Electronic Supplementary Information

Crooked Ag_2Te Nanowires with Rough Surface: Facile Microwave-assisted Solution Synthesis, Growth Mechanism, and Electrical Performances

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Experimental Section

Silver nitrate, sodium telluride, sodium hydroxide and ethylene glycol (EG) were purchased from Shanghai Chemical reagent Co. All the chemicals were analytical grade and used as received. Distilled water was used throughout the experiment. In the typical synthetic procedure, 1 mmol of $AgNO_3$, 0.5 mmol of Na_2TeO_3 and 0.2 g of NaOH were dissolved in 45 mL of EG to form a homogeneous solution. Then the solution was poured into a 50 mL round-bottomed flask and subsequently microwave-heated rapidly to 190 ^oC and maintain at this temperature for 15 min, After microwave heating, the solution cooled down naturally and the precipitate was collected, centrifuged and washed with distilled water three times and ethanol once, then dried at 60 ^oC in vacuum. The microwave oven used for sample preparation was a focused multi-mode microwave synthesis system (Sineo MAS-II, Shanghai, China), and the experimental parameters such as the temperature, heating rate and reaction time can be well controlled.

The crystal structures of the samples were recorded by an X-ray powder diffractometer (XRD, Rigaku D/max-2550PC) with Cu-Kα radiation (45 kV, 50 mA). The morphology and composition of the samples were detected by field emission scanning electron microscopy (FESEM, FEI Quanta 200F) with energy-dispersive spectrometer (EDS). The relative density of the bulk samples were measured using Archimedes' method. To evaluate the electrical performances of the obtained materials, the products were pressed into a strip with a rectangular shape of about 10×4.6×1 mm^3 (20 MPa pressure at room temperature). Silver pastes were coated as electrical contacts of the electrodes to the sample. The electrical conductivity was measured by a DC four-probe technique using a 2400 sourcemeter (Keithley 2400, Keithley Instruments Inc., America) under an argon atmosphere. The Seebeck coefficient was detected on a computer-controlled multifunctional measuring system under an argon atmosphere (Keithley 2700 multimeter, Keithley Instruments Inc., America). During the experiment, a temperature gradient (dT) of about 3-15 K between the cool and hot ends of bar-shaped sample was established by heating the hot ends with a microheater, while the thermally induced voltage (dV) was tested by a voltage probe. Then the Seebeck coefficient can be obtained from the slope of straight line of the formula, $S = -dV/dT$.

Experimental Results Section:

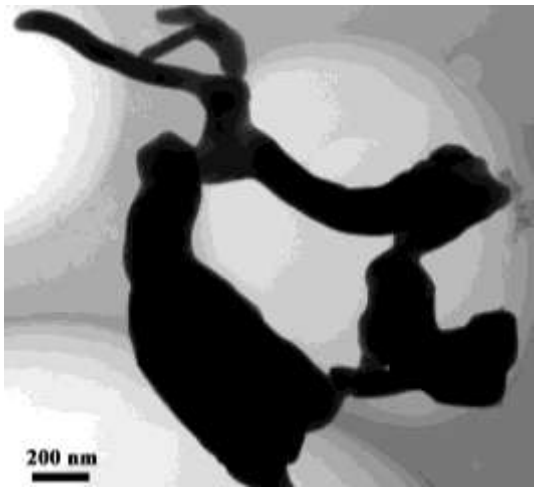

Fig. S1 TEM image of the sample prepared by microwave-assisted solution method at 190 ^{o}C for 5 min

