Electronic Supplementary Material (ESI) for Nanoscale.

Supplementary Information

Effects of thickness and laser irradiation on electrical properties of e-beam evaporated 2D bismuth

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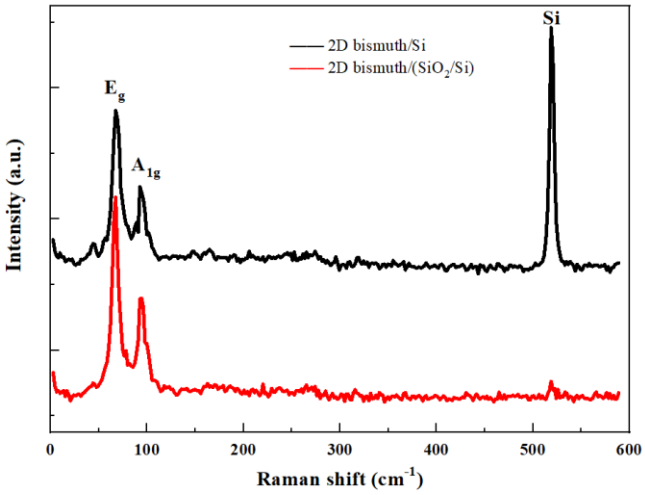

Figure. S1. Raman spectra of obtained 20-nm 2D bismuth on different substrates. There are two Raman modes located at ~ 66.2 cm^{-1} and ~ 93.4 cm^{-1} which are corresponding to two characteristic optical phonon modes E_g (in-plane) and A_{1g} (out-of-plane).

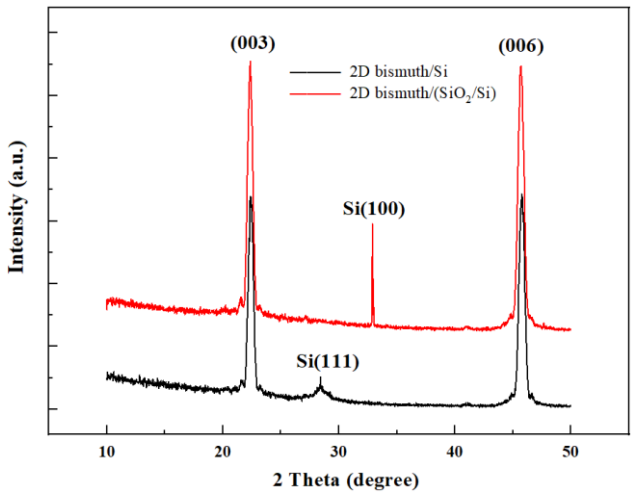

Figure. S2. XRD patterns of 20-nm 2D bismuth on different substrates.

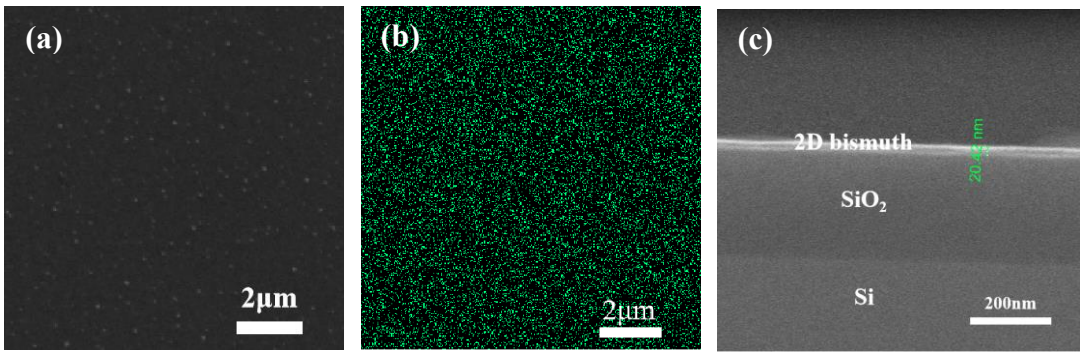

Figure. S3. (a) SEM image, (b) EDS mapping and (c) cross-sectional photo of 20-nm 2D bismuth.

