Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supporting Information

Photo-Switchable Rectifier Based on $MAPbBr_3$-$MAPbCl_3$ Halide Perovskite Heterostructure for Dual-Wavelength Optical Communications

Yun-Peng Zhao [a, b #], Zhi-Hong Zhang [b, c #], Shan-Shan Yan [b], Bao-Shi Qiao [b], Zhen-Dong Lian [b], Zhi-Peng Wei [c], Francis Chi-Chung Ling [d], Hong-Yu Chen [a], Shi-Chen Su [a, *], Kar Wei Ng [b, *], and Shuang-Peng Wang [b, *]

[a] *School of Semiconductor Science and Technology, South China Normal University, Foshan 528000, China*

[b] *Instituted of Applied Physics and Materials Engineering, University of Macau, Taipa 999078, Macau SAR, China*

[c] *State Key Laboratory of High Power Semiconductor Lasers, Changchun University of Science and Technology, Changchun 130022, China*

[d] *Department of Physics, The University of Hong Kong, Hong Kong 999077, China*

[#] These authors contributed equally.

*Corresponding Authors:

Shuang-Peng WANG: spwang@um.edu.mo (Email) +853 8822 4048 (Tel.)

Kar Wei NG: billyng@um.edu.mo (Email)

Shi-Chen SU: shichensu@scnu.edu.cn (Email)

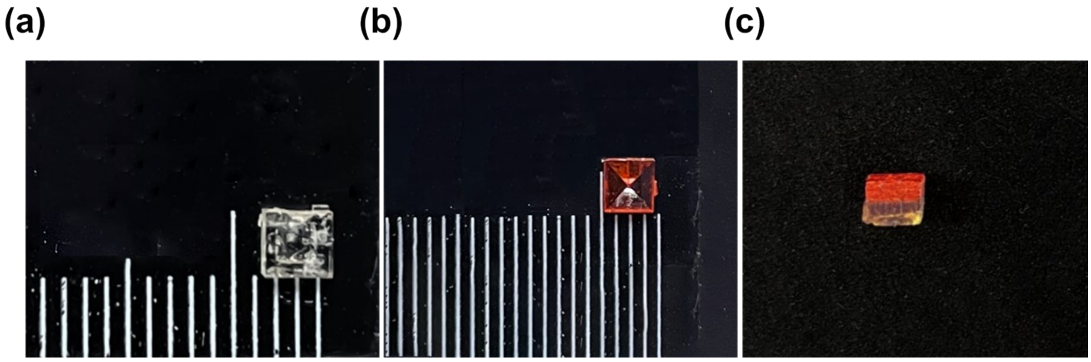

Figure S1. (a) The $MAPbCl_3$ single crystal and (b) The $MAPbBr_3$ single crystal with long growth time. (c) The fabricated heterojunction of $MAPbCl_3/MAPbBr_3$ after cleavage.

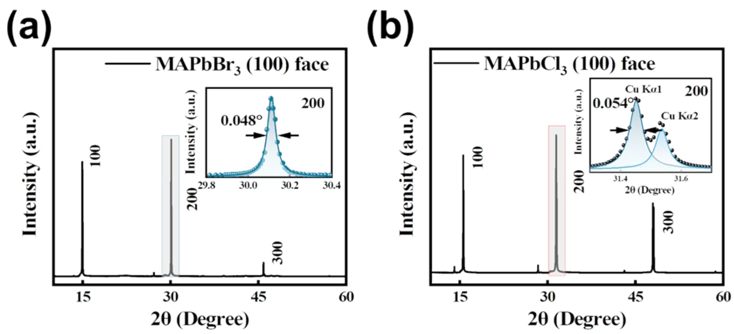

Figure S2. X-ray diffraction patterns of (a) $MAPbBr_3$ and (b) $MAPbCl_3$ single crystal wafers.

