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ARTICLE

Highly Sensitive and Ultrafast Graphene Nanoribbons/$CsPbBr_3$ Quantum Dots Phototransistor with Enhanced Vertically Metal Oxide Heterostructures

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Xiang Liu,*[a] Wenjian Kuang [a], Haibing Ni [b], Zhi Tao [b], Qianqian Huang [b], Jing Chen[b] ,Qingquan Liu[a], Jianhua Chang*[a] and Wei Lei*[b]

Supporting information

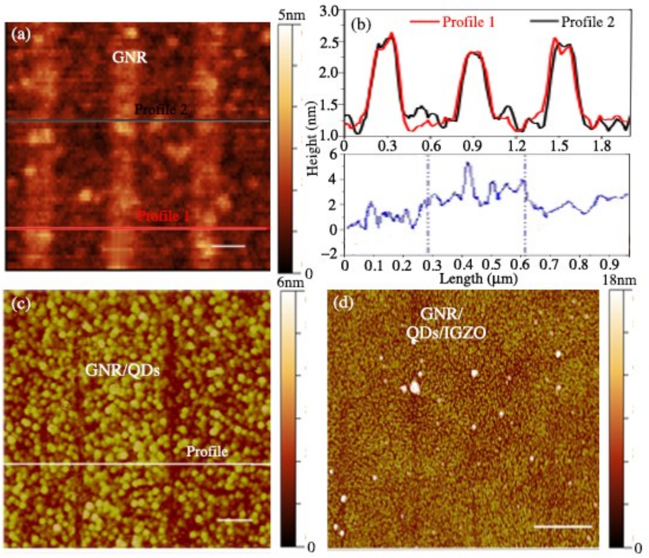

Fig.S1 (a)AFM image of GNR surface morphology (scale bar: 300 nm). (b) The height information of profile 1 and 2 in GNR surface and profile of GNR/QDs hybrids. (c) AFM image of GNR/QDs hybrids' surface morphology. (d) AFM image on top of GNR/QDs/IGZO surface to illustrate roughness of this film.

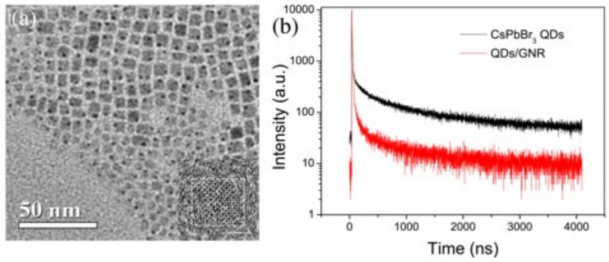

Fig.S2 (a)TEM image of overall $CsPbBr_3$ QDs in solution and detailed morphology of single QDs. (b) Time resolved Photoluminescence of QDs and QDs/GNR hybrids excited by 512 nm laser under room-temperature.

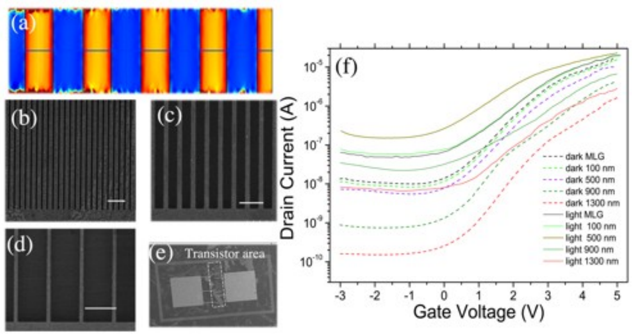

Fig.S3 (a) Top-view of simulated electric field distribution of GNR on SiO_2 substrate. SEM images of the origin GNR with different gaps :100 nm (b), 500 nm (c) and 900 nm (d). (e) SEM image of this phototransistor. (f) Transfer characteristic curves for vertical phototransistors under dark and 512 nm incident lights with different gaps.

