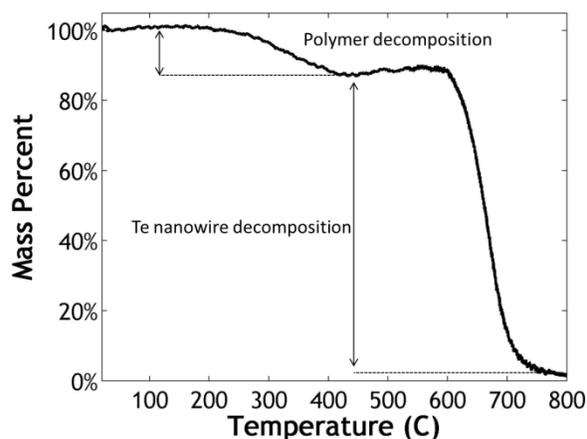


## Supplementary Information

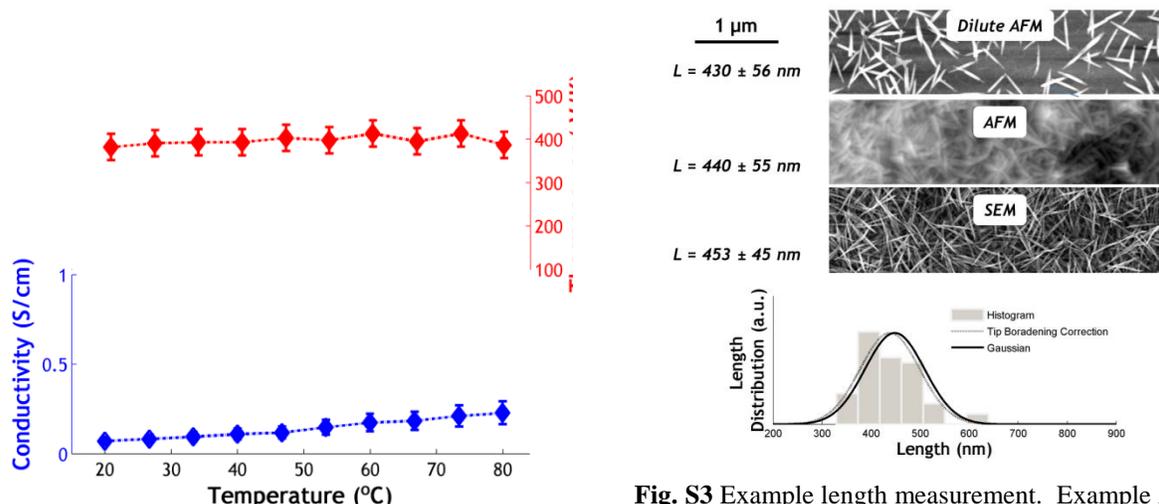
### Post-Synthesis Solvent Volume Normalization:

In the post-synthesis cases, various amounts of EG or DMSO were added after the final solution was prepared. Amounts were normalized to the amount of polymer present for direct comparison to pre-synthesis cases and the body of literature on PEDOT:PSS. In detail, the PEDOT:PSS (Clevios™ PH1000) solution contained 0.65 wt% solid post-filtering (or 99.35 wt% water) as determined by thermogravimetric analysis (TGA). This is in agreement with the vendor's claim that the dissolved solids are between 0.45 and 1.5 wt%.

In the pre-synthesis case, 5 mL of DMSO was added to 100 mL of PH1000 solution yielding a 5 vol% DMSO addition. Given that the specific density of the PH1000 solution is nearly 1 g/cm<sup>3</sup>, this is 5 mL of DMSO to every 0.65 g of PEDOT:PSS. In the post-synthesis case, the amount of PEDOT:PSS in the resulting dry hybrid material was determined again by TGA where the amount of PEDOT:PSS was taken as the amount that decomposes at low temperature (100 °C < T < 350 °C) and the amount of Te was taken as the amount that decomposes at high temperatures (T > 350 °C). See sample TGA in Fig. S1. So for normalization, an equivalent amount of DMSO was used to match the pre-synthesis cases. For example, if the resulting dry hybrid material contained 0.01 g of PEDOT:PSS in 3 mL of product, then  $(0.01/0.65) \times (5 \text{ mL}) = 76.9 \text{ }\mu\text{L}$  of DMSO would be added to the 3 mL of product yielding the equivalent of 5 vol% DMSO addition of the pre-synthesis case.



**Fig. S1** Example TGA of the TeNW hybrid material. The material was dried thoroughly before the TGA so there was no appreciable mass loss before 100°C. Boiling point of Te is ~980°C which exceeds the temperature range of the TGA. A slow temperature ramp rate (~1 °C/min) was used to facilitate evaporation of Te.



**Fig. S2** Temperature dependence on thermopower and electrical conductivity for Te nanowires coated in ascorbic acid.

**Fig. S3** Example length measurement. Example AFM and SEM images of nanowire films used to measure the size of the nanowires and an example histogram distribution showing a Gaussian fit and the minor shift in distribution when correcting for AFM tip broadening.

### Nanowire Length and Diameter Measurements:

AFM and SEM images were used to determine the nanowire length and diameter. For the AFM image analysis, three dimensional coordinates (x,y,z) of the ends of nanowires (for length measurements) and the edges (for diameter measurements) can be obtained directly. For the SEM images, only the lateral dimensions can be obtained (x,y). Since both ends of the nanowire must be visible for this measurement, it does bias toward nanowires that are laying parallel to the substrate's surface. However, grazing incident x-ray scattering previously performed on these films indicate a negligible amount of nanowire alignment to the substrate.<sup>1</sup> So even with this selection bias, the horizontal nanowires should be a good representation of all nanowires in the sample. This allows for good agreement between the SEM with only (x,y) and the AFM with (x,y,z) coordinates. Also to verify this approach, a dilute solution of nanowires was spun cast, allowing for the nanowires to separate and lie parallel to the substrate. Upon analyzing several (> 30) nanowires, it is evident that the variation in length between separate nanowires is much greater than any length measurement uncertainty ( $\Delta l = \sqrt{2}\Delta x$  where the coordinate uncertainty,  $\Delta x$ , is primarily due to AFM tip broadening of <10 nm) as shown in Fig. S3. The distribution of nanowire lengths and diameters has a Gaussian profile and therefore the standard deviation is an appropriate metric to represent the variation in nanowire length and diameter.

### Two Component Parallel Connected Composite Model:

A two-component, effective medium model for a parallel connected composite has previously been developed in literature.<sup>2</sup> In this model, the effective parallel thermopower is expressed as:

$$S_{\text{effective, parallel}} = \frac{S_1\sigma_1x_1 + S_2\sigma_2(1-x_1)}{\sigma_1x_1 + \sigma_2(1-x_1)} \quad (\text{S1})$$

and the effective parallel electrical conductivity can be expressed as:

$$\sigma_{\text{effective, parallel}} = x_1\sigma_1 + (1-x_1)\sigma_2 \quad (\text{S2})$$

where  $S_i$  is the thermopower,  $\sigma_i$  is the electrical conductivity, and  $x_i$  is the volume fraction of component  $i = 1, 2$ . Note that a similar expression can be obtained for a series connected composite that is weighted by the thermal conductivity and is also derived in this reference.

### Supplementary Information References:

1. S. K. Yee, N. Coates, J. J. Urban, A. Majumdar and R. A. Segalman, presented in part at the 3rd Micro/Nanoscale Heat & Mass Transfer International Conference, Atlanta, GA, March 3-6, 2012, 2011.
2. Y. Gelbstein, *J. Appl. Phys.*, 2009, **105**.