Supporting Information

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1. Synthesis and Characterization of Aligned Pearl-Like Nanotube Arrays

A dense Al_2O_3 buffer layer is first deposited on a Si substrate by the ion-beam-assisted deposition technique, and then the iron layer is coated on the top surface of the buffer layer. The synthesis process was performed in a quartz tube furnace. Forming gas (Ar with 6% H_2) was used as the carrier gas, and pure ethanol served as the carbon source. In a typical synthesis, nanotube growth was carried out between 800 and 850 ºC. Arrays with thickness up to hundreds of micrometer can be prepared by this approach.

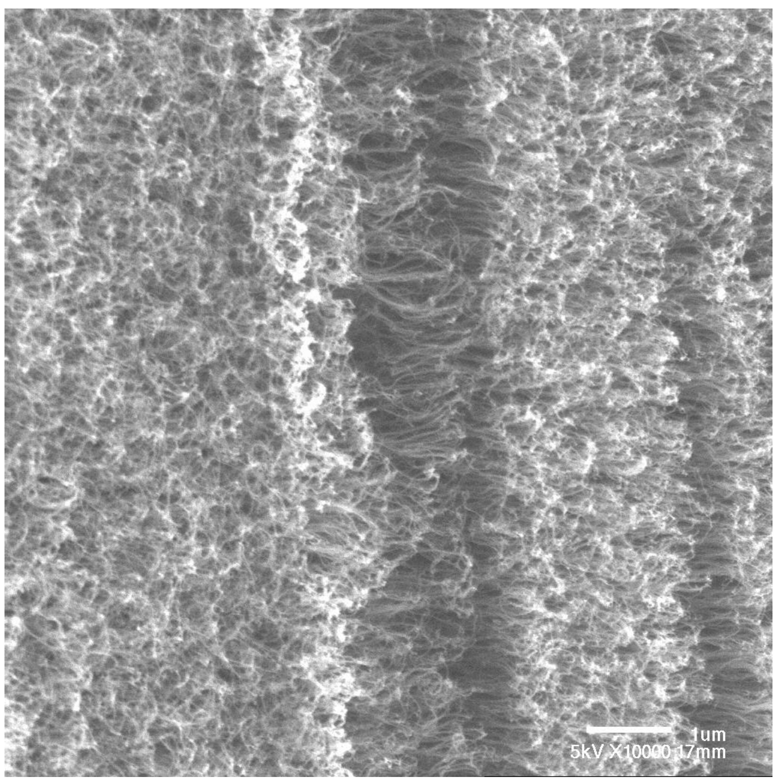

Figure S1. SEM on the top surface of carbon nanotube arrays.

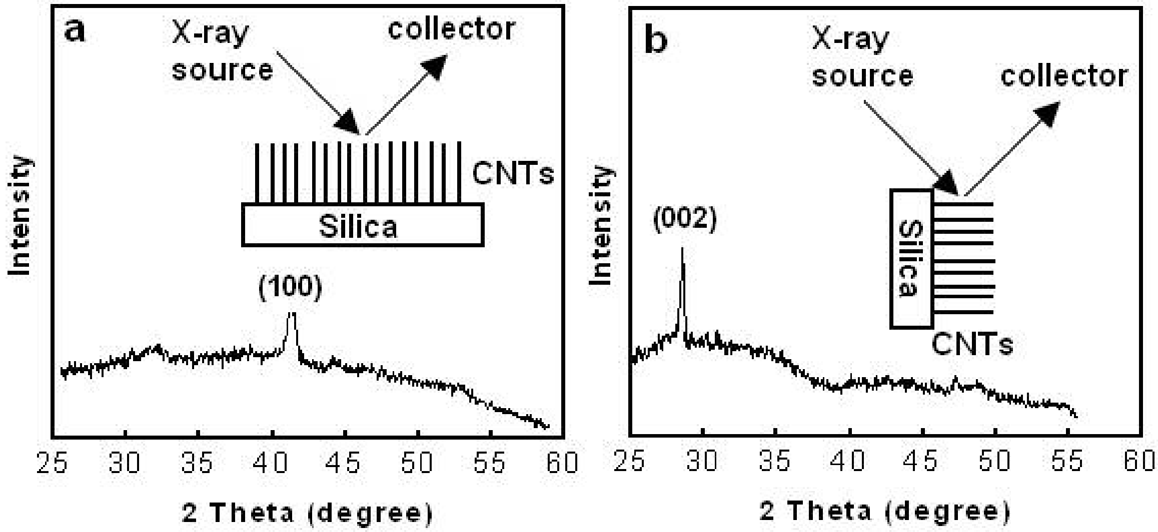

Figure S2. X-ray diffraction patterns of the nanotube arrays with different X-ray incidence directions. (**a**) X-ray strikes the top surface. (**b**) X-ray strikes the sideway of arrays.

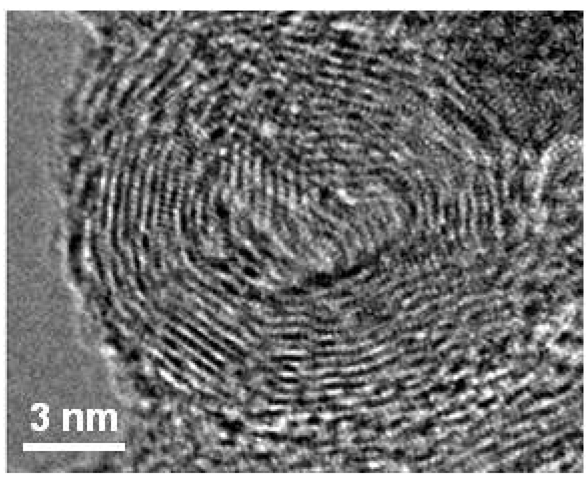

Figure S3. Cross-sectional view of a pearl-like nanotube by high resolution TEM.

