Electronic Supplementary Information

Broadband Ultrafast Photovoltaic Detectors Based on Large-scale Topological Insulator Sb_2Te_3/STO Heterostructures

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1. Film thickness of Sb_2Te_3

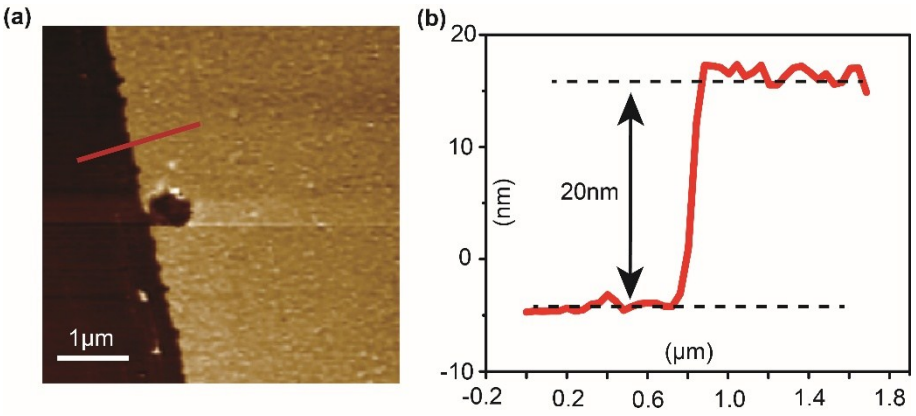

Figure S1. Film thickness of the Sb_2Te_3 film in Sb_2Te_3/STO heterostructure. (a) The AFM image of 20 QL Sb_2Te_3 film. (b) The line profile along the red line in (a).

2. Absorption spectra of Sb_2Te_3 film

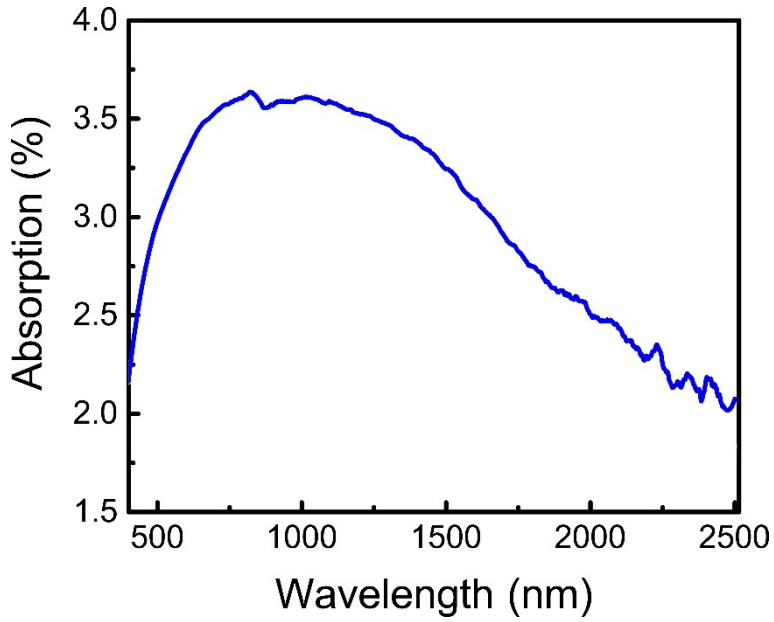

Figure S2. Absorption spectra of the Sb_2Te_3 topological insulation film with the thickness of 20 nm from 400 nm to 2500 nm.

3. Transmittance spectra of ITO top electrode

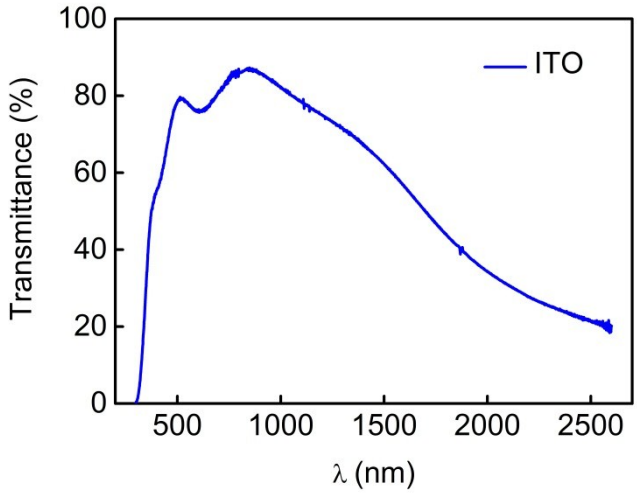

Figure S3. The transmittance spectra of the ITO top electrode.

