Conversion to Ag$_2$Te or CuTe nanotubes

The conversion to Ag$_2$Te or CuTe nanotubes follows a different procedure as Ag or Cu atoms are easily united to nanoparticles, which hardly alloy with Te nanotube. Thus, the fabrication for Ag$_2$Te and CuTe nanotube is modified. After the synthesis of tellurium nanotube, the solution is cooled down to room temperature naturally and, following centrifuged and washed with double-distilled water and absolute ethanol several times. Following, the produce is dissolved in 40 ml EG in a beaker and stirred at room temperature. Meanwhile, the silve precursor, 0.509 (3 mmol) AgNO$_3$ is dissolved in 5 ml EG individually and, stirred slightly by glass rod for 5 mins. Then, the AgNO$_3$ solution is added to the Te nanotube slowly by dropper and, the mixed
solution is reacted for 0.5 h. The products are washed several times with double-distilled water and absolute ethanol and, dried in a vacuum oven at room temperature. The conversion to CuTe is similar with that of Ag₂Te, except that AgNO₃ is replaced by 0.3488g (1.5 mmol) Cu(NO₃)₂·5H₂O, and 5 ml of 1.89 M ascorbic acid in water is added to promote the formation of Cu atoms.

**Synthesis method of Bi₂Te₃ nanowires**

A two-step approach was adopted to synthesize Bi₂Te₃ nanowires. Firstly, 0.2394 g (1.5 mmol) of TeO₂, 0.75 g PVP and 0.56 g (10 mmol) KOH were dissolved in 15 ml EG in a 100 ml three-necked bottle, and after vigorous stirring at room temperature for 10 min, the mixed solution was heated up to 150 ºC. Then 1 ml of N₂H₄·H₂O was rapidly injected into the solution and, the solution turned black instantly. The reaction was done for 3h in flowing N₂ to avoid oxidation, and Te nanowires were prepared. The process is similar to that adopted to synthesize Te nanotubes, but higher reaction temperature and higher concentration of reductant were adopted to suppress the outwards diffusion of Te atoms. Secondly, 0.485 g (2 mmol) Bi(NO₃)₃·5H₂O were dissolved in 5 ml EG at room temperature. The solution of Bi precursor was injected into the reaction solution of Te nanowires which are used as the templates, and the temperature of the mixed reaction solution was cooled down to 120 ºC, maintained for 3 hours. By this way, Bi₂Te₃ nanowires are prepared.
Figure S1 TEM images of aliquots taken at various times during the Te nanotube synthesis step: (a) 0 min; (b) 1 min; (c) 5 min; (d) 30 min. Scale bars represent 200 nm.

Insets show the changing in color at different reaction time
Figure S2 Low-magnification TEM image of (a) Te nanotubes and (b) Bi$_2$Te$_3$ nanotubes, respectively.
Figure S3 Low-magnification TEM analysis of nanotube materials, EDS profile with EDS mappings and HRTEM image with SAED pattern inset. (a-b) PbTe; (c-d) Ag$_2$Te; (e-f) Cu$_2$Te
Figure S4 XPS spectra of as-prepared nanotube materials (a-b) PbTe; (c-d) CuTe; (e-f) Ag$_2$Te
Figure S5 Raman spectra of as-prepared nanotube materials (a) Cu$_x$Te; (b) Ag$_2$Te; (c) PbTe.
Figure S6 The SEM image (a), EDS spectrum (b), XRD pattern (c) and distribution of the diameter (d) of as-synthesized Bi$_2$Te$_3$ nanowires.