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ADVANCED MATERIALS

Supporting Information

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Vertically Aligned and Penetrated Carbon Nanotube/Polymer Composite Film and Promising Electronic Applications

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Supporting Information

Experimental Section

Mechanical and electrical measurements. In order to calculate the resistance in the vertical direction, the samples were prepared by vertically cutting the two ends and longitudinally cutting the four sides of a composite array. Their resistances were then measured with four-probe method. For a sample with width of 10 μm, length of 10 μm, and height (the aligned direction of CNTs) of 1 mm, the resistance was measured to be 5.43×10^{3} Ω at room temperature. Therefore, for a square CNT/resin film with a width of 5 mm and a thickness of 10 μm typically used in this work, the resistance was calculated to be less than 0.2 Ω. On the other hand, the resistance of CNT/resin film can also be estimated from individual CNTs. The electrical resitivity of a multi-walled CNT is 3×10^{-5} Ω•cm (*Adv. Mater.* **2007**, *19*, 3358). For a composite film with a CNT diameter of 10 nm and a density of 10^{11} cm^{-2}, the resistivity can be calculated to be in the order of 10^{-4} Ω•cm.

Characterizations. Structures of CNTs and composite films were characterized by transmission electron microscopy (TEM, JEOL JEM-2100F operated at 200 kV) and scanning electron microscopy (SEM, Hitachi FE-SEM S-4800 operated at 1 kV). Raman measurements were made by Renishaw inVia Reflex with excitation wavelength of 514.5 nm and laser power of 20 mW at room temperature. The composite films were sliced with an ultramicrotome (Reichert-Jung) and a microtome (Leica RM2265). Mechanical tests were performed using a Shimadzu Table-Top Universal Testing Instrument. Electrical characterizations were mainly made through physical property measurement system (KEITHLEY 2182A nanocoltmeter with 6221A DC and AC current source). The resistivity changes in the gas sensor were monitored by an Agilent 34401A digital multimeter.

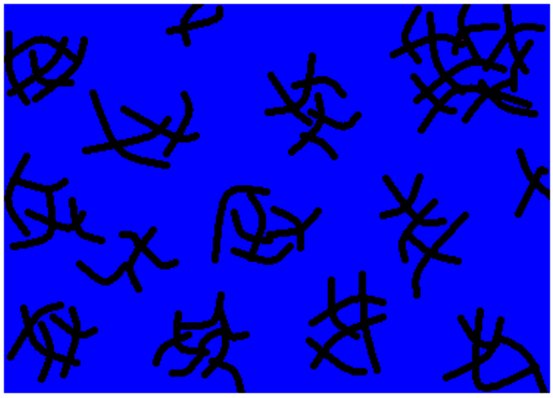

Figure S1. Schematic illustration of the structure for a randomly dispersed CNT/polymer composite material. The black and blue colors correspond to CNT and polymer, respectively.

