Supporting Information

High-bandwidth InGaN self-powered detector arrays toward MIMO visible light communication based on micro-LED arrays

Xiaoyan Liu[1], Runze Lin[1], Honglan Chen[1], Shuailong Zhang[2], Zeyuan Qian[1], Gufan Zhou[1], Xinwei Chen[1], Xiaojie Zhou[1], Lirong Zheng[1], Ran Liu[1] and Pengfei Tian[1]*

[1]Institute for Electric Light Sources, School of Information Science and Technology, Engineering Research *Center* of Advanced Lighting Technology, and Academy of Engineering and Technology, Fudan University, Shanghai 200433, China
[2]Department of Chemistry, University of Toronto, 80 Saint George Street, Toronto, Ontario M5S 3H6, Canada

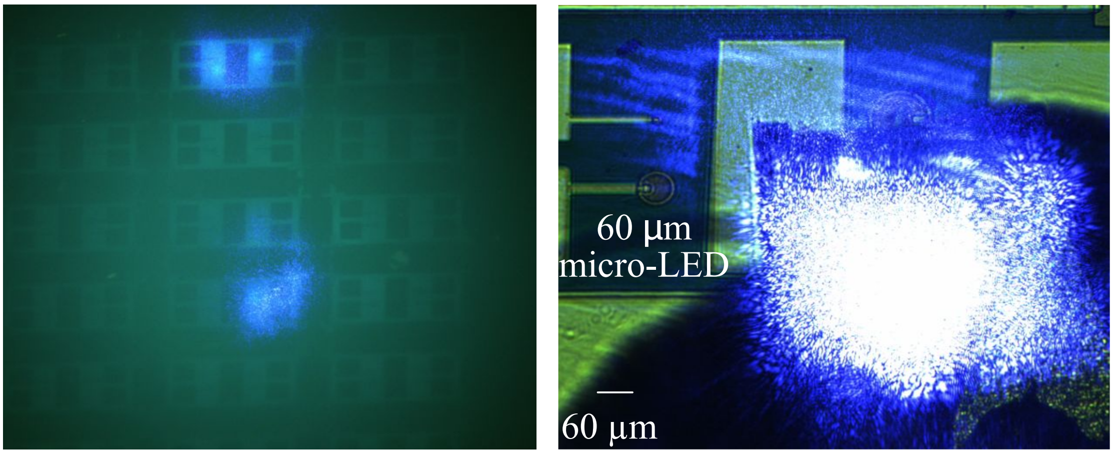

Figure S1. Photographs of the light spots from the 405 nm LD.

The two light spots from the two 405 nm LDs are separated. It can be observed that the light spots cover the entire µLED-based PDs, as shown in the left picture of Figure S1. In addition, notably, the distribution of the light spot is not uniform in the right picture of Figure S1. Therefore, in order to estimate accurately the properties of the µLED-based PDs, the area of the brightest region is considered an efficient area of the incident-light spot. From the picture in right of Figure S1, the diameter of the LD light spot is estimated to be about 380 µm.

Table S1. LDRs of the different μLED-based PDs at bias voltages of 0 V and -5 V.

LDR (dB) / μLED-based PDs (μm)	Bias voltage (V)	
	0	-5
40	186	152
60	196	162
100	197	164

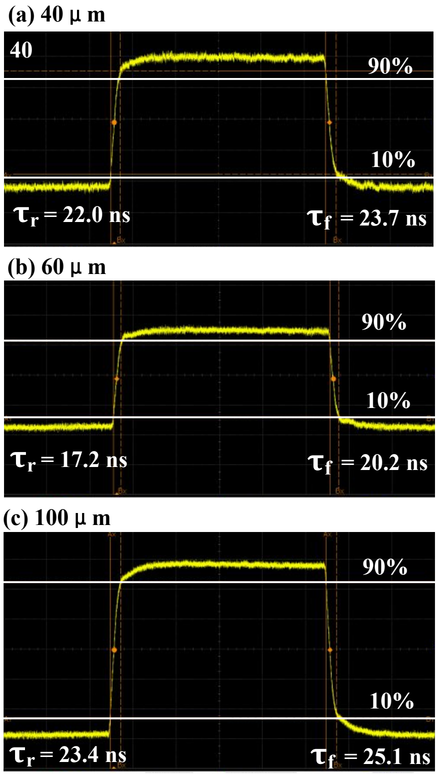

Figure S2. Transient photocurrent response at pulsed light illumination of 1 MHz frequency at the incident-light power density of 11.0 W cm^{-2} under a bias voltage of 0 V for varying μLED-based PDs with diameters of (a) 40 μm, (b) 60 μm and 100 μm, respectively.

