Supporting Information

Revealing self-aligned γ-SnTe ultrathin nanosheets in thermoelectric β-SnTe

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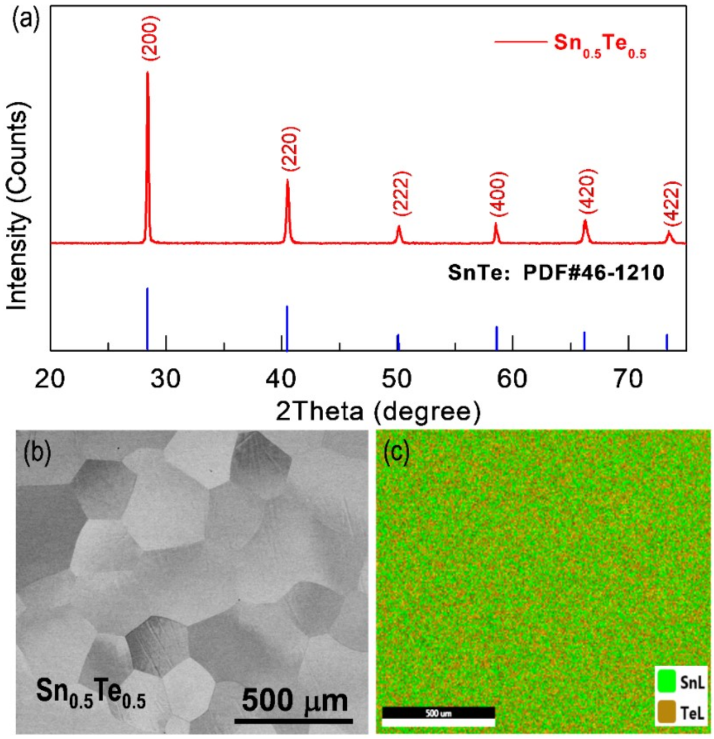

Figure S1. The single-phase polycrystalline β-SnTe sample. (a) A typical X-ray diffraction pattern of the $Sn_{0.5}Te_{0.5}$ bulk sample. The scans were recorded in the range of 2θ = 20-75° with a step size of 0.02°. The X-ray diffraction pattern can be indexed as β-SnTe ($Fm\bar{3}m$) with a rock-salt structure. The calculated lattice parameter of β-SnTe is *a*=*b*=*c*=0.63621(3) nm. (b) and (c) Back-scattered electron scanning electron microscopy image and the corresponding energy dispersive X-ray spectroscopy (EDS) elemental maps of a polished $Sn_{0.5}Te_{0.5}$ sample. The EDS results are consistent with the X-ray studies, indicating that the single-phase polycrystalline β-SnTe sample was obtained. Additionally, there is no apparent element enrichment at the grain boundaries in the $Sn_{0.5}Te_{0.5}$ sample.

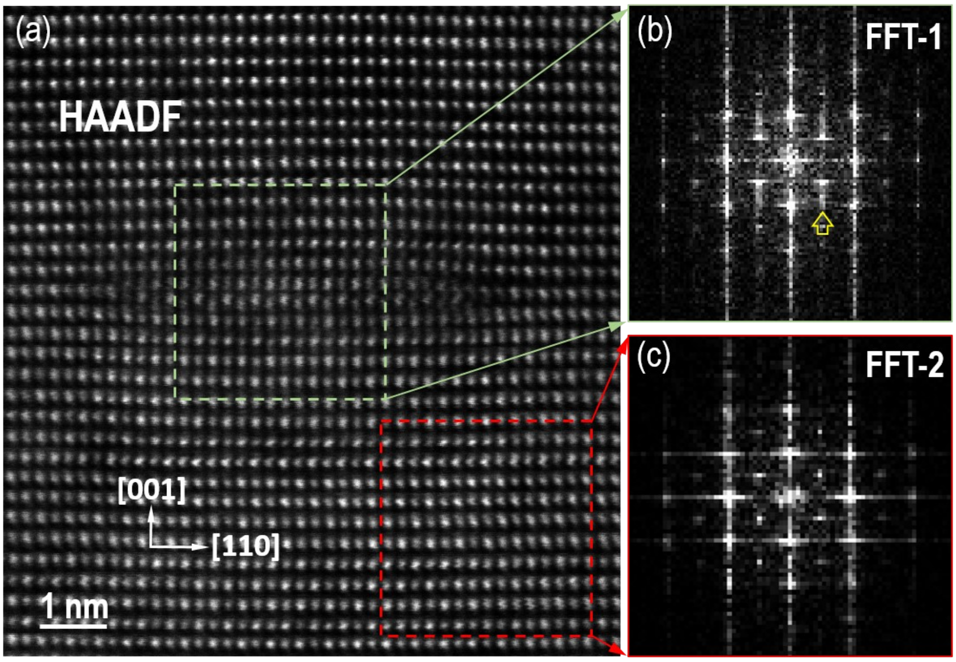

Figure S2. (a) HAADF-STEM image and (b,c) the fast Fourier transform (FFT) patterns of β-SnTe sample containing a nanosheet, viewed along the $[1\bar{1}0]$ zone axis of β-SnTe. It is noted that the FFT-1 pattern is taken from the β-SnTe region containing the nanosheet, and the FFT-2 pattern from the perfect β-SnTe region. By comparing FFT-1 with FFT-2, the extra spots in the FFT-1 pattern can be discerned, as demonstrated by a yellow arrow in (b), resulting from the appearance of the γ-SnTe nanosheet in β-SnTe.