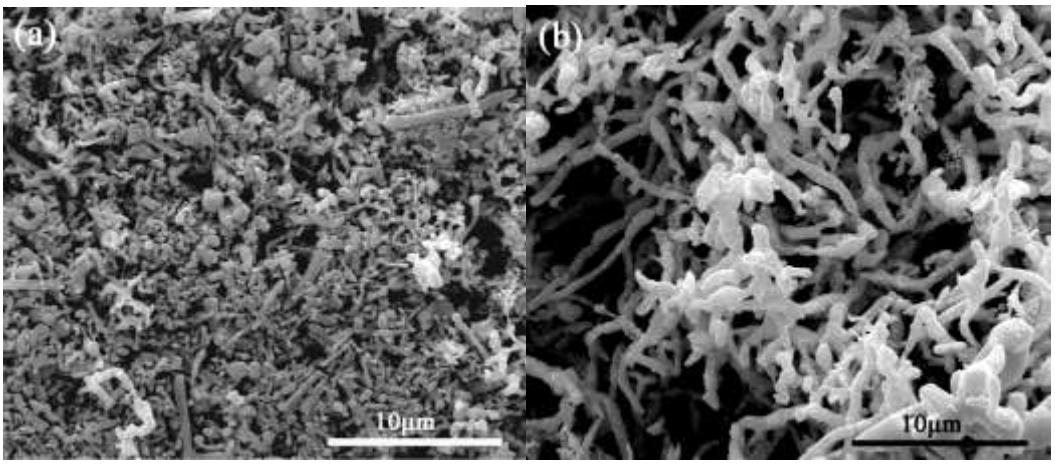

Fig. S2 FESEM images the products obtained with different reaction temperatures:

(a) 130 ^{o}C, (b) 160 ^{o}C

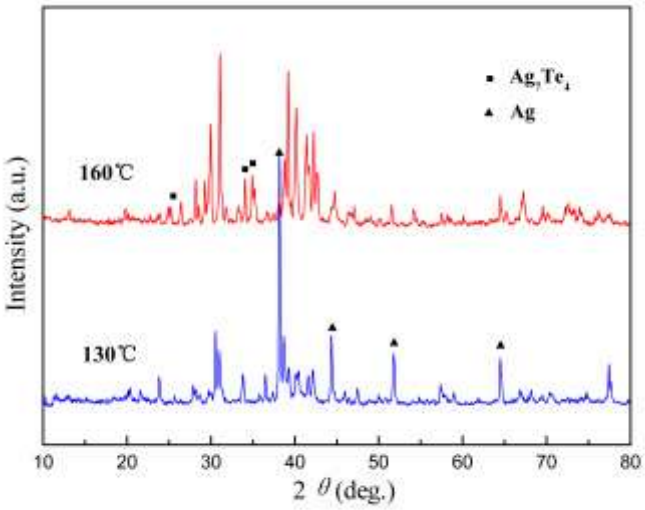

Fig. S3 XRD patterns of the samples obtained with different reaction temperatures**.**

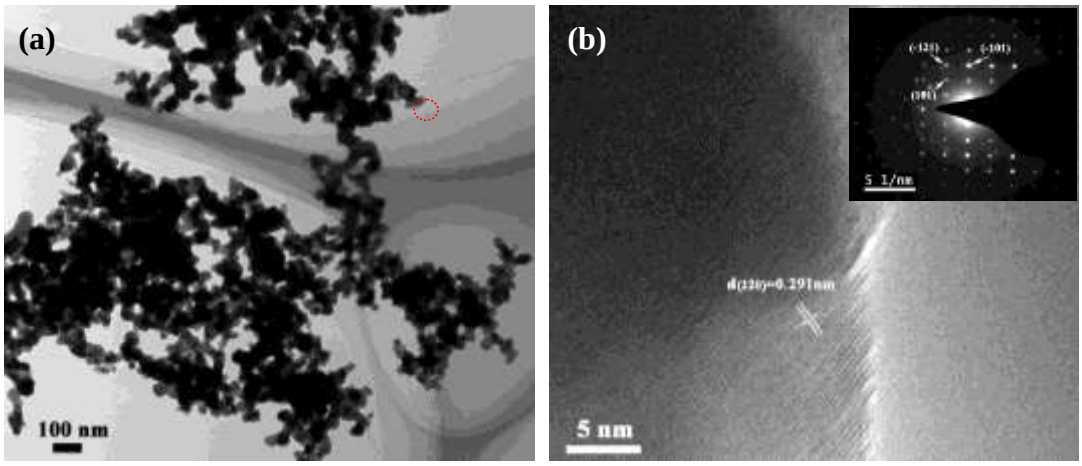

Fig. S4 (a) TEM image of the sample synthesized by microwave-assisted solution method at 190 ^{o}C for 4 min, (b) HRTEM image and SAED pattern recorded from the edge of nanoparticle.

