Above 130mW Class 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. This paper reported the improved configurations of our OWPT system for compact IoT [1]. Amount of transmission power and its efficiency were investigated.

2. Concept and simulation of IoT-OWPT

OWPT system for compact IoT is basically consisted of portable light source, lens system and solar cell on IoT terminals. The light beam can be transmitted to solar cell from long distance. The initial goal of light source module size is 10x10cm^2 at front surface. High intensity type infrared LED (IR LED) was chosen here. A GaAs solar cell with size of 1.7x1.7cm^2 was chosen. In order to enhance light intensity, irradiation area be small enough. In this condition, 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. Besides, anti-reflective coated (AR coated) lenses were applied, which can enhance the total transmittance 1.18 times. From the numerical simulation, the maximum irradiation light intensity is 720mW, and the light collection efficiency of such lens system is around 70.3%, and maximum output at 1.7x1.7cm^2 GaAs solar cell will be 182.81mW around 95cm transmission distance.

3. Experiment and results

For the light source, high intensity Infrared LED with 858nm wavelength (1024mW@1A, 2.9V) is set, which has 35.3% conversion efficiency. Solar cell was single-junction GaAs solar cell and the efficiency for IR-LED was about 40%[1]. The lens system consists of an Aspheric Condenser lens with 32.5mm diameter, 23.5mm focal length and NA=0.55 and Fresnel lens with 100mm aperture, 100mm focal length and 0.5mm pitch.

The irradiation size on solar cell side was around 2.5x2.5cm^2 at distance of 100cm and the light intensity on this 2.5x2.5cm^2 irradiation area was 520.8mW. By assuming 40% photovoltaic efficiency, output of solar cell on this size is 208mW. The light collection efficiency of the lens system was 51%.

Besides, 131.4mW maximum output power on 1.7x1.7cm^2 size solar cell was occurred when open-circuit voltage V_{oc} to be 0.91V and short-circuit current I_{sc} to be 143.71mA. The total optical-electricity efficiency of system was 12.8%, and power transmission efficiency was 4.5%.

4. Conclusion

The possibility of portable OWPT system for compact IoT terminals about 130mW class output power from long distance at 100cm is confirmed. Besides, improvement on power transmission efficiency can be expected for light collection efficiency we achieved in experiment is still 20% lower than the simulation value.

Ref. 1) 石田, 宮本, JSAP2018spring, 17a-B203-6.

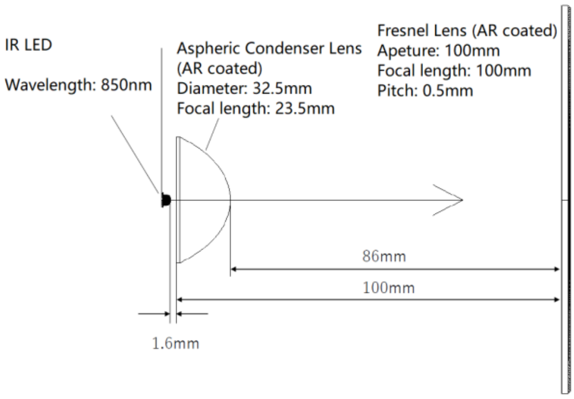

Fig. 1. Simulation result of lens system

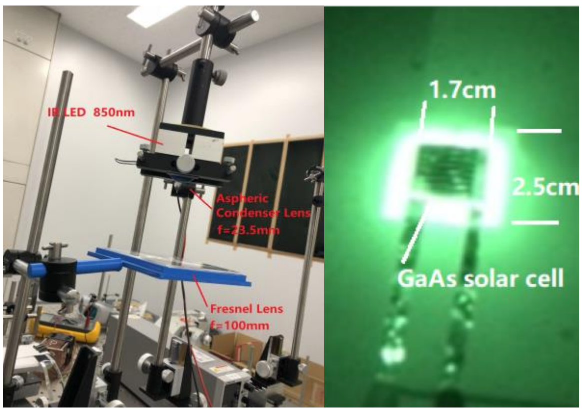

Fig. 2. Prototype of OWPT system

Table 1. power transmission experiment (100cm)

Irradiation size(cmxcm)	Light intensity(mW)	Output power(mW)	Photovoltaic efficiency
2.5x2.5	520.8	(208)	(40%)
1.7x1.7	306.6	131.4	42.9%