[a] School of electronic and information engineering, Nanjing University of information science and technology, Nanjing, China. .E-mail: xjlx1906@126.com，jianhuachang@nuist.edu.cn
[b] Display centre, Southeast University, Nanjing 210096, China. E-mail: lw@seu.edu.cn.
Electronic Supplementary Information (ESI) available: [details of any supplementary information available should be included here]. See DOI: 10.1039/x0xx00000x

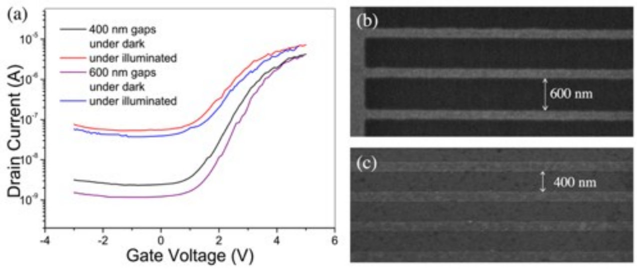

Fig.S4 (a) Transfer character curves of GNR/QDs/IGZO transistor with 400 nm and 600 nm gaps under dark and 512 nm light's illumination. (b)SEM image of GNR film with 600 nm gaps. (c) SEM image of GNR film with 400 nm gaps.

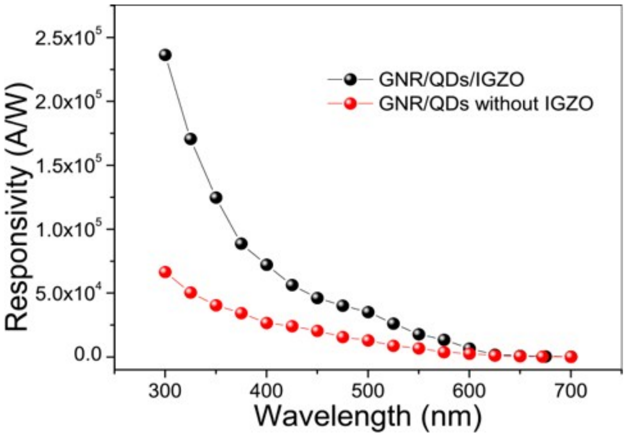

Fig.S5 Responsivity of GNR/QDs/IGZO and GNR/QDs phototransistors versus different wavelengths.

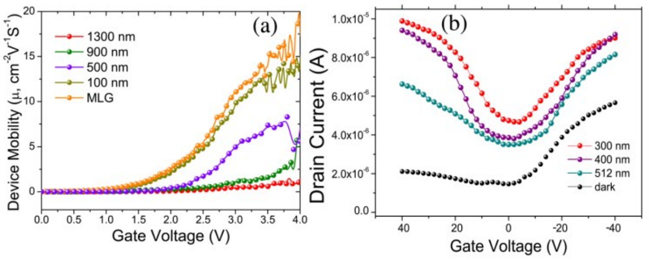

Fig. S6 (a) Device's field effect mobility of phototransistors with different GNR gaps. (b) linear transfer characteristic curves for P-type planar phototransistor (V_{DS}=0.6 V) with different incident light wavelengths.

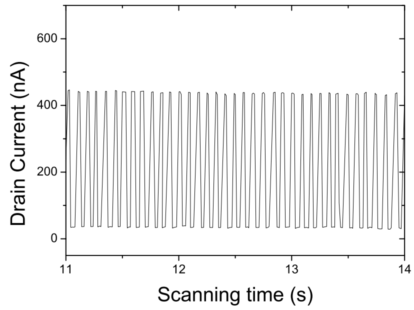

Fig. S7 Time-duration on/off measurement for vertical phototransistor with an ultrafast light signal (512 nm, 0.1 mW/cm^2 mean power density).

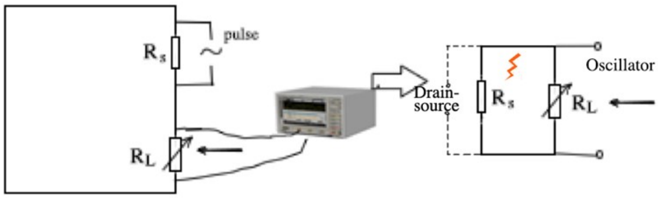

Fig. S8 The schematic for measuring the dynamic pulse signal and connecting method with the series variable resistance box (left). And the estimating method to obtain equivalent resistance by transformation of Thevinen law.