LED-based above 200mW Optical Wireless Power Transmission for Compact IoT

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1. Introduction

Power supplying for IoT (Internet of Thins) always plays as an issue. Wiring and using battery needs maintenance and costs excessive labour and money. Optical wireless power transmission (OWPT) has advantages such as high degree of freedom, which is promising as optimal choice.

In this paper, improved configurations of our LED-based optical wireless power transmission (OWPT) system[1,2] that realized large electricity power supply amount remotely for compact IoT terminals is designed and demonstrated.

2. Concept and simulation of IoT-OWPT

OWPT system for compact IoT is basically consisted of portable power transmitter (light source), beam control system (lens system) and power receiver on IoT terminals (solar cell). For portability purpose, the size of light source module is constrained under 10x10cm^2 at front surface. For good performance on photovoltaic conversion efficiency, GaAs solar cell with size of 1.7x1.7cm^2 was chosen. Considering the bandgap of 1.43eV of GaAs, the limitation of absorbable wavelength should be 870nm, thus infrared LED (IR LED) is considered here.

Multiple-lens system shown in Fig. 1 consists of an aspheric condenser lens that condense light and reduces light leakage first and then a Fresnel lens with large aperture to focus light on small irradiation area were designed. The aspheric condenser lens is 32.5mm diameter and 23.5mm focal length, and Fresnel lens is 100mm aperture and 100mm focal length. Both lenses are AR coated for restraining reflection. Based on the Fresnel Law, we reduced the half angle width of LED from 45° to 40° compared with the prototype system[2], and more than 10% efficiency improvement on optics system is predictable by doing so. From the numerical simulation on optimized system, the efficiency of the lens system is around 80.6% within 2.1x2.3cm^2 irradiance size from 100cm transmission distance.

3. Experiment and results

As the discussion that stated above, high intensity IR LED with 810nm wavelength (1040mW@1A, 3.55V) is set with around 30% efficiency. The single-junction GaAs solar cell has about the 40% efficiency for 810nm wave.

The irradiation size on solar cell side at distance of 100cm was around 2.1x2.3cm^2 which is in good agreement with the simulation. The efficiency of the optic lens system was 65.4%. The detailed data is shown in table 1. Besides, 204.81mW maximum output power on 1.7x1.7cm^2 size solar cell was measured with 20.1% total optical-electricity efficiency of system and 5.8% power transmission efficiency.

4. Conclusion

The possibility of portable OWPT system for compact IoT terminals over 200mW class output power from long distance at 100cm is confirmed. Besides, improvement on power transmission efficiency can be expected due to light collection efficiency we achieved in experiments is still 20% lower than the simulation value.

References

1) 石田, 宮本, JSAP2018spring, 17a-B203-6.
2) Y. Zhou, Y. Ishida and T. Miyamoto, JSAP2018fall, 18p-232-13.

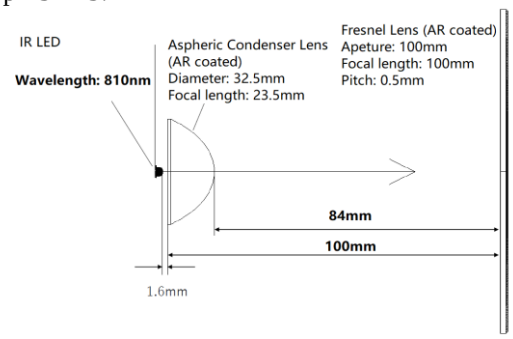

Fig. 1. Simulation result of lens system

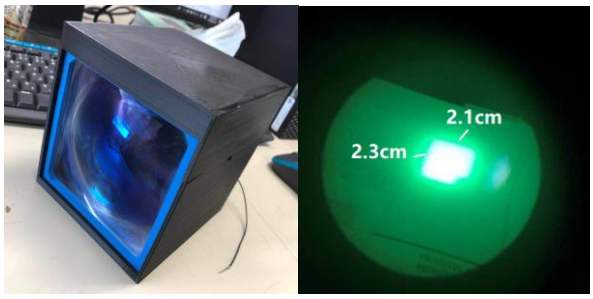

Fig. 2. OWPT system modularization and IR imaging

Table 1. Efficiency of different optics components

Components	Light intensity	Efficiency
LED	1020mW	98.1%
Aspheric lens	1005mW	98.5%
Fresnel lens	680mW	67.7%
Total efficiency		65.4%