2. Conduction Dimensionality of the Pearl-Like Nanotube Fibers

In more detail, the relationship between conductivity and temperature in Mott's hopping model can also be expressed as $\sigma \propto \exp(-A/T^{[1/(d+1)]})$, where A is a constant and d is the dimensionality.[1] The plot of lnσ vs. $T^{-1/4}$ (for d=3), $T^{-1/3}$ (for d=2) and $T^{-1/2}$ (for d=1) have linear fitting coefficients of 0.990, 0.978, and 0.951, respectively (Figure S4–S6). The result suggests that the electron transport is consistent with a 3D hopping mechanism.

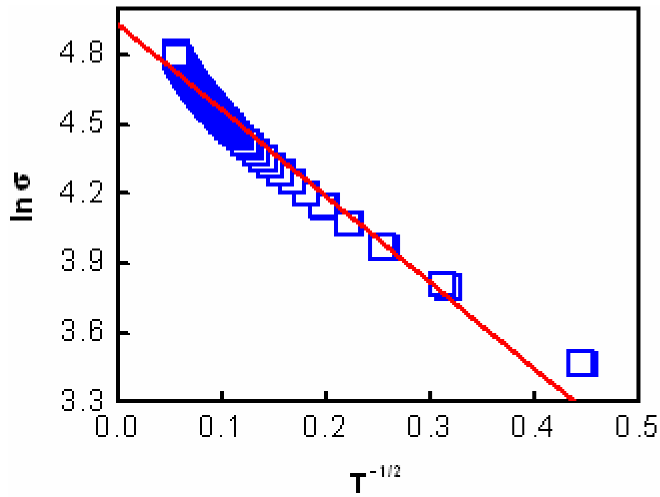

Figure S4. The plot of lnσ vs. $T^{-1/2}$ based on the Mott's variable range hopping model as $\sigma \propto \exp(-A/T^{[1/(d+1)]})$, where σ is the electrical conductivity, A is a constant, T is the temperature, and d is the dimensionality. For this plot, d=1, i.e. one-dimension hopping mechanism.

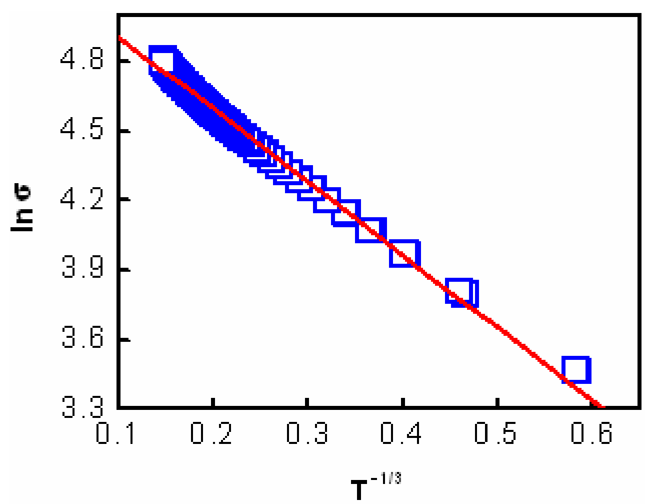

Figure S5. The plot of lnσ vs. $T^{-1/3}$ based on the Mott's variable range hopping model as $\sigma \propto \exp(-A/T^{[1/(d+1)]})$, where σ is the electrical conductivity, A is a constant, T is the temperature, and d is the dimensionality. For this plot, d=2, i.e. two-dimension hopping mechanism.

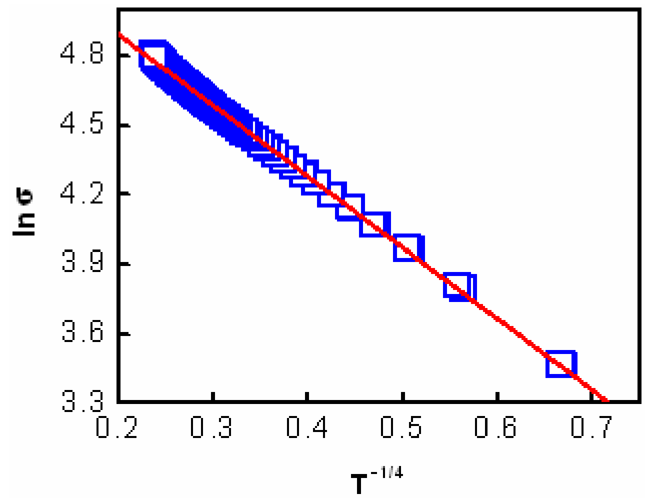

Figure S6. The plot of lnσ vs. $T^{-1/4}$ based on the Mott's variable range hopping model as $\sigma \propto \exp(-A/T^{[1/(d+1)]})$, where σ is the electrical conductivity, A is a constant, T is the temperature, and d is the dimensionality. For this plot, d=3, i.e. three-dimension hopping mechanism.

Full list of references:

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