Supporting Information for

Perovskite/Poly(3-hexylthiophene)/Graphene Multiheterojunction Phototransistors with Ultrahigh Gain in Broadband Wavelength Region

Chao Xie and Feng Yan*

Department of Applied Physics, The Hong Kong Polytechnic University, Hong Kong, China

* E-mail: apafyan@polyu.edu.hk

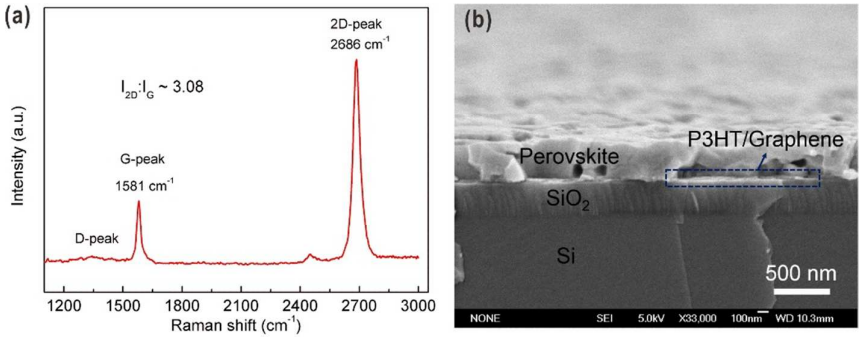

Fig. S1 (a) Raman spectrum of the graphene film on SiO_2/Si substrate. The large intensity ratio of I_{2D}:I_G (~3.08), combined with the weak *D* peak at ~1343 cm^{-1}, suggests good crystal quality of the monolayer graphene. (b) Cross-sectional SEM image of the $CH_3NH_3PbI_{3-x}Cl_x$ perovskite/P3HT/graphene multiheterojunction on SiO_2/Si substrate.

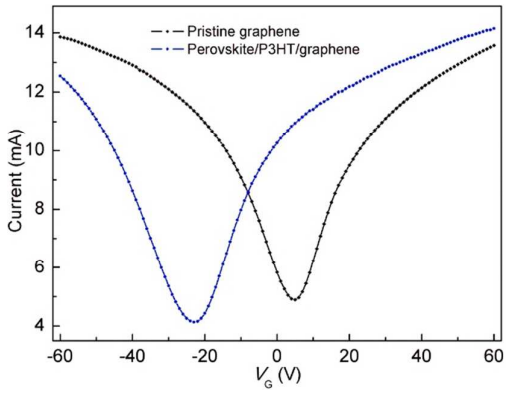

Fig. S2 Channel current of pristine graphene and $CH_3NH_3PbI_{3-x}Cl_x$ perovskite/P3HT/graphene measured under dark environment.

