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Integration of n-$MoTe_2$ Field Effect Transistor and $MAPbI_3$ perovskite photovoltaic cell toward Energy Harvesting and Self-powered Photo-sensing

We have integrated a molybdenum ditelluride ($MoTe_2$) field effect transistors (FETs) with a $MAPbI_3$ perovskite photovoltaic solar cell in the circuit. As the advantages of integration, our circuit operates simultaneously as self-power energy harvesting and photo-sensing. Among many transition metal dichalcogenide (TMD) semiconductors, $MoTe_2$ is selected because of less light-sensitivity and stable electrical properties compared to the other representative 2D TMD semiconductors: MoS_2, $MoSe_2$, WSe_2, etc. The few nm-thin n-type $MoTe_2$ FET operating at a low voltage is fabricated on a glass substrate as back-to-back bonded to the other glass which has perovskite PV cell. As the PV cell has large open circuit voltage (V_{OC}) over 0.9 V under artificial sun (AM 1.5) or visible photon illumination, we simply have used a red light emitting diode (LED) to generate ~1 V of photovoltage. Surprisingly, two operation modes in circuit are possibly observed depending on the light intensity of red LED: self-power current/voltage source and photosensor mode. Interestingly, despite of small output current and voltages in the circuit, 940 nm near infrared (NIR) is also sensitively detected.

References

[1] W. Zhang, G.E. Eperon, H.J. Snaith, Nat. Energy, 1 (2016) 16048.
[2] S.D. Stranks, H.J. Snaith, Nat. Nanotechnol., 10 (2015) 391.
[3] J. Even, L. Pedesseau, C. Katan, J. Phys. Chem. C, 118 (2014) 11566-11572.
[4] D. Shin, D. Kang, J. Jeong, S. Park, M. Kim, H. Lee, Y. Yi, J. Phys. Chem. Lett., 8 (2017) 5423-5429.
[5] Y. Cho, J.H. Park, M. Kim, Y. Jeong, J. Ahn, T. Kim, H. Choi, Y. Yi, S. Im, Adv. Funct. Mater., 28 (2018) 1801204.
[6] Y. Jeong, J.H. Park, J. Ahn, J.Y. Lim, E. Kim, S. Im, Adv. Mater. Interfaces, 5 (2018) 1800812.
[7] H. Choi, J. Jeong, H.-B. Kim, S. Kim, B. Walker, G.-H. Kim, J.Y. Kim, Nano Energy, 7 (2014) 80-85.

Figures

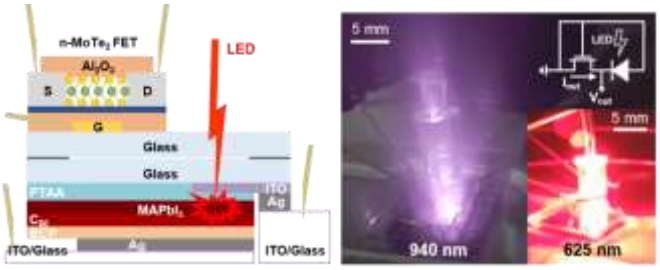

Figure 1: Cross section scheme of one package device where n-$MoTe_2$ and perovskite PV cell are back-to-back bonded. Photo image of the package device for low energy NIR detection under 940 nm illumination. The NIR illumination image is compared to that of 625 nm LED illumination.