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

Topological Insulator Bi_2Se_3 Nanowire/Si Heterostructure Photodetector with Ultrahigh Responsivity and Broadband Response

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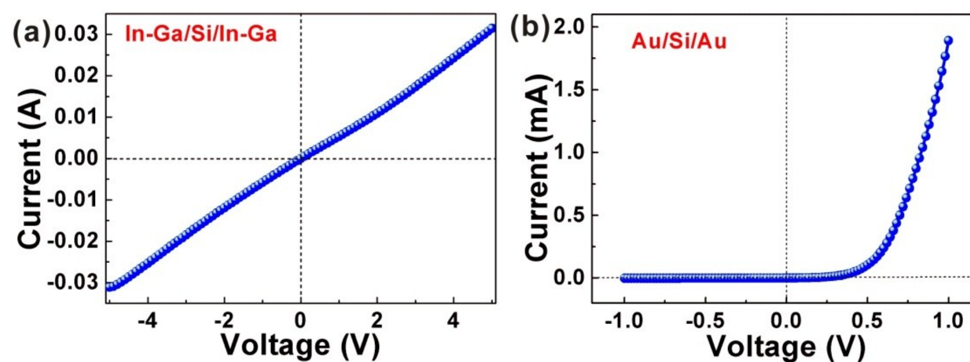

Fig. S1 *I-V* curves of the In-Ga/Si/In-Ga and Au/Si/Au devices.

Table. S1 Components of an individual Bi_2Se_3 NW

Element	Weight %	Atomic %
Se	28.86	51.77
Bi	71.13	48.22

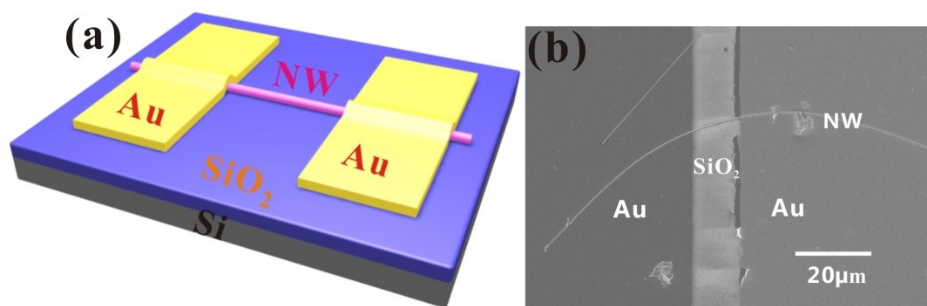

Fig. S2 (a) Schematic illustration of the Bi_2Se_3 NW based device with Au Ohmic contacts. (b) Typical SEM image of the Ohmic contact device.

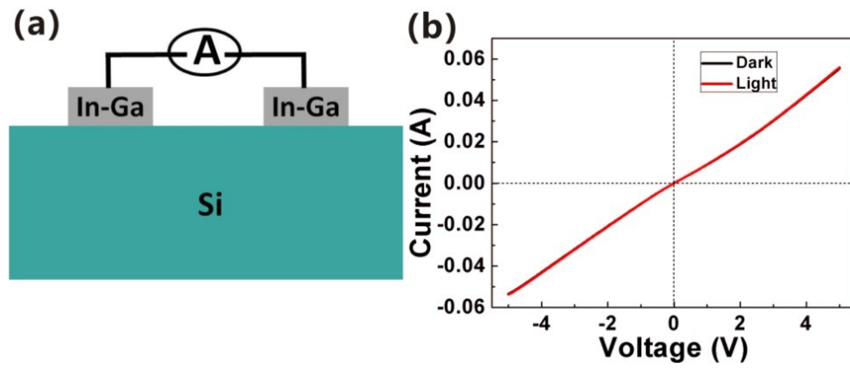

Fig. S3 (a), (b) were the schematic illustration and photoresponse of the In-Ga/Si/In-Ga device.