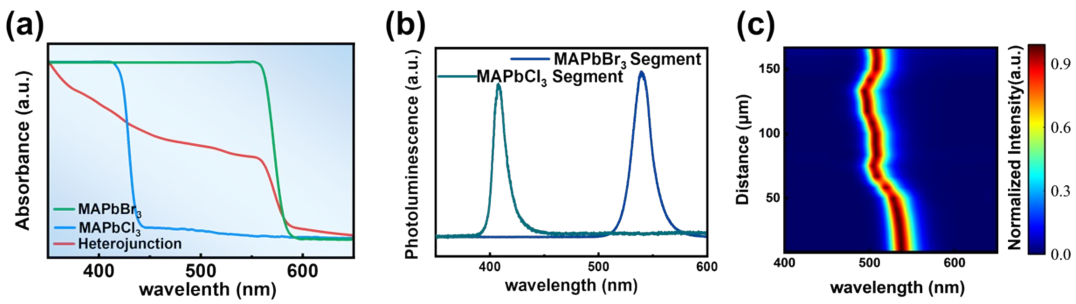

Figure S3. (a) Absorption spectra and (b) PL spectra of $MAPbBr_3$ and $MAPbCl_3$ bulk single crystals. (c) PL Mapping of the surface of prepared $MAPbCl_3/MAPbBr_3$ heterostructure.

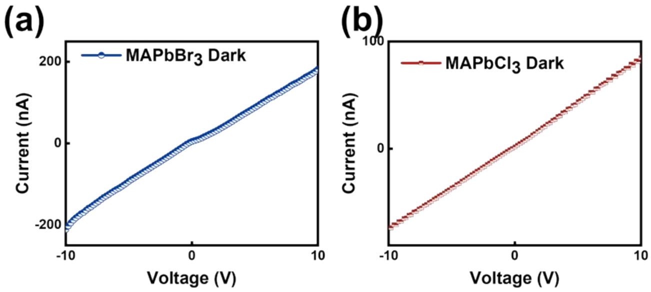

Figure S4. Dark current of (a) $MAPbBr_3$ bulk single crystal and (b) $MAPbCl_3$ bulk single crystal.

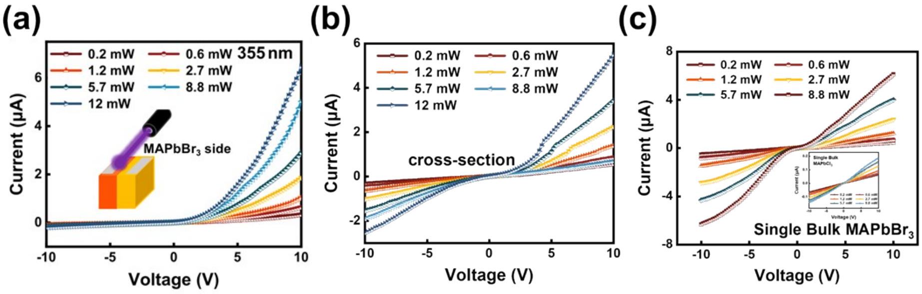

Figure S5. (a) *I-V* characteristics of the heterostructure device irradiation $MAPbBr_3$ segment measured under a 355 nm laser with different intensities. (b) The *I-V* characteristics of the heterostructure under 355 nm illumination (c) The *I-V* characteristics of bulk single crystals.

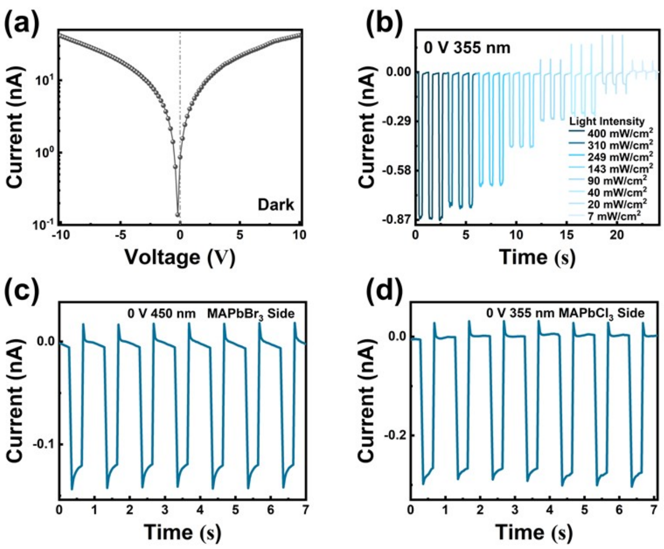

Figure S6. (a) Dark current curve of heterostructure device. (b) Under 355 nm illumination, The *I-t* curves of the device at 0 V bias. (c and d) Self-driven characteristics of the device when irradiated at 450 nm on the $MAPbBr_3$ side and 355 nm on the $MAPbCl_3$ side.