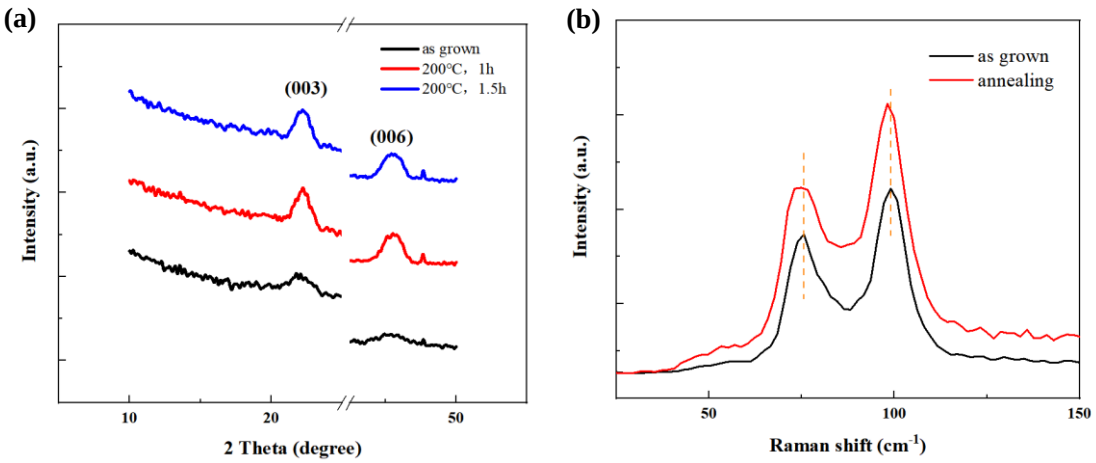

Figure. S4. (a) XRD patterns of as grown and annealed 8-nm 2D bismuth. The crystallite size increases from 6.1 nm to 8.0 nm after annealing, leading to the reduced grain boundary's scattering. (b) Raman spectra of as grown and annealed 8-nm 2D bismuth. The red shift after annealing indicates the strain relaxation in the layer. These two changes contribute to the increase of electrical conductivity shown in Tab. S1.

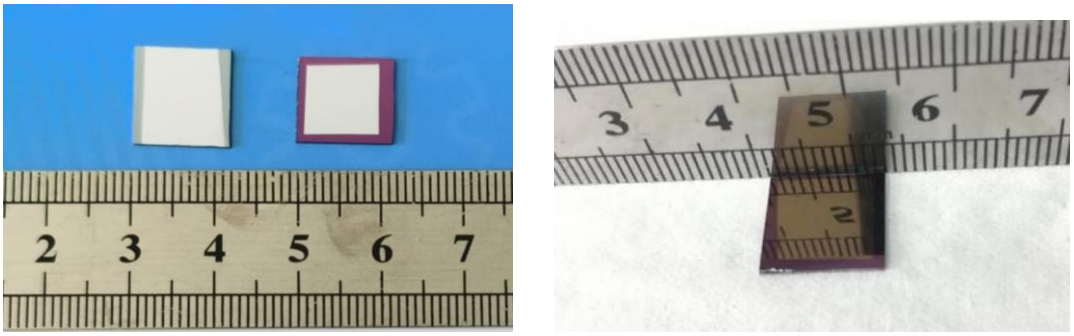

Figure. S5. Optical photographs of 2D bismuth samples.

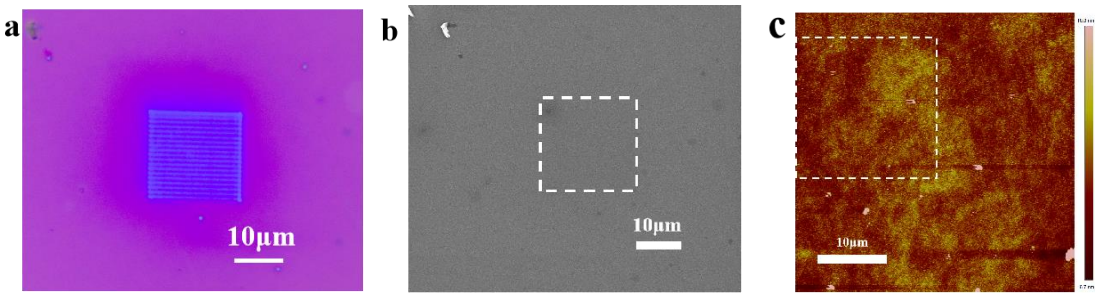

Figure. S6. (a) Optical photograph, (b) SEM image, (c) AFM image of 2D bismuth after laser irradiation. The box area (20 × 20μm^2) is the laser irradiation area.