4. Confirmation of the p-n junction in the Sb_2Te_3/STO photodetector

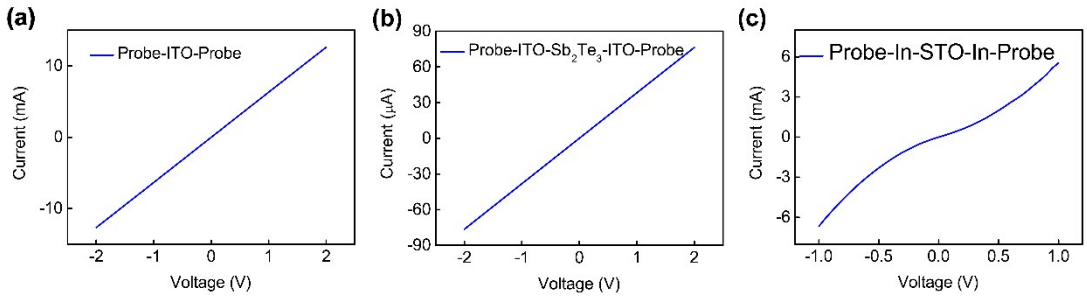

Figure S4. Contact performance. (a) and (b) show the contact behaviors of ITO with probe and Sb_2Te_3, indicating perfect Ohmic contact. (b) ITO with Sb_2Te_3 contact, suggesting a negligible barrier.

5. Ideality factor.

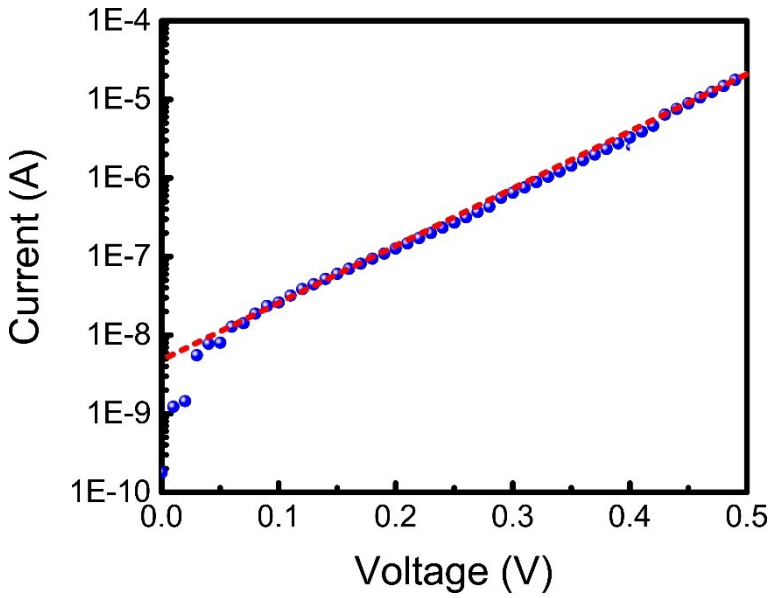

Figure S5. I-V curve of the Sb_2Te_3/STO heterostructure. The semi-logarithmic cure is fitted by a straight line.

The ideality factor (n) of the heterojunction could be deduced to be 1.59 from the slop of the semi-log I–V curve in the forward bias direction, according to the following equation:[1]

$$n = \frac{q}{k_B T} \frac{dV}{d \ln I}$$

where q is the electron charge, k_B is the Boltzmann constant, and T is the absolute temperature.