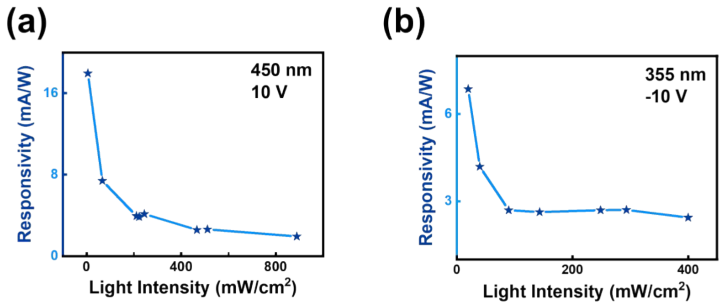

Figure S7. Plots of the responsivity as a function of light intensity under (a) 450 nm with 10 V bias and (b) 355 nm laser with -10 V bias.

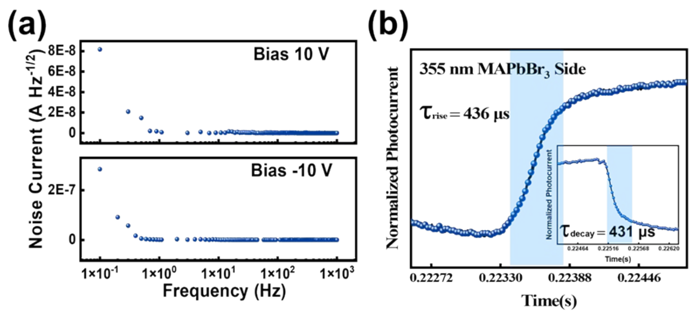

Figure S8. (a) The noise current of the device under 10 V and -10 V biases. (b) the rise and fall times of the device under 355 nm illumination.

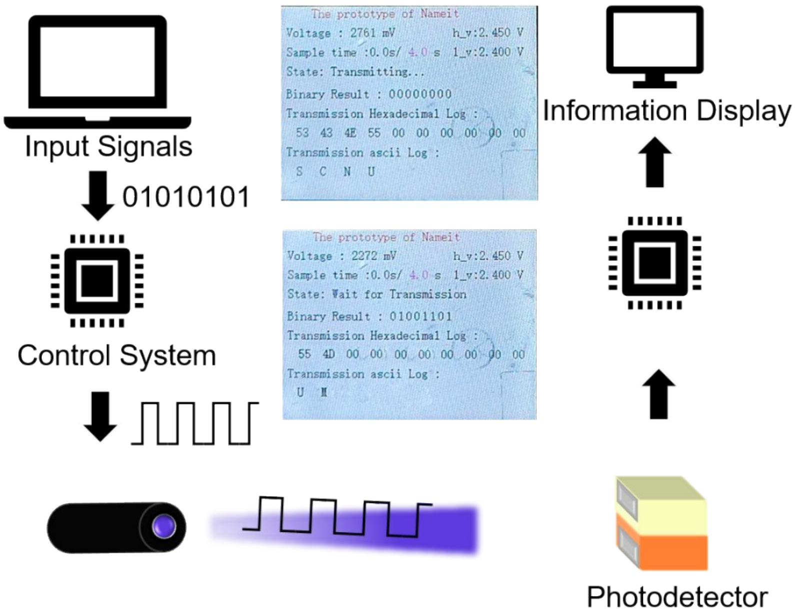

Figure S9. Schematic diagram of the dual-colored optical communication system based on the photodetector.

