Supporting Information

Balanced Carrier Injection and Charge Separation of $CuInS_2$ Quantum Dots for Bifunctional Light-Emitting and Photodetection Devices

Shuai Chang[†]*, *Yeling Zhao*[†], *Jialun Tang*[‡], *Zelong Bai*[‖]*, *Liangyu Zhao*[‖] *and Haizheng Zhong*[†§]

† Beijing Key Laboratory of Nanophotonics and Ultrafine Optoelectronic Systems, School of Materials Science & Engineering, Beijing Institute of Technology, 5 Zhongguancun South Street, Beijing, 100081, China

‡ Beijing Advanced Innovation Center for Soft Matter Science and Engineering, Beijing University of Chemical Technology, Beijing, 100029, China

‖ School of Aerospace Engineering, Beijing Institute of Technology, 5 Zhongguancun South Street, Beijing, 100081, China

§ Shenzhen Research Institute, Beijing Institute of Technology, Shenzhen, 518057, China

*E-mail: schang@bit.edu.cn; 7520180019@bit.edu.cn

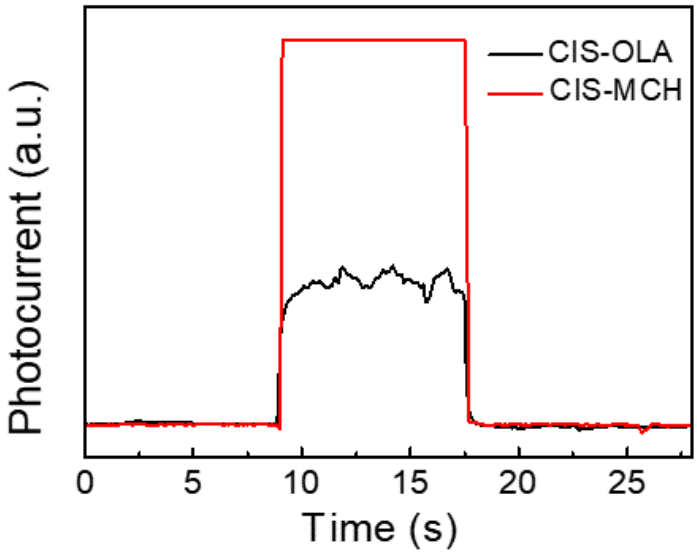

Figure S1. Time response of the photocurrent of devices based on CIS-MCH QDs and CIS-OLA QDs under 530 nm illumination.

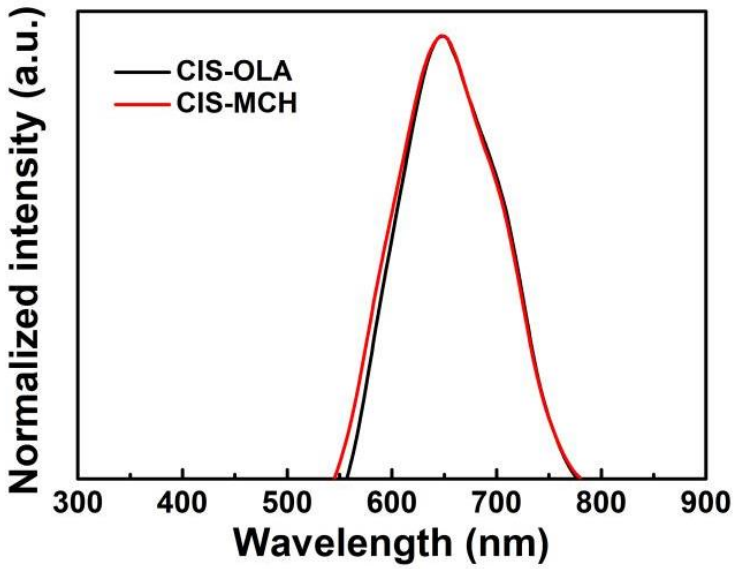

Figure S2. EL spectra of the devices operating in LED mode.

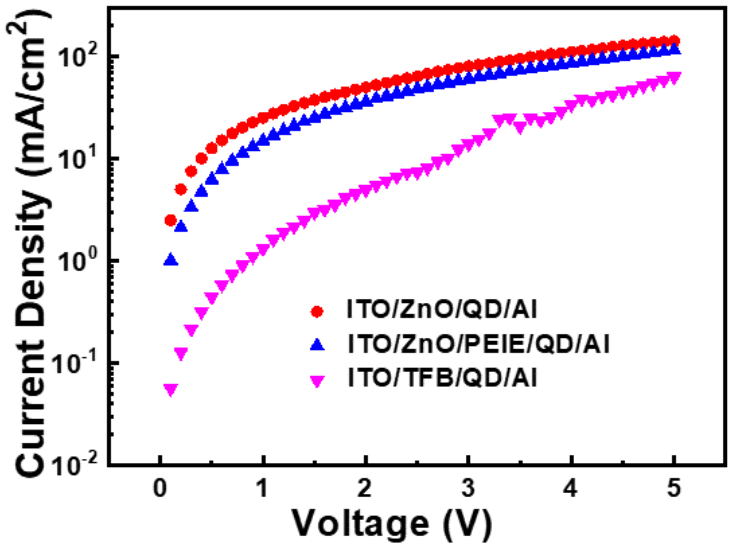

Figure S3. Current density-applied voltage curves of electron-only and hle-only devices.