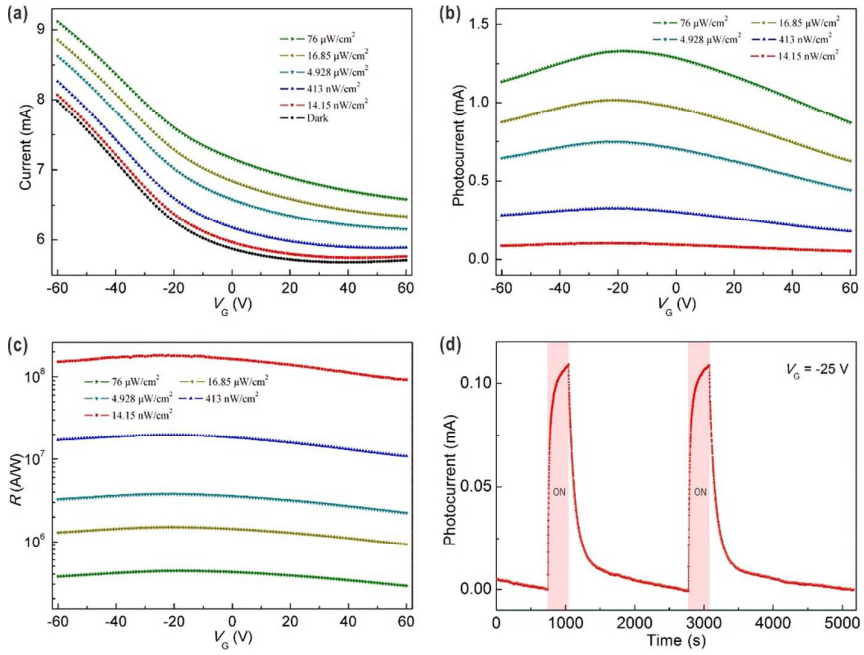

Fig. S3 (a) Channel current of the $CH_3NH_3PbI_{3-x}Cl_x$ perovskite/graphene phototransistor as a function of back-gate (V_G) under different illumination levels. Wavelength: 598 nm, V_{DS}=0.1 V. (b) Photocurrent and (c) responsivity (R) of the phototransistor as a function of V_G under different illumination levels. (d) Time-dependent photoresponse of the phototransistor to periodical on/off illumination (intensity: 14.15 nW/cm^2) at V_G=-25 V, V_{DS}=0.1 V.

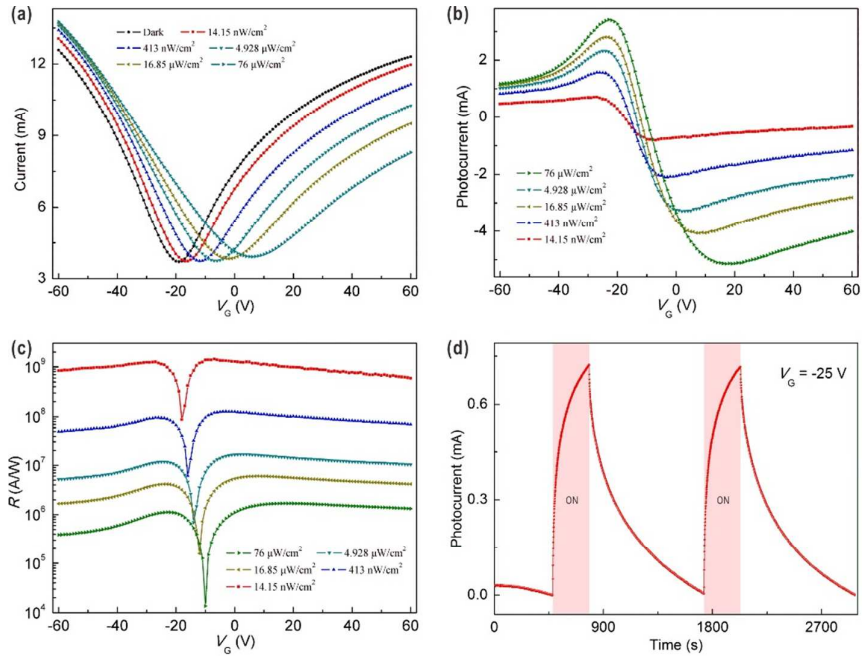

Fig. S4 (a) Channel current of the $CH_3NH_3PbI_3$ perovskite/P3HT/graphene phototransistor as a function of back-gate (V_G) under different illumination levels. Wavelength: 598 nm, V_{DS}=0.1 V. (b) Photocurrent and (c) responsivity (R) of the phototransistor as a function of V_G under different illumination levels. (d) Time-dependent photoresponse of the phototransistor to periodical on/off illumination (intensity: 14.15 nW/cm^2) at V_G=-25 V, V_{DS}=0.1 V.

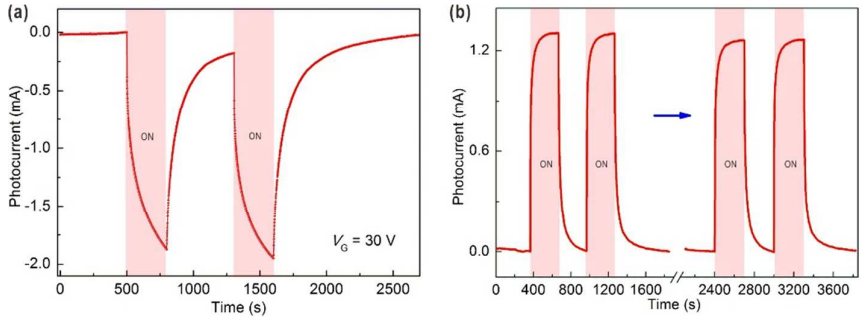

Fig S5 Time-dependent photoresponse of the $CH_3NH_3PbI_{3-x}Cl_x$ perovskite/P3HT/graphene phototransistor to periodical on/off illumination (intensity: 14.15 nW/cm^2) (a) at V_G=30 V, V_{DS}=0.1 V; (b) at V_G=-25 V, V_{DS}=0.1 V after being stored in a golvebox for ~4 weeks.