6. Responsivity spectra from 405 nm to 1550 nm

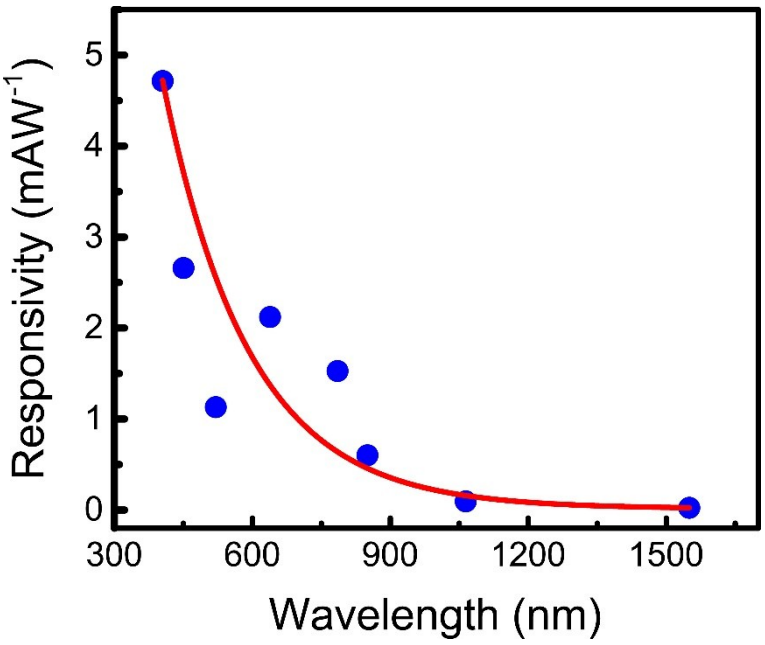

Figure S6. Responsivity spectra of the Sb_2Te_3/STO photodetector. Power densities at each illumination wavelength were calibrated to be same (236.81mWcm^{-2}).

7. Hall effect measurement of STO at 300K

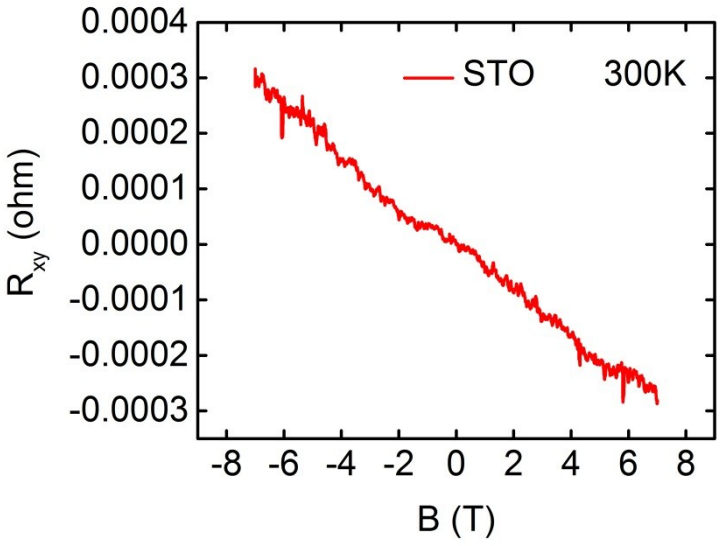

Figure S7. Hall effect measurement of STO at 300K. The electron concentration (N_e) of 3×10^{20} cm^{-3} is extracted from the Hall slop.

8. Temperature-dependent photoresponse of the heterostructure under 1064 nm illumination

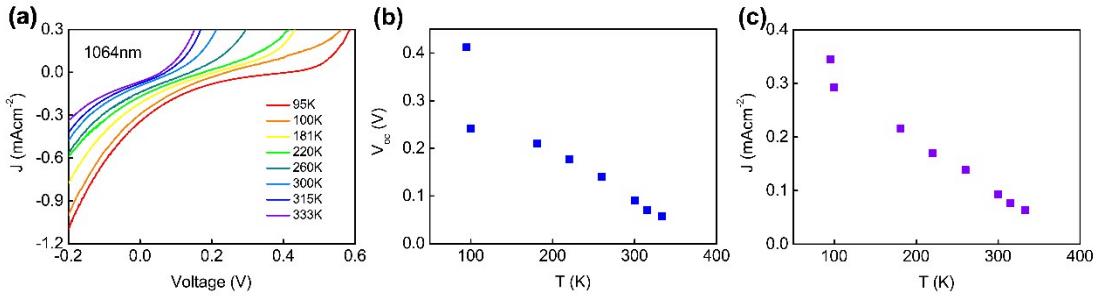

Figure S8. Temperature-dependent photoresponse of the heterostructure under 1064 nm illumination. (a) J-V characteristics of the heterostructure at different T. (b) and (c) show the dependence of V_{oc} and J_{sc} on remperature (T).

References:

1. X. Zhang, X. Zhang, X. Zhang, Y. Zhang, L. Bian, Y. Wu, C. Xie, Y. Han, Y. Wang and P. Gao, *Journal of Materials Chemistry*, 2012, **22**, 22873-22880.