TEM image of the sample fabricated by microwave-assisted solution method at 190 ^{o}C for 4 min are provided in Fig. S4a. The products are composed of numerous nanoparticles with particle sizes of 30-50 nm and the nanoparticles connect with each other. Fig. S4b shows a typical HRTEM image taken from the edge of one nanoparticle marked by an ellipse in Fig. S4a. The interplanar spacing is 0.291 nm, corresponding to the (220) plane of monoclinic Ag_2Te. The corresponding SAED pattern (inset of Fig. S4b) indicates the single crystalline nature of the nanoparticle. This part of discussion supports the information that Ag_2Te nanoparticles are formed during the process of microwave-assisted solution synthesis (4 min).

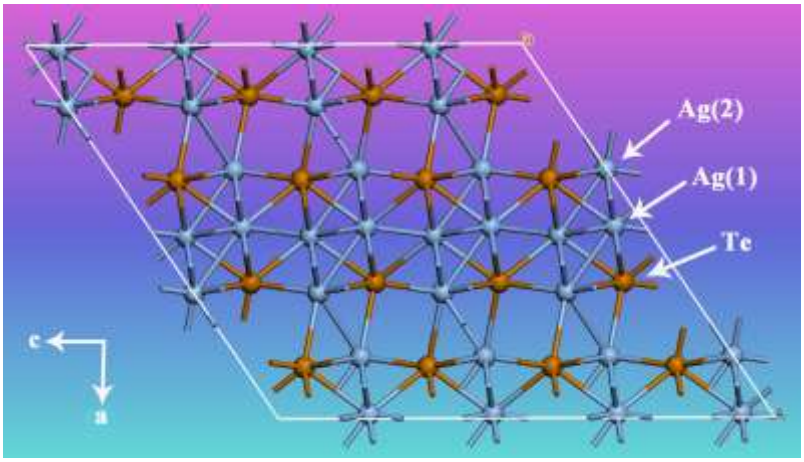

Fig. S5 Schematic of the layered crystal structure of Ag_2Te along the *b* axis.

Ag_2Te crystallines aggregate into nanorods in order to minimize the surface energy through the process known as oriented attachment. This self-assemble process is possible drived by dipole-field, which derived from the layered crystal structure of monoclinic Ag_2Te. As reported by groups of Qin [1] and Lee [2], β-Ag_2Te can be seen as a layered structure (Fig. S5). Paralleling along the [100] axis, Ag(1) atoms and coordinating tellurium atoms form a sheet of tetrahedral, sharing four edges with other $Ag(1)Te_4$ tetrahedra. $Ag(2)Te_4$ tetrahedra are linked to two other $Ag(2)Te_4$ tetrahedra via common edges and to four $Ag(2)Te_4$ tetrahedra via common vertices in another sheet. For the monoclinic Ag_2Te, oppositely charged ions produce positively charged {011} Ag and negatively charged {011} pairs of Ag-Te atomics planes. Therefore, this particular stacking of the nanoparticles might be caused by the dipole mechanism and dipole-induced electrostatic interactions between the building units that act as the aligning force.

[1] A. M Qin, Y. P Fang, P. F. Tao, J. Y Zhang, and C. Y. Su, Inorg. Chem. 46 (2007) 7403-7409.

[2] S. H. Lee, J. H. In, Y. D. Yoo, Y. H. Jo, Y. C. Park, H. J. Kim, H. C. Koo, J. H. Kim, B. S. Kim, and K. L. Wang, Nano Lett. 12 (2012) 4194-4199.