

Electronic Supplementary Information

for

Necklace-like ultrathin silver telluride nanowire films and their reversible structural phase transition

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Experimental Section

Chemicals. All reagents are of analytical grade and used without further purification. All chemicals were analytical grade. All other chemicals are commercially available from Shanghai Chemical Reagent Co. Ltd. Polyvinylpyrrolidone (PVP, $M_w \approx 40,000$), Na_2TeO_3 , hydrazine hydrate (85 wt%), aqueous ammonia solution (25-28 wt%), acetone, silver nitrate (AgNO_3), N,N-Dimethyl formamide (DMF) and CHCl_3 were used as received without further purification.

Synthesis of Te NWs. The synthesis of uniform Te NWs was described previously.¹ In the typical synthesis, 0.0922 g of Na_2TeO_3 and 1.0000 g of PVP were dissolved in 33 mL of distilled water under vigorous magnetic stirring to form a homogeneous solution at room temperature, then put the homogeneous solution into a 50 mL Teflon-lined stainless steel autoclave and after that, 1.67 mL of hydrazine hydrate (85%, w/w%) and 3.33 mL of aqueous ammonia solution (25-28%, w/w%) were added into the mixed solution, respectively, under vigorous magnetic stirring for a few minutes. The container was closed and maintained at 180 °C for 3 h. After that, the autoclave was cooled to room temperature naturally.

Synthesis of necklace-like Ag_2Te NWs. In a typical synthesis, 10 mL freshly prepared Te NWs from the previous experiment were precipitated by adding 21 mL of acetone and centrifuged at the 3000 rpm for 5 min. The product obtained was washed by water and ethanol for several times and then dispersed into 20 mL of ethylene glycol with vigorous magnetic stirring at room temperature until formed a homogeneous solution. After that, 0.0669 g of AgNO_3 was added into the previous solution quickly. The mixed solution was shook at a rotation rate of 260 rpm in the dark using an Innova 40 benchtop incubator shaker at 80 °C for 1 h.

Synthesis of normal shape Ag_2Te NWs. In a typical synthesis, 10 mL freshly prepared Te NWs from the previous experiment were precipitated by adding 21 mL of acetone and centrifuged at the 3000 rpm for 5 min. The product obtained was washed by water and ethanol for several times and then dispersed into 20 mL of ethylene glycol with vigorous magnetic stirring at room temperature until formed a homogeneous solution. After that, 0.0669 g of AgNO_3 was added into the previous solution quickly. The mixed solution was stirred in the dark at room temperature for 12 h.

Fabrication of Ag_2Te NW films by Langmuir-Blodgett (LB) method technique. The Ag_2Te NW films were prepared at room temperature using a LB method described previously by our group in the previous report.² In the method we used a trough (Nima Technology, 312D) filled with Millipore Milli-Q water (resistivity 18.2 M Ω .cm) until the water brimmed and the level just over the top by about 2 mm. 5 mL of the freshly prepared Ag_2Te NWs was precipitated by adding about 12 mL of acetone and centrifuging at 3000 rpm for 5 min. 1 mL of DMF was added to resolve the Ag_2Te NWs to form a homogeneous solution at room temperature. After that, a mixture solution of 4 mL of DMF and 5 mL of CHCl_3 were added into the as-prepared homogeneous solution. After that, the homogeneous solution was dispensed onto the water surface from a 100 μL syringe drop by drop. A few minutes later, after spreading and volatilization, the Ag_2Te NWs layer was then compressed with a compression rate of 20 cm min^{-1} . All films were transferred onto substrates layer by layer while the surface pressure was kept constant as soon as the fold appearance that paralleled to the barrier direction occurred. The surface of trough and barrier were then cleaned with $\text{C}_2\text{H}_5\text{OH}$ and CHCl_3 for several times, to ensure that there is no dust or contaminants left on it.

