Electronic Supplementary Material (ESI) for Nanoscale

Supplemental Information of " Phase Transformation and Thermoelectric Properties of Bismuth-Telluride Nanowires "

1. Seebeck coefficient measurement

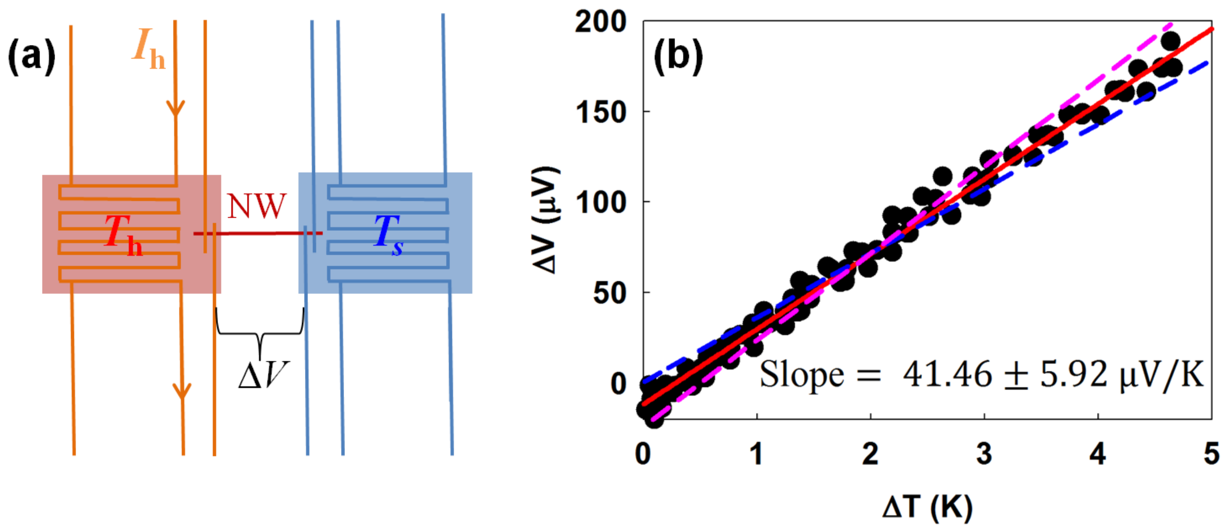

Figure S1. Seebeck coefficient measurement. (a) Schematic of the measurement setup. At each ambinent tempeature, after the sample reaches the thermal equilibrium with the ambient (usually takes 1-2 hours), the temperature of the left SiN_x membrane is increased by up to 5 K via joule heating (I_h). The temperatures of the heating and sensing sides (T_h and T_s respectively) are measured using the embedded Pt resistive thermometers. The Seebeck voltage (ΔV) is measured using a nanovoltmeter (Keithley 181). After I_h is applied, the voltage and temperature readings are made after 5 seconds, which is much longer than the thermal time constant of the suspended device (< 1 sec). (b) Measured seebeck voltage ΔV under differnet temperature differences ΔT (defined as $T_h - T_s$), for the BiTe nanowire sample at 300 K. The Seebeck coefficient S is extracted from the slope of the $\Delta V\ vs. \Delta T$ plot. The least square fitting (red solid line) yields $S = 41.46\ \mu V/K$ while the maximum and minimum slopes (dashed lines) gives the uncertainty of the fitting (5.92 $\mu V/K$). The reported uncertainty in S (in Fig. 4(c)) included the uncertainty in the fitting ((5.92 $\mu V/K$ in this case) as well as the uncertainty in the temperature measurement.

2. Electrical conductivity measurement

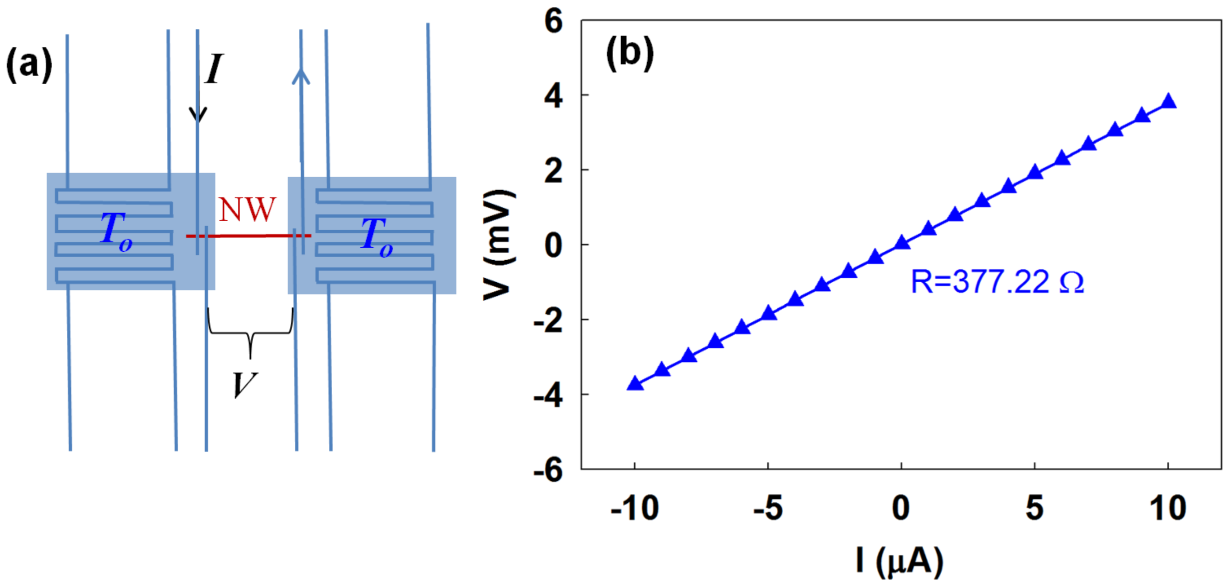

Figure S2. Electrical conductivity measurement. (a) Schematic of the measurement setup. The contacts between the nanowire and the Pt electrodes were made with FIB induced Pt. A small direct current (up to 10 μA) is applied to the outer electrodes and the 4-point voltage V was measured. (b) Measured $I - V$ curves for the BiTe sample at 300K. The linear I-V curves indicate Ohmic contacts. The measured 4-probe resistance is 377.22 Ω.

3. Measurement uncertainties

The uncertainty in the k measurements is about 15-18%, including the standard deviations of multiple (usually three) measurements at a certain temperature, uncertainty in the temperature coefficient of resistance (TCR), and uncertainty in nanowire diameters. The uncertainty in the ρ measurements is about 6-8%, primarily due to the uncertainty in nanowire diameters. Finally, the uncertainty in the S measurements is about 20%, due to the uncertainty in the slopes of the $\Delta V\ vs.\Delta T$ plots (see Supplemental Information) and the temperature measurements.

The uncertainty in ZT determination is about 30-33% based on the above-mentioned uncertainty in the individual variables ($S, \sigma, and\ \kappa$) and the propagation of the uncertainty, assuming the variables are independent. It is worth mentioning that the geometry of the NWs does not come into the ZT equation ($ZT = \frac{S^2T}{\rho\kappa} = \frac{S^2T}{RG}$, where R and G are electrical resistance and thermal conductance, respectively), therefore, the uncertainty in ZT can be written is:

$$\frac{\delta(ZT)}{ZT} = \sqrt{2\left(\frac{\delta S}{S}\right)^2 + \left(\frac{\delta R}{R}\right)^2 + \left(\frac{\delta G}{G}\right)^2} \qquad \text{(Eq. S1)}$$