one that can be put on the market easily in near future. However, the design of such system has not been fully investigated yet. In this paper, the guideline of long-distance LED-based OWPT system design and experiment results are shown based on previous report[1).

2. Configuration of LED-based OWPT

The principle of initial system design was reported in [1]. GaAs solar cell and infrared LED was selected for high PV conversion efficiency. Due to spatially incoherent, collimation of LED is hard, thus a lens system configuration for specific transmission distance and irradiation size are indispensable. Based on desired system size and transmission distance, the focal length of lens can be decided by Newton's formula, and irradiation size can be determined by transversal magnification. For long distance power transmission of several meters, the distance between light source and image lens needs to be increased to avoid beam divergence, which also increases system length. System height is limited by aperture size of image lens, and for controlling it, etendue of light source need to be small enough, which means small chip size and narrow divergence angle.

3. Experimental results

The experiment configuration is shown in Fig. 1. A 1.7×1.7 cm^2 GaAs solar cell and an infrared LED (810 nm, 1040 mW, 0.56 mm^2 chip, ±40°) were prepared. An aspheric condenser lens with 32.5 mm diameter and 23.5mm focal length is used to restrain beam divergence, and a Fresnel lens to focus. Totally 11 kinds of Fresnel lenses were tested for comparing. The transmission distance is set from 1 m to 3 m. Experimental results are shown in Fig. 2. The f value is the focal length of Fresnel lens, and D is the aperture size. For lens system, the efficiency will improve with aperture increasing, and at solar cell side, due to a part of intensity was irradiated outside of solar cell, while larger focal length value causes longer interval of lenses, which leads out smaller irradiation size, thus less geometrical loss happened. What's more, smaller irradiation size will also increase radiant intensity, and higher PV conversion efficiency is predictable. For long distance power transmission, increasing focal length of image lens and lenses interval is an effective method to largely improve system efficiency. On the other side, if we notice the 200 mm focal length configuration in Fig. 2, even system performance is satisfied, system length is increased to 23.6 cm, which requires aperture size increasing as well for ensuring system efficiency. Too big system size is drawback in some applications. Thus, increasing solar cell size is another simple but effective method to achieve high power and restrain system size at the same time.

4. Conclusion

The designing of LED-based OWPT system for long distance power transmission and corresponded experimental results were reported. The more detail information will be discussed during conference.

References

1) Y. Zhou and T. Miyamoto, JSAP2019autum, 19p-E204-7.

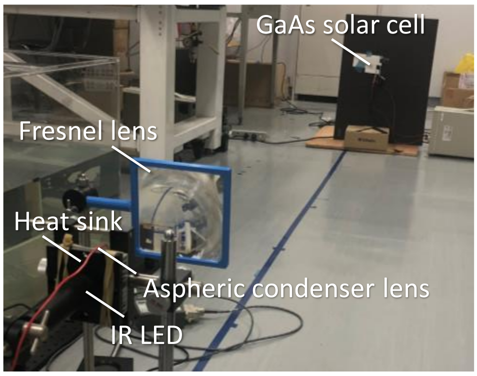

Fig.1. Experiment setting

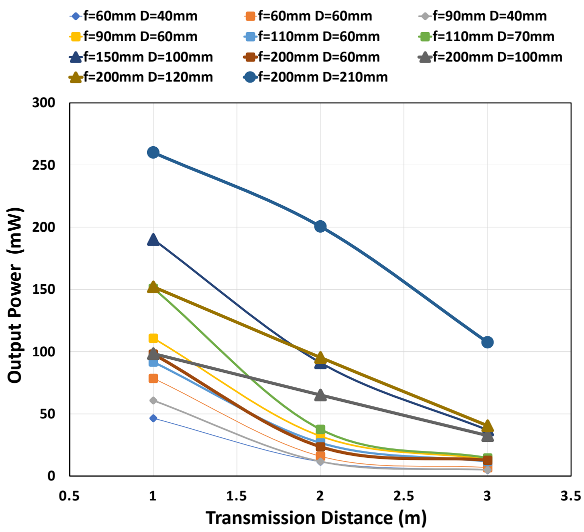

Fig.2. Experiment results