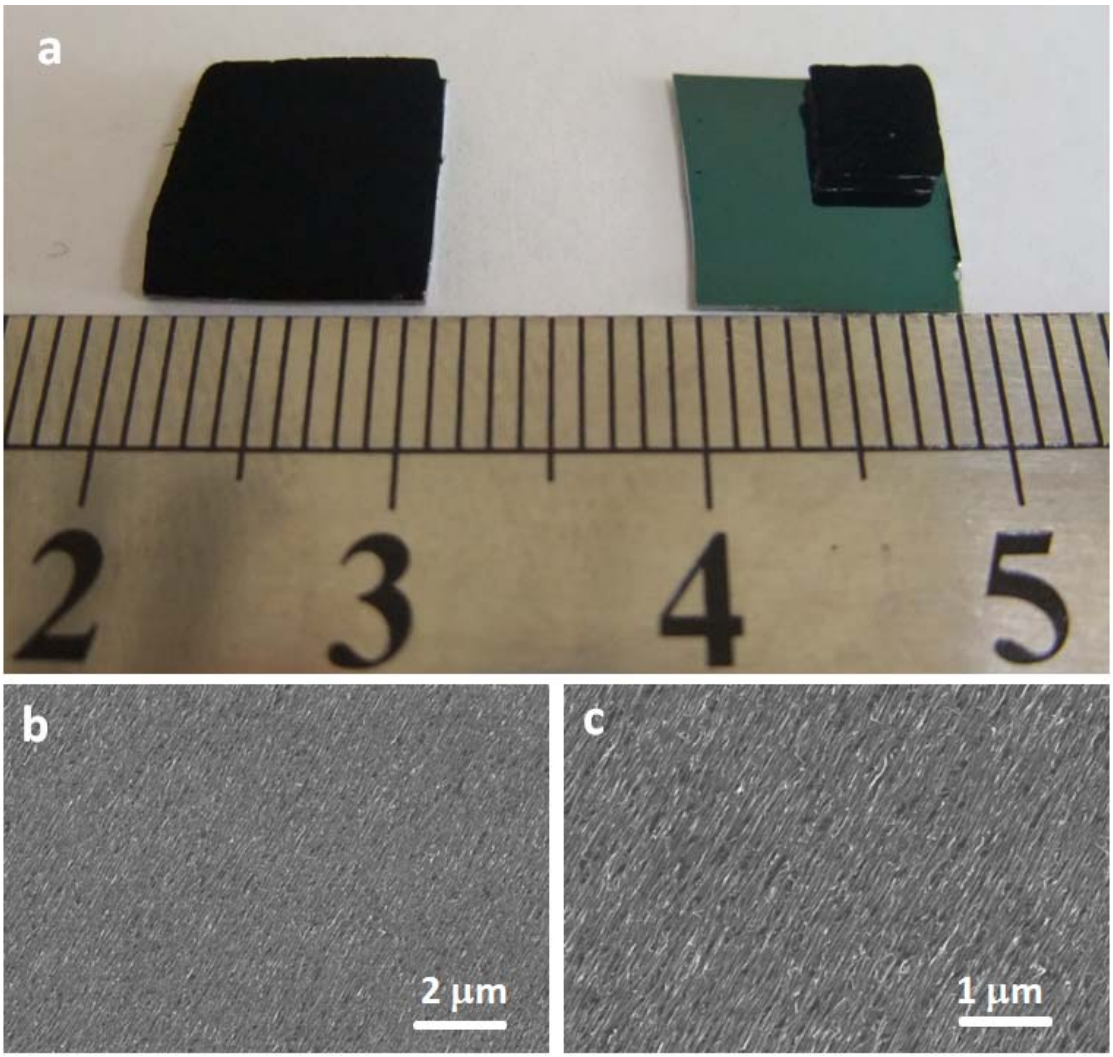

Figure S2. CNT densities could be greatly increased by pressing as-synthesized array from one or two sides. **a**, Photographs of a CNT array before and after being pressed. **b** and **c**, SEM images of CNT/resin film derived from the pressed CNT array.