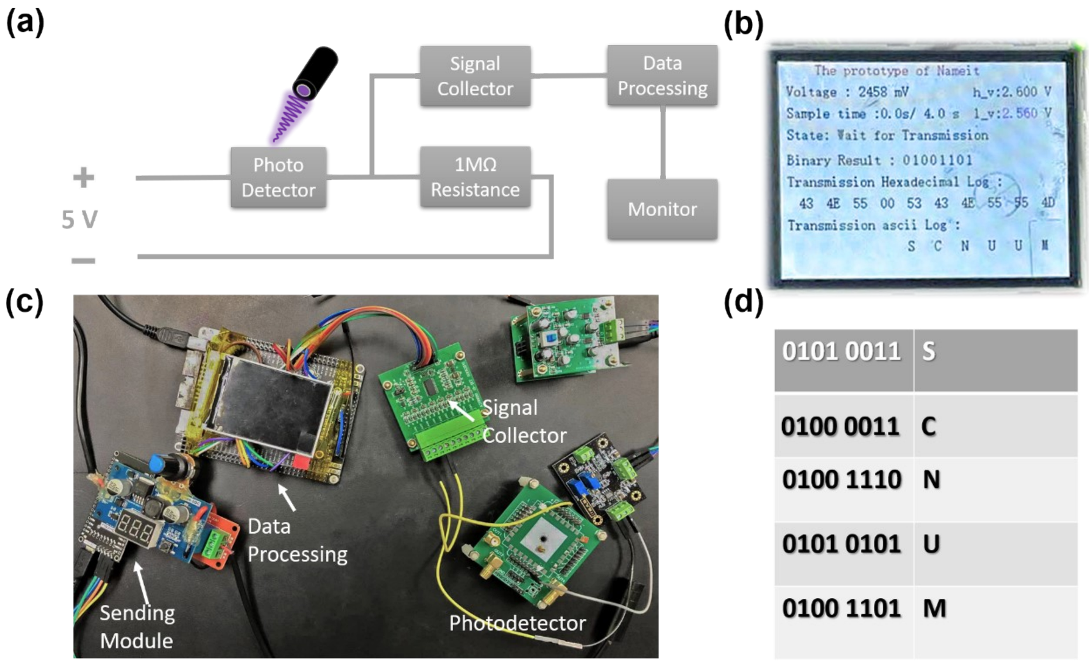

Figure S10. (a) Schematic diagram of the dual-colored optical communication system based on the photodetector. (b) The decoding result after receiving signals. (c) A proof of concept of the UV communication system. (d) ASC II code for five alphabets "SCNUM" as the received signals.

Device Configuration	Light Source	Response speed (Rise time/Fall time)	Ref.
Pt/$CH_3NH_3PbCl_3$/Ti/Au	365 nm	24 ms/62 ms	[1]
Cu/$MAPbCl_3$-$MAPbBr_3$/Cu	400 nm	376 ms/251 ms	[2]
Pt/$MAPbBr_3$/Au	white light	70 µs/ 150 µs	[3]
Ag/(4-AMP)$(MA)_2Pb_3Br_{10}$/$MAPbBr_3$/Ag	405 nm	600 µs/600 µs	[4]
FTO/$MAPbI_xBr_{3-x}$/$MAPbBr_3$/Au	450 nm	2.3 s/2.76 s	[5]
Au/$MAPbI_xBr_{3-x}$/$MAPbBr_3$/$MAPbI_3$/Au	805-825 nm/ 400-805 nm	3 us/181 us 3 us/153 us	[6]
Au/$MAPbCl_3$/$MAPbBr_3$/Au	430 nm	0.43 s/ 1.39 s	[7]
Ag/$MAPbBr_3$/$MAPbCl_3$/Ag	450 nm/ 355 nm	647 µs/683 µs 584 µs/1270 µs	This work

Table S1. Comparison of performance parameters of similar structure single crystal devices[1-7].

Reference

1. G. Maculan, A. D. Sheikh, A. L. Abdelhady, M. I. Saidaminov, M. A. Haque, B. Murali, E. Alarousu, O. F. Mohammed, T. Wu and O. M. Bakr, *J. Phys. Chem. Lett.*, 2015, **6**, 3781-3786.
2. X. Qiu, Y. Wang, M. Li, L. Huang, J. Yang, G. Li, X. Zhang, K. Xiao and W. Sun, *Ceram. Int.*, 2023, **49**, 518-527.
3. P. A. Shaikh, D. Shi, J. R. D. Retamal, A. D. Sheikh, M. A. Haque, C.-F. Kang, J.-H. He, O. M. Bakr and T. Wu, *J.l Mater. Chem. C*, 2016, **4**, 8304-8312.
4. X. Zhang, C. Ji, X. Liu, S. Wang, L. Li, Y. Peng, Y. Yao, M. Hong and J. Luo, *Adv. Opt. Mater.*, 2020, **8**, 2000311.
5. M. Cao, J. Tian, Z. Cai, L. Peng, L. Yang and D. Wei, *Appl. Phys. Lett.*, 2016, **109**, DOI: 10.1063/1.4971772.
6. J. Zhao, X. Wang, Y. Xu, Y. Pan, Y. Li, J. Chen, Q. Li, X. Zhang, Z. Zhu and Z. Zhao, *ACS Appl. Mater. Interfaces*, 2022, **14**, 25824-25833.
7. C. Liu, H. Chen, P. Lin, H. Hu, Q. Meng, L. Xu, P. Wang, X. Wu and C. Cui, *J. Phys.: Condens. Matter*, 2022, **34**, 405703.