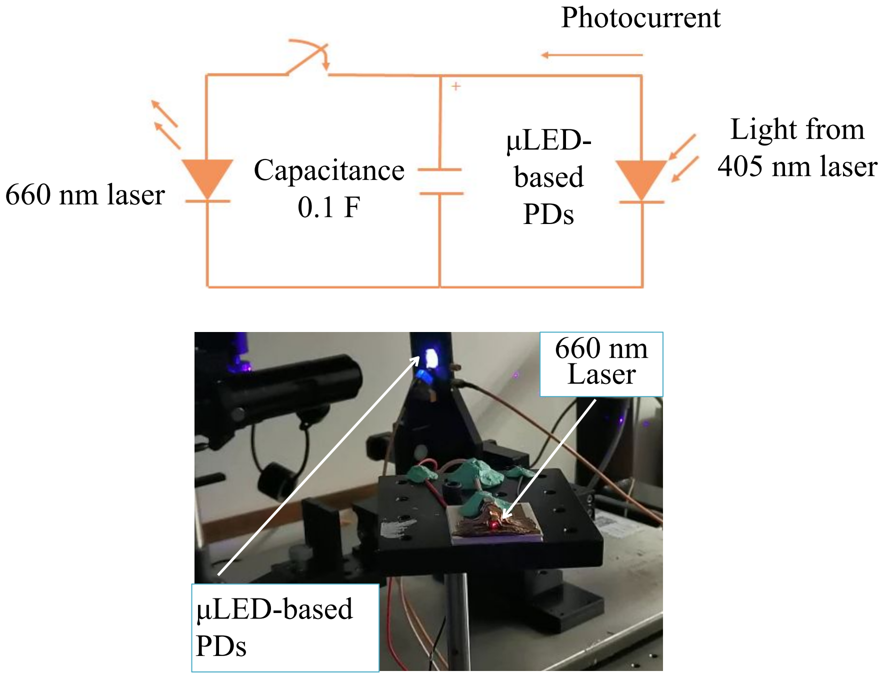

Figure S3. Working principle of the multifunctional device for energy harvest and power other system (such as the 660 nm LD). Top: schematic diagram. Bottom: experimental setup.

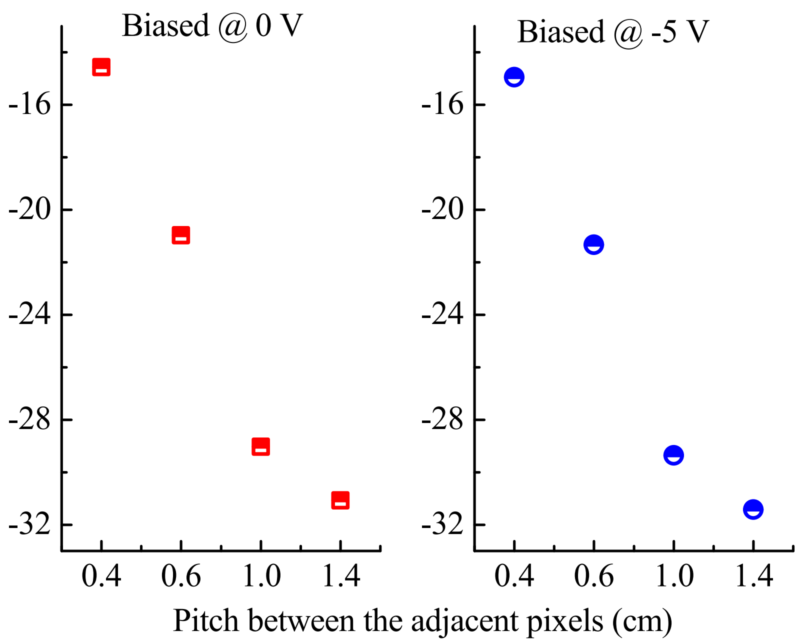

Figure S4. Optical crosstalk characteristics of the μLED-based PDs.

In order to study the optical crosstalk property, we measured the photocurrent of the μLED-based PD pixel under the alignment and non-alignment.[1] Two 405 nm lasers were used as transmitters in our study, which are denoted as laser 1 and laser 2. In the experiment, the laser 1 is aligned to the given μLED-based PD pixel, while the laser 2 is non-aligned. The influence of the distance between the light spots of the laser 1 and laser 2 on the photocurrent of the μLED-based PD pixel were studied to evaluate the optical crosstalk. During the experiment, the spot size of the laser is not changed. With the laser 2 turning off and laser 1 turning on, the photocurrent of the given μLED-based PD pixel aligned to the laser 1 was measured. The laser 1 was then turn off, and the laser 2 was switched on. The corresponding photocurrents under different distances of 0.4, 0.6, 1.0 and 1.4 cm were recorded. The photocurrent of the μLED -based PD pixel under the illumination of the laser 1 was then compared with that under the illumination of the laser 2, which was shown in Figure S4. By this method, the optical crosstalk characteristics of the μLED-based PD are evaluated. Figure S4 shows the optical crosstalk (in dB) as a function of the distance between the aligned laser 1 and non-aligned laser 2. It can be seen that when the pixels are relatively close, the optical crosstalk has a certain influence on communication performance. However, when the pixel distance increases (such as 1 cm and above), the optical crosstalk is less than -25 dB. The appropriate pixel distance is influenced by the size of the light spot (such as the laser spot).

Reference:

[1] Zhang, S.; Watson, S.; McKendry, J. J. D.; Massoubre, D.; Cogman, A.; Gu, E.; Henderson, R. K.; Kelly, A. E.; Dawson, M. D. 1.5 Gbit/s Multi-Channel Visible Light Communications Using CMOS-Controlled GaN-Based LEDs. *J. Lightwave Technol.* **2013**, 31, (8), 1211-1216.