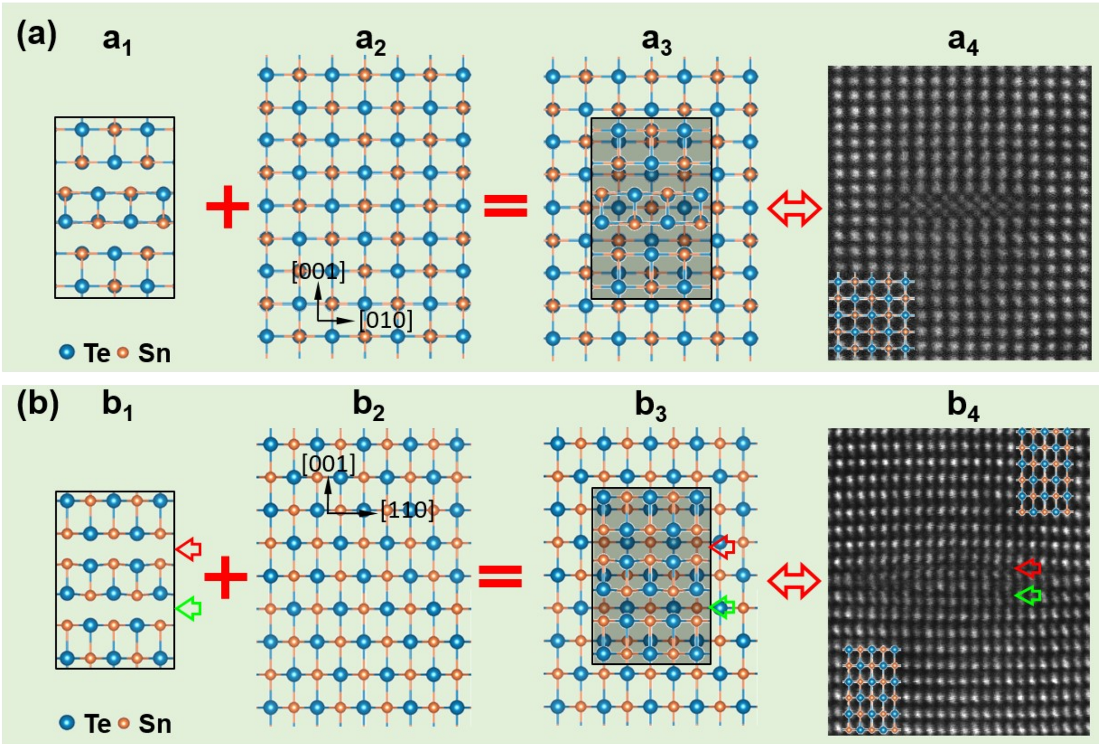

Figure S3. A schematic drawing of the β-SnTe region containing γ-SnTe nanosheet overlapped with the normal β-SnTe matrix, viewed along the (a) [100] and (b) $[1\bar{1}0]$ zone axis of β-SnTe. From the viewpoint of structural model, the overlapping of β-SnTe region containing γ-SnTe nanoscale precipitate (a_1 and b_1) and the normal β-SnTe matrix (a_2 and b_2) results in the superposed structure models (a_3 and b_3), which matched well with the experimental HAADF-STEM images (a_4 and b_4). In (b_1), two types of nanosheet/β-SnTe interface can be distinguished. If the β-SnTe part containing γ-SnTe nanosheet (b_1) is in the majority of the HAADF-STEM sample along the viewing direction, these two types of nanosheet/β-SnTe interface can also be discerned, as shown in the HAADF-STEM images (b_4). The interfaces are indicated by colored arrows in (b_1), (b_3), and (b_4).

Movie S1. **The structure evolution of γ-SnTe ultrathin nanosheet to β-SnTe occurs under *in situ* electron-beam irradiation.** The *in situ* electron-beam irradiation experiments were performed on a JEOL ARM200F microscope equipped with a probe aberration corrector, operated at 200 keV. Under the HAADF conditions, the video of the phase transition from γ-SnTe ultrathin nanosheet to β-SnTe was captured by recording the preview window during the experiments. In HAADF-STEM mode, the imaging conditions are a beam current of ~6.4 pA, a pixel dwell time of 37.8 μs/pixel and a pixel size of ~0.037Å^2, which corresponds to a radiation dose of ~4.1×10^6 e/nm^2. It is noted that the phase transition occurs in the course of the acquisition of time series consisting of 20 frames.