Characterization. High-resolution transmission electron microscope (HRTEM) images were performed on a JEOL-2010 transmission electron microscope operated at an acceleration voltage of 200 kV. The phase purity of the as-prepared products at different temperature was determined by High temperature X-ray diffraction (HT-XRD) using a Philips X'Pert Pro Super X-ray diffractometer equipped with temperature control console. The energy-dispersive X-ray spectroscopy (EDS) analysis was also done with a JEOL-2010 TEM with an Oxford windowless Si (Li) detector equipped with a 4-pulse processor. X-ray photoelectron spectra (XPS) were recorded on an ESCALab MKII X-ray photoelectron spectrometer, using Mg KR radiation as the exciting source. Field-emission scanning electron microscopy (FESEM) was carried out with a field-emission scanning electron microanalyzer (Zeiss Supra 40 scanning electron microscope at an acceleration voltage of 5 kV.). Differential scanning calorimetry (DSC) curves were performed on DSCQ 2000 which manufactured by the TA Instruments. UV-Vis spectra were recorded on UV-2600 in absorbance mode at room temperature. The resistance-temperature curves were measured by Keithley model 2410 as a current source, Keithley model 2182 voltage meter as a voltmeter and Linkam Temperature Programmer T95 as a temperature regulating device, respectively.

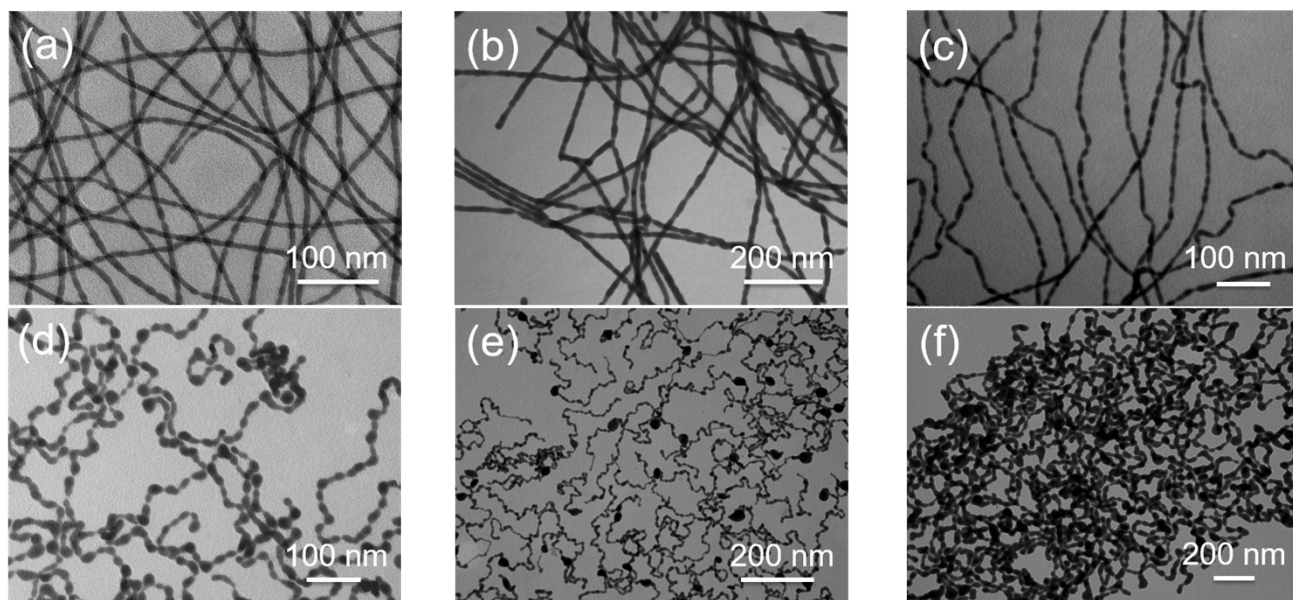


Figure S1. TEM images of the necklace-like Ag_2Te NWs with different reaction temperature. (a) 60 °C, (b) 70 °C, (c) 75 °C, (d) 90 °C, (e) 100 °C, (f) 110 °C, respectively.