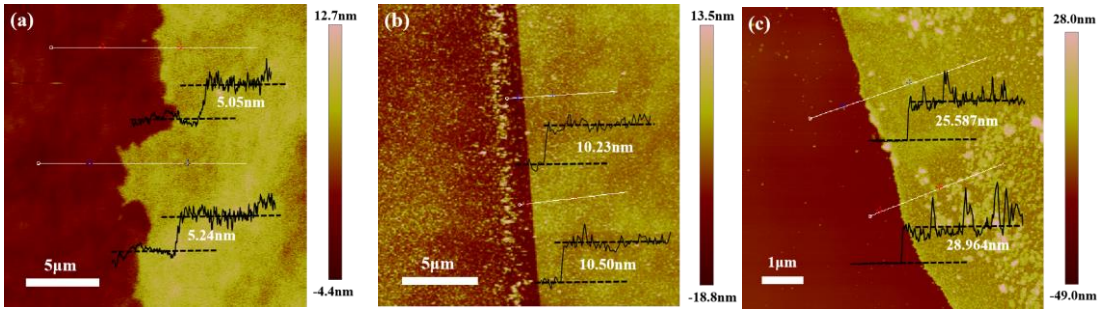

Figure. S7. AFM thickness measurements of (a) 5-nm, (b) 10-nm and (c) 30-nm 2D bismuth. The measured thickness is 5.1nm, 10.4 nm and 27.3 nm, respectively, which is very close to the value read from thickness monitor.

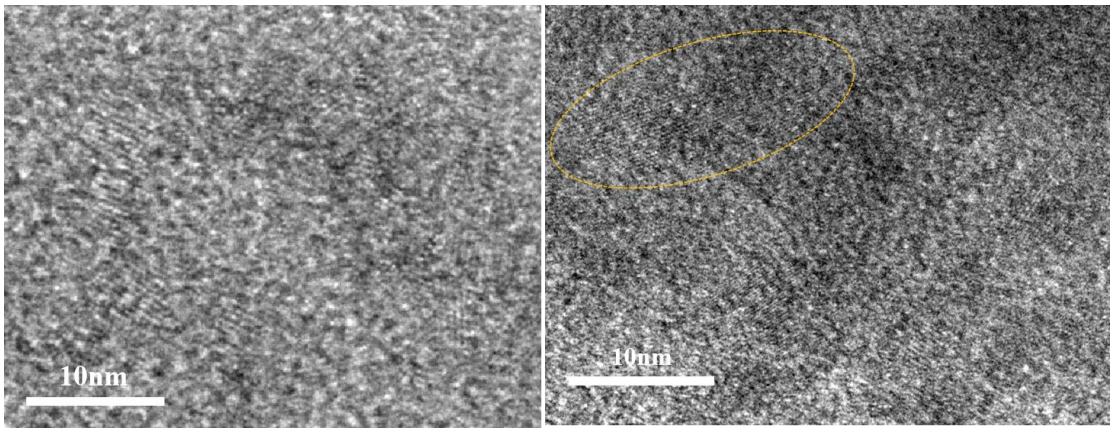

Figure. S8. TEM images of 2D bismuth. The nanocrystal size of the circle area is about 20nm.

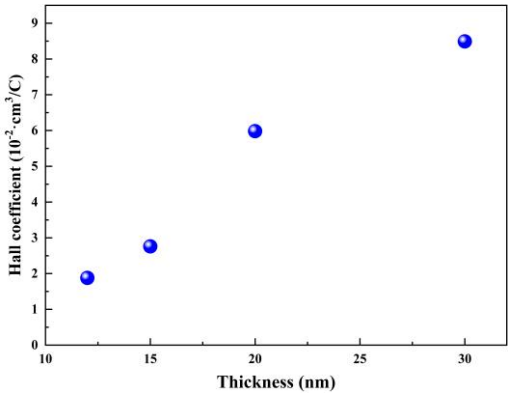

Figure. S9. Hall coefficient of different thickness 2D bismuth on SiO_2 substrate. Hall coefficient shows a positive correlation with thickness.

Table. S1 Conductivity of 2D bismuth before and after annealing

Thickness (nm)	Average $\boldsymbol{\sigma}$ before annealing (S/m)	Average $\boldsymbol{\sigma}$ after annealing (S/m)
8	2.69×10^{3}	1.27×10^{4}
15	4.40×10^{3}	3.23×10^{4}
30	3.20×10^{4}	9.09×10^{4}

Table. S2 Thickness measurement results of 2D bismuth

Estimated thickness (nm)	5	10	20	30
Actual thickness (nm)	5.1	10.4	20.4	27.3