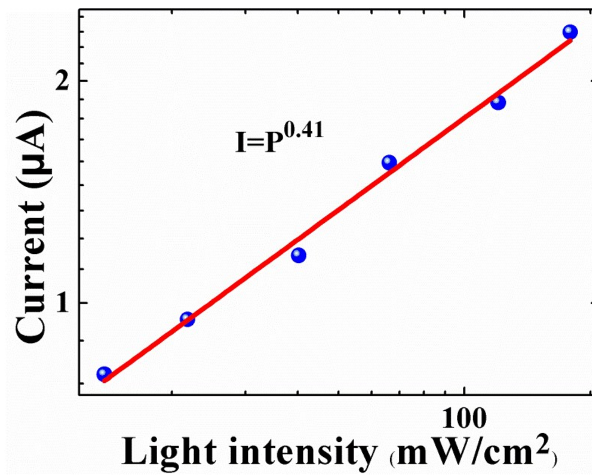

Fig. S4 Photocurrent of the Bi_2Se_3 NW/Si heterostructure as a function of light intensity. The curve can be fitted according to power law.

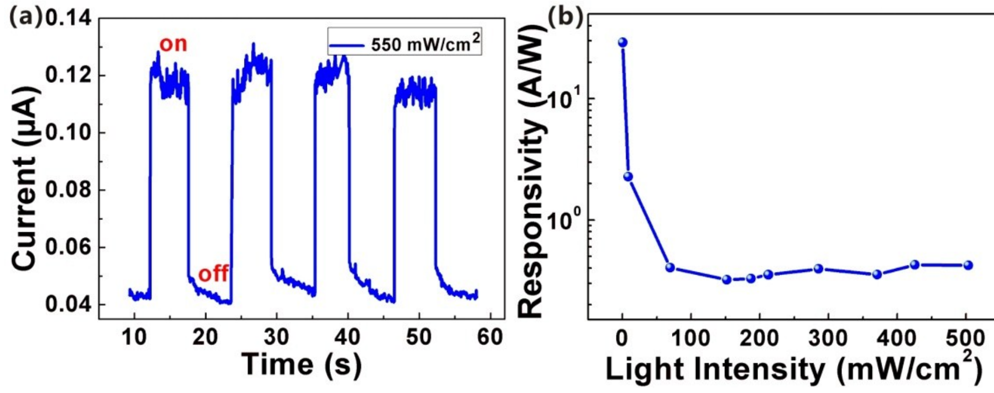

Fig. S5 (a) Photoresponse of the device measured at bias voltage of -5 V under the illumination of 1064 nm light. (b) Responsivity of the device as a function of light intensity under 1064 nm light illumination.

Table. S2 Statistics of responsivities of six devices (with number from 1-6)

Devices	1	2	3	4	5	6
R (A W^{-1})	924.2	312.5	437.5	143.75	490.63	343.7

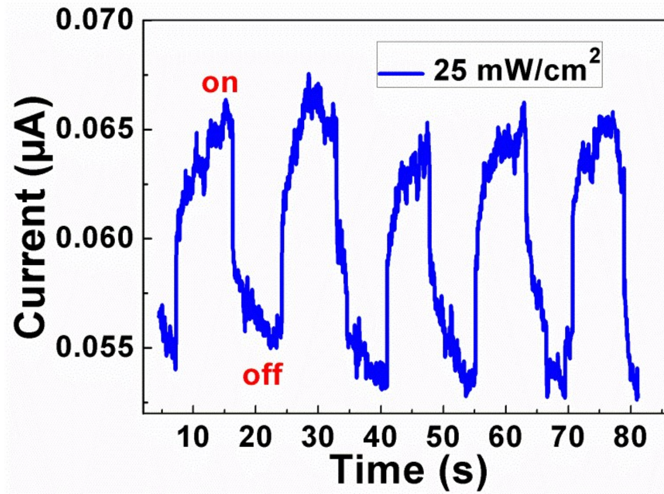

Fig. S6 Photoresponse of the devices measured under the illumination of 1310 nm light (25 mW cm^{-2}). The bias voltage was fixed at -5 V.