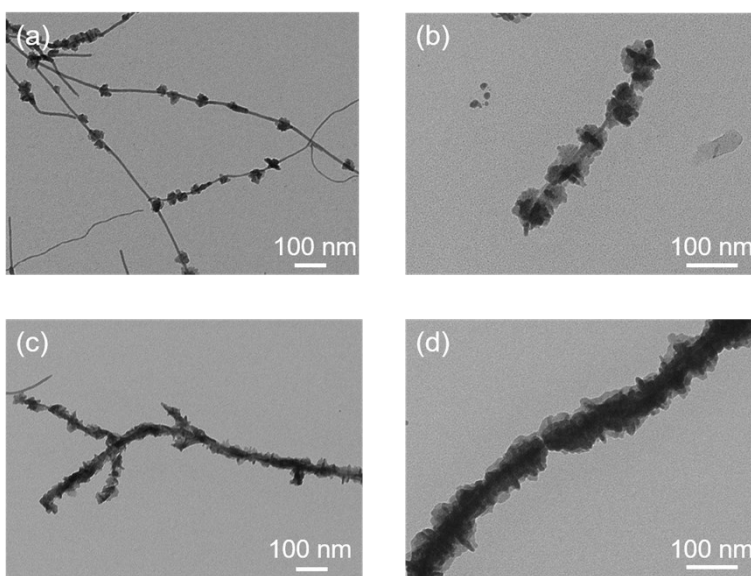


Figure S2. TEM images of the necklace-like Ag_2Te NWs with different reaction time. (a) 0.5 h, (b) 1.5h, (c) 2 h, (d) 3 h, respectively.

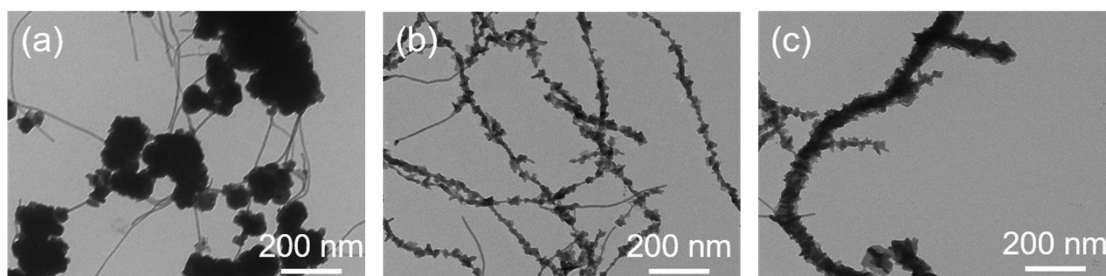


Figure S3. TEM images of the necklace-like Ag_2Te NWs with different rotation rate. (a) 100 rpm, (b) 200 rpm, (c) 300 rpm, respectively.

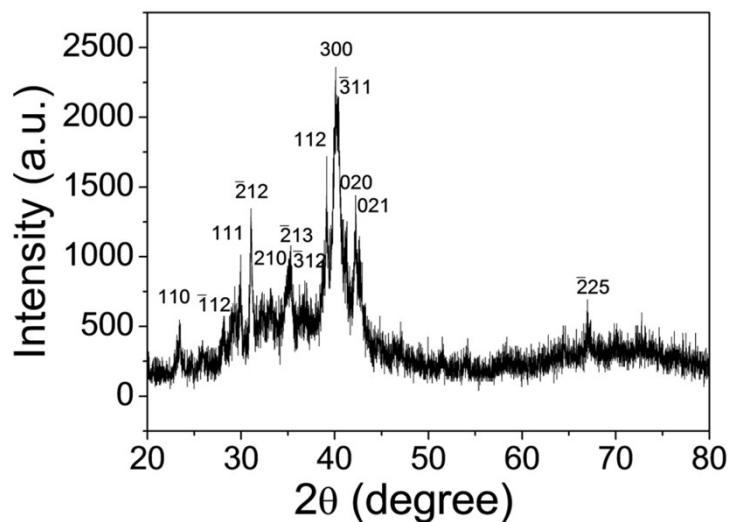


Figure S4. XRD pattern of the as-synthesized β -Ag₂Te NWs.