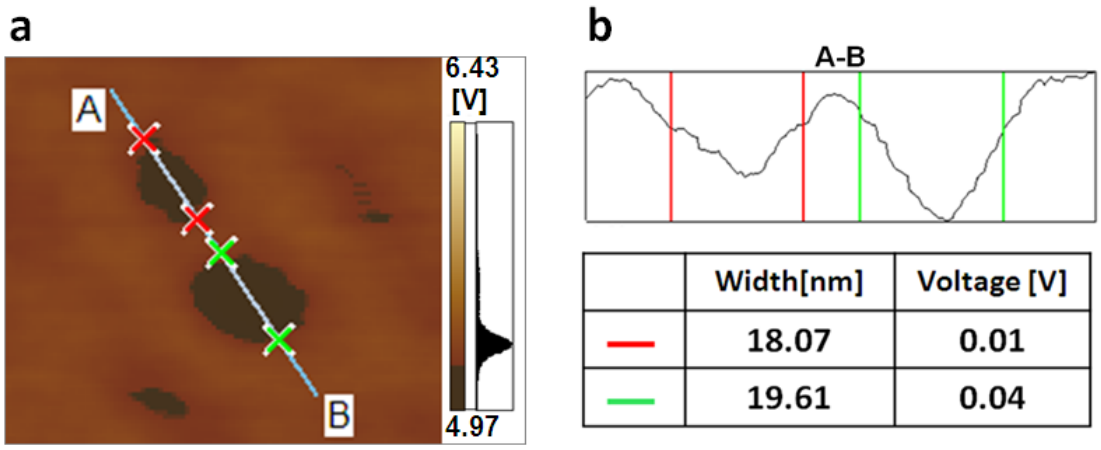

Figure S3. AFM image by top view of a vertically aligned and penetrated CNT/resin film.

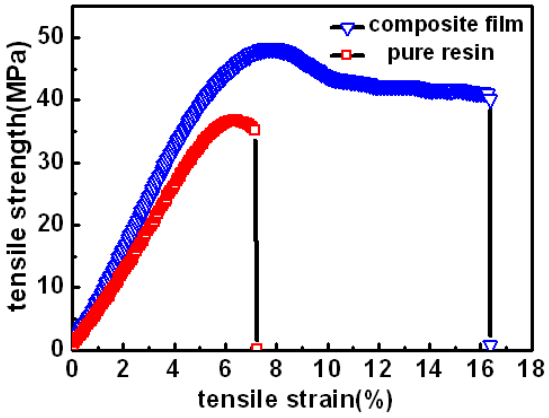

Figure S4. A comparison for stress-stain curves of pure resin and vertically aligned CNT/resin films in the horizontal direction.