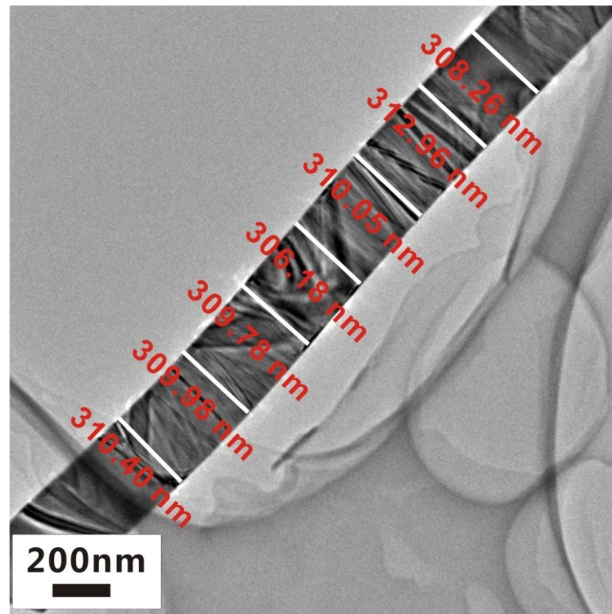

Fig. S7 Low-resolution TEM image of a single Bi_2Se_3 NW. The diameter of the NW can be deduced to be 309.66 ± 3.48 nm by measuring different positions in a single NW, and the mean error was less than 1.13%.

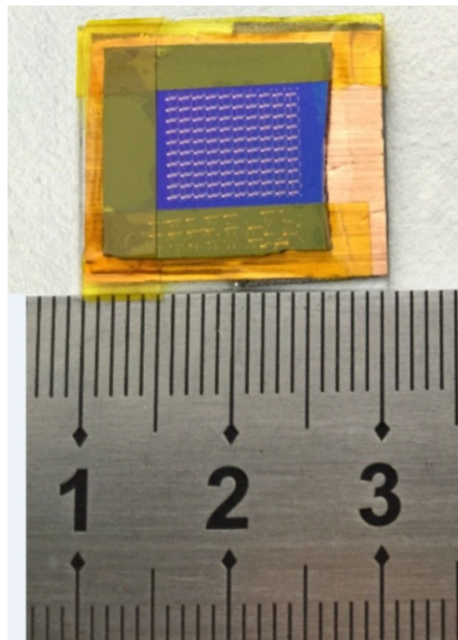

Fig. S8 Photograph of the Bi_2Se_3 NWs/Si heterostructure photodetectors, consisting of 10×10 devices in the same substrate.

Formulae's used in the study:

Work function	$\Phi_s = hv - E_{max}$
Photocurrent	$I_{ph}= I_{light} - I_{dark}$
On/off ratio	On/off ratio = I_{light}/I_{dark}
Responsivity	$R\ (A\ W^{-1}) = I_{ph}/P_{in}$
Detectivity	$D^* = (AB)^{1/2}/NEP \approx A^{1/2}R/(2qI_d)^{1/2}$
Gain	$G = R\ hc/(q\lambda)$

Where Φ_s = Work function (eV)

hv = the energy of the He I radiation source (eV)

E_{max} = maximum binding energy (eV)

I_{ph} = photocurrent (μA)

I_d = the dark current (μA)

R = Responsivity (A W^{-1})

P_{in} = the incident light power on the active area of the photodetector (mW cm^{-2})

D^* = Detectivity (Jones)

A = the active area of the photodetector (cm^2)

B = the bandgap (eV)

NEP = the noise equivalent power (W)

q = the unit charge (C)

h = the Planck's constant (J s)

c = the velocity of light (m s^{-1})

λ = the wavelength of illuminated light (nm)