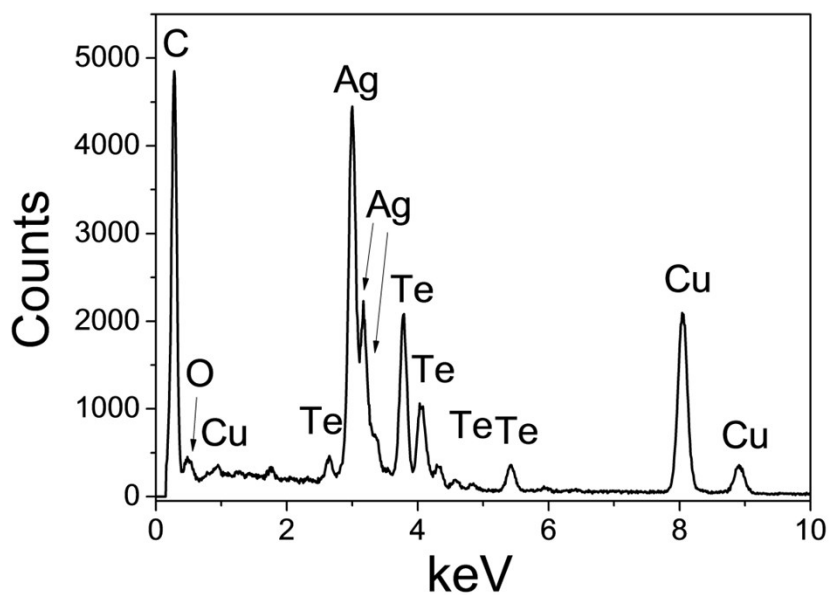


Figure S5. EDS pattern of the as-synthesized β -Ag₂Te NWs.

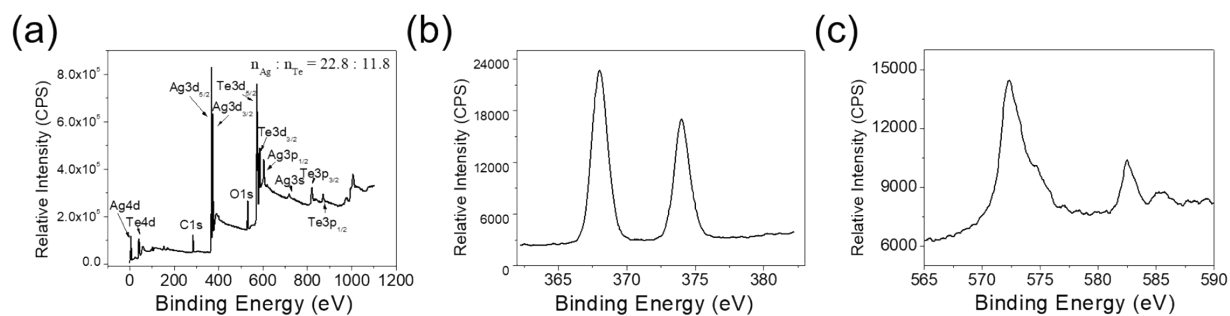


Figure S6. XPS spectra for the obtained Ag₂Te NWs. (a) Survey of the sample. (b and c) survey of the Ag 3d and Te 3d region, respectively.

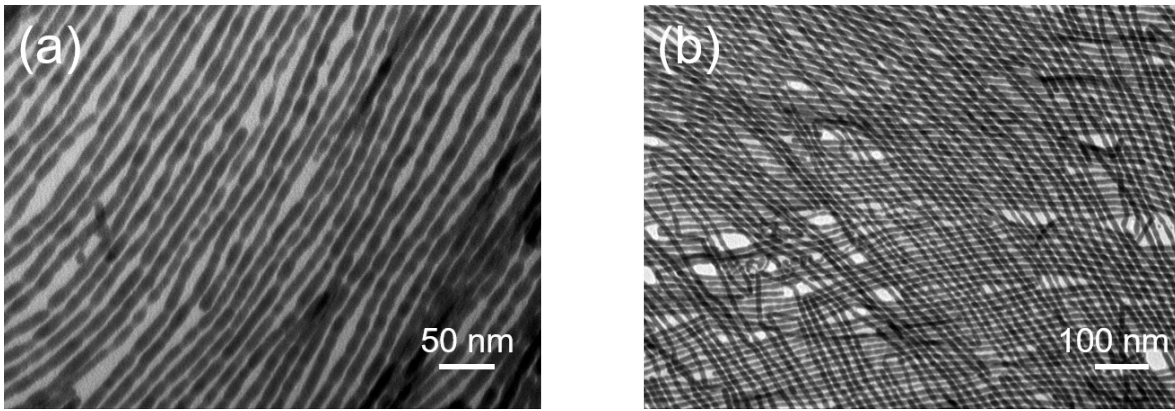


Figure S7. TEM images of necklace-like Ag_2Te NW Films assembled by LB method with (a) one layer, (b) double layers.