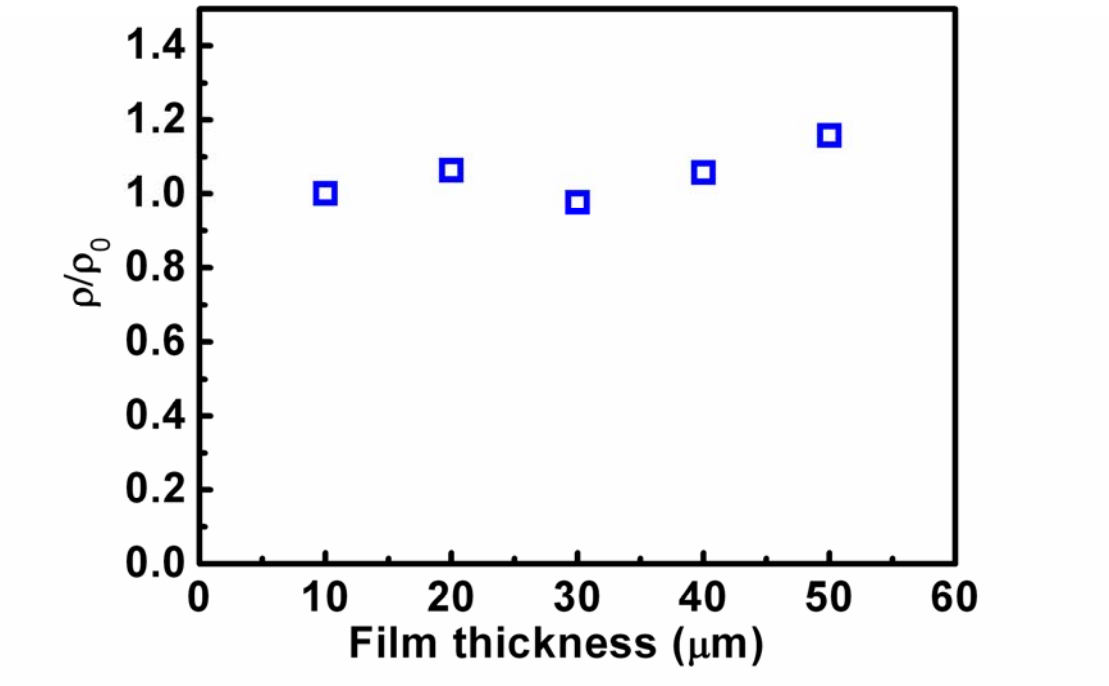

Figure S5. In-plane electrical resistivities of CNT/resin films with different thicknesses at room temperature. Here ρ_0 and ρ are electrical resistivities of composite films at the reference thickness of 10 μm and of other thicknesses, respectively.

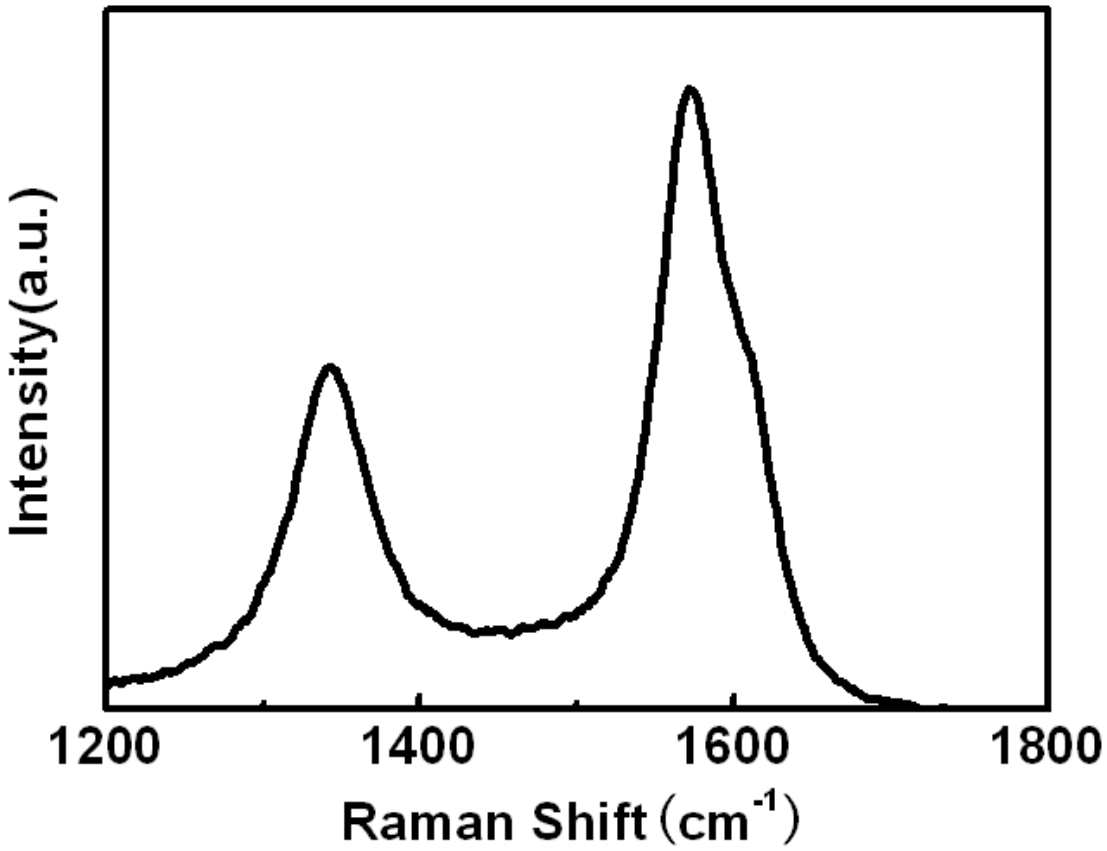

Figure S6 . A typical Raman spectrum of CNTs.