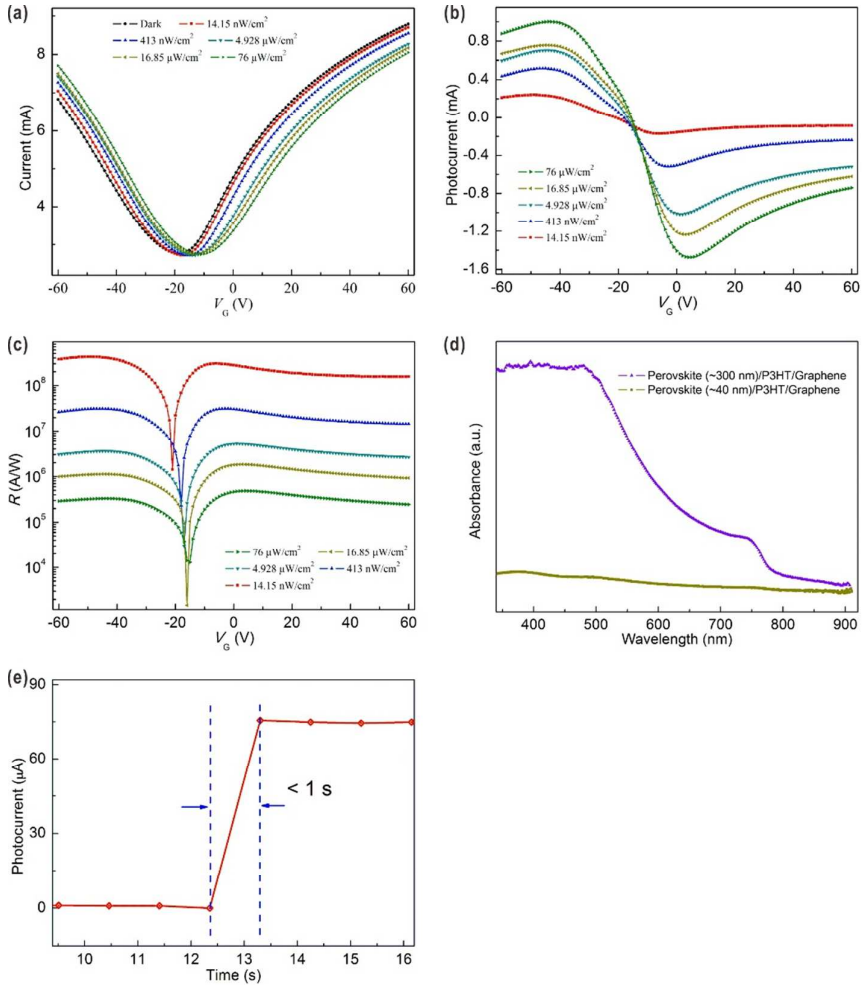

Fig S6 (a) Channel current of the $CH_3NH_3PbI_{3-x}Cl_x$ perovskite (~40 nm)/P3HT/graphene phototransistor as a function of back-gate (V_G) under different illumination levels. Wavelength: 598 nm, V_{DS}=0.1 V. (b) Photocurrent and (c) responsivity (R) of the phototransistor as a function of V_G under different illumination levels. (d) Absorption spectrum of the $CH_3NH_3PbI_{3-x}Cl_x$ perovskite (~40 nm)/P3HT/graphene film on glass, along with that of the $CH_3NH_3PbI_{3-x}Cl_x$ perovskite (~300 nm)/P3HT/graphene film for comparison. (e) Enlarged view of the rising edge of the time-dependent photoresponse, which shows the rising time of the phototranistor.