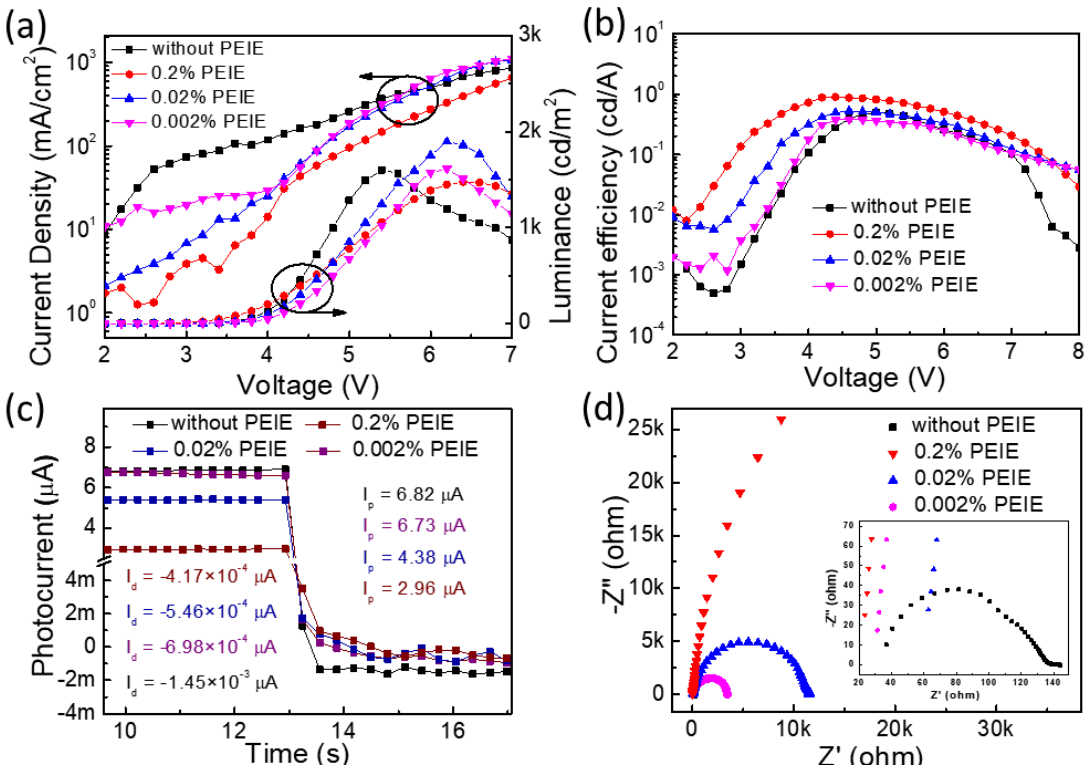

Figure S4. a) Current density and luminance characteristics for devices with and without PEIE modification. b) Current efficiency as a function of applied voltage of devices with and without PEIE modification. c) Photocurrent and dark current characteristics for devices with and without PEIE modification. d) Nyquist plots of devices with and without PEIE modification.

Table S1. Parameters of the device performance in LED mode

thickness (nm)	V_{on} (V)	L_{max} (cd/m^2)	CE_{max} (cd/A)	Maximum EQE_{LED}
13	2.6	971	0.13	0.15%
22	2.8	1600	0.50	0.50%
30	2.8	1330	0.31	0.33%

Table S2. Parameters of the device performance in PD mode

thickness (nm)	I_d (μA)	I_L (μA)	τ_{up} (ms)	τ_{down} (ms)	Switch ratio (a.u.)	R (mA/W)	D^* (jones)	Maximum EQE_{PD}
13	-1.04×10^{-3}	3.97	275	232	3817	0.31	1.7×10^{10}	0.07%
22	-1.45×10^{-3}	6.82	143	238	4703	0.53	2.5×10^{10}	0.13%
30	-1.82×10^{-3}	5.60	133	344	3077	0.44	1.8×10^{10}	0.10%

Table S3. Performance of reported photodetection and light-emitting bifunctional devices.

Active layer	Detection wavelength (nm)	Light Power (mW/cm^2)	R at V_{bias} (mA W^{-1})	D^* (jones)	L_{max} (cd/m^2)	CE_{max} (cd/A)	Ref.
P_2NHC	390	-	77 at -16V	-	16000	2.2	1
4CzIPN	350	1	14.1 at -1V	8.3×10^{10}	4237	0.91	2
4CzIPN	350	1	31.2 at -1V	1.7×10^{11}	8233	1.68	2
Perovskite	350	-	20 at -1V	-	$> 10^3$	-	3
$CuInSe_2$ QDs (photodetection only)	330	10	11.3 at 0V	1.6×10^{12}	-	-	4
$CuInS_2$ QDs	405	10	12.6 at 0V	1.8×10^{11}	1600	0.5	This work

References

（1）Ali, F.; Periasamy, N.; Patankar, M. P.; Narasimhan, K. L. Integrated Organic Blue LED and Visible−Blind UV Photodetector. *J. Phys. Chem. C* **2011,** *115*, 2462-2469.

（2）Shi, Z.; Yuan, J.; Zhang, S.; Liu, Y.; Wang, Y. Simultaneous Dual-Functioning InGaN/GaN Multiple-Quantum-Well Diode for Transferrable Optoelectronics. *Opt. Mater.* **2017,** *72*, 20-24.

（3）Li, N.; Miao, Y.; Zhu, F. Electroluminescence and Photo-Response of Inorganic Halide Perovskite Bi-Functional Diodes. *Nanophotonics* **2018,** *7*, 1981-1988.

（4）Guo, R.; Shen, T.; Tian, J. Broadband Hybrid Organic/$CuInSe_2$ Quantum Dot Photodetectors. *J. Mater. Chem. C* **2018,** *6*, 2573.