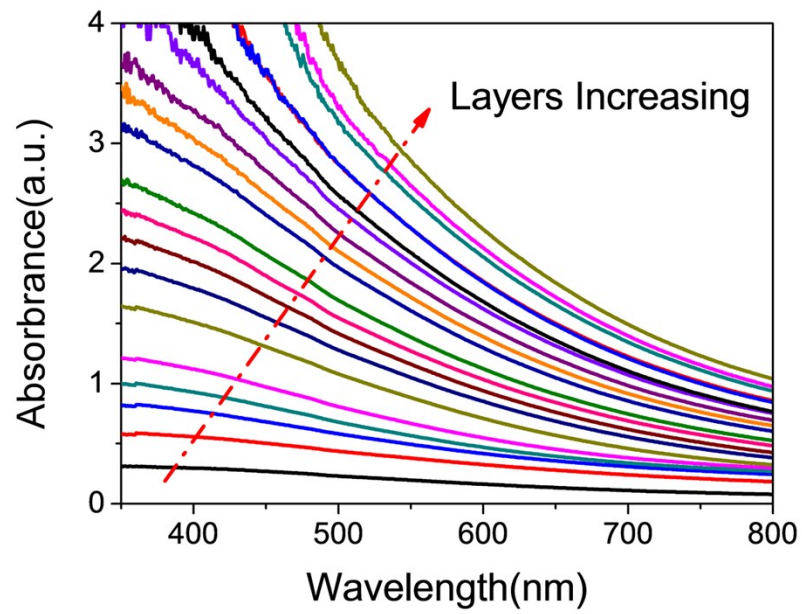


Figure S8. UV-Vis spectra of Ag_2Te NW Films with different layers from 1 to 20 layers.

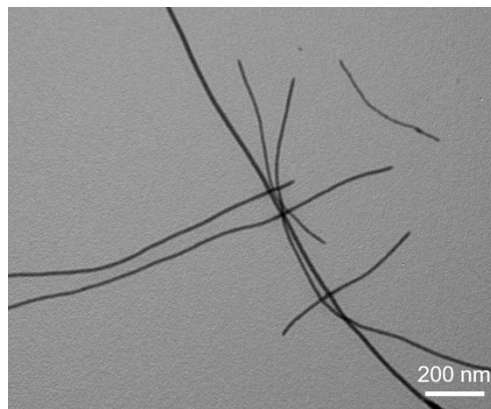


Figure S9. TEM images of the normal shape Ag_2Te NWs.

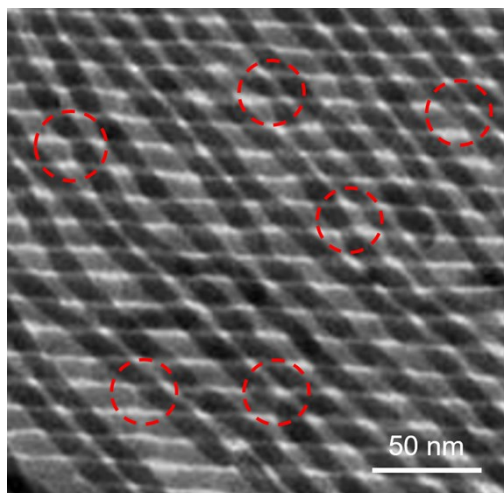


Figure S10. TEM images of vertical crossing necklace-like Ag_2Te NW films.

	NS-2L	NL-2L	NS-4L	NL-4L	NS-6L	NL-6L
25 °C	134847 Ω	57984 Ω	35943 Ω	19706 Ω	17844 Ω	9651 Ω
150 °C	39739 Ω	21029 Ω	16627 Ω	9690 Ω	7881 Ω	4326 Ω

Table. S1. The temperature-resistance of normal shape (NS) Ag_2Te NW films and necklace-like (NL) Ag_2Te NW films with different number of 2 layers, 4 layers, 6 layers before phase transition (25 °C), and after phase transition (150 °C).

References:

- 1 H.-S. Qian, S.-H. Yu, J.-Y. Gong, L.-B. Luo and L.-f. Fei, *Langmuir*, 2006, **22**, 3830-3835.
- 2 J.-W. Liu, J. Xu, H.-W. Liang, K. Wang and S.-H. Yu, *Angew. Chem. Int. Ed.*, **2012**, 51, 7420-7425.