Supporting Information

I. The detailed process to determine the chirality of a CNT

The electron diffraction pattern of a SWCNT has an equatorial line L0 and several layer lines L1, L2, L2, etc.. The distance between the layer lines and the equatorial line can be written as d1, d2, d3, etc.. The relationship between the chiral angle of a CNT and d1, d2, and d3 in its electron diffraction pattern has been given as formula (2) in Reference 27. We take SWCNT1 in S1 and SWCNT2 in S2 for instance. From the diffraction patterns shown in the insets of Figures 2 (a) and 2 (b), the chiral angles are obtained to be 22.6 degree for SWCNT1 and 28.2 degree for SWCNT2, respectively. From the HRTEM images in the insets of Figures 2 (a) and 2 (b), the diameters of SWCNT1 and SWCNT2 are measured to be 2.1 nm and 2.5 nm, respectively. Therefore, the chirality of SWCNT1 is (19, 12) and the chirality of SWCNT2 is (19, 17). For DWCNTs and TWCNTs, we first identify the layer lines corresponding to each wall of the multi-layered CNT in the electron diffraction pattern and then obtain the chiral angle of each wall using formula (2) in Reference 27. Coupled with the diameter of the wall measured from the HRTEM image, the chirality of each wall can be determined.

We determine separately the chirality of the same CNT at both the left side and the right side of the segments of the CNT in the device and we obtain the same result. Therefore, we are confident that the chirality we determine by TEM is the chirality of the CNT in the measured device, because we believe that the nanotube's chirality preserves during its growth in a small scale.

II. Dynamic current response of the suspended CNT to its axial strain

The current at a fixed bias voltage is measured with the strain during repeatedly stretching and releasing the CNT in the device. The obtained reversible results indicate the electrical and physical contacts between the CNTs and the metal electrodes are stable. The dynamic current response of the suspended DWCNT in Device D1 is shown below in Figure S1. The dynamic current response of the suspended SWCNT in Device S1 has been given in Figure 2(e) in Ref. 26.

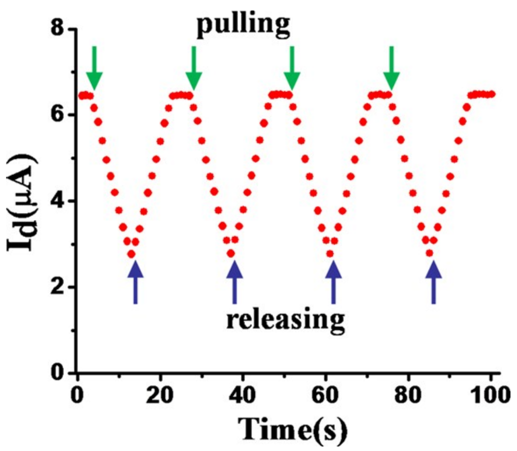

Figure S1. Dynamic current response of the suspended DWCNT in Device D1 to the 0-2% axial strain.

III. The details on strain measurement

To avoid the CNT to touch the bottom of the trench, we have pulled the CNT to stride over the trench in the final nanomanipulation process, therefore, the CNT is in tension in the as-prepared device. To release the pre-tension in the CNT, we decreased the distance between the S and D electrodes step by step using the PC and observed the change of the S-D current. When the suspended CNT is totally released to zero strain state, the S-D current remain constant when the distance between S and D electrodes keeps on decreasing, as shown in Figure S1. Therefore, we can find the original length of the suspended CNT without strain and the position of the PC (x_0) when the CNT having its original length (L_0). At each position of the PC, we measured the I_d-V_d and I_d-V_g curves. High magnification SEM photos of the suspended CNT corresponding to a series of the PC positions (x_0, x_1, x_2, x_3, etc.) were taken after all electrical measurements had been done to avoid the electron beam induced damage. Thus, the linear relationship between the displacement of the PC (Δx) and the elongation of the CNT (ΔL) was obtained by fitting. Knowing the value of Δx of the PC when the I_d-V_d and I_d-V_g curves were measured, we can obtain the corresponding ΔL of the CNT and calculate the strain in the CNT using $\varepsilon=\Delta L /L$.

IV. The details to assess the uncertainty of the experimental results

In the present work, the uncertainty of the experimental results mainly comes from the length measurement by SEM. The uncertainty of the elongation of the CNT (ΔL) and the original length of the CNT (L) are assessed to be 3-4% and 2-3%, respectively, which makes the uncertainty of the strain ($\varepsilon=\Delta L /L$) being 5-7%. The uncertainty of the strain leads to the uncertainty of the fitting results of β and $dE_{gap}/d\varepsilon$. The error ranges of β, $dE_{gap}/d\varepsilon$, β' (n), β' (p) and (Exp-Theor)/Theor (%) are listed in Table 1. So that the uncertainty of the obtained $dE_{gap}/d\varepsilon$ of the six CNTs is4.9-7.5%.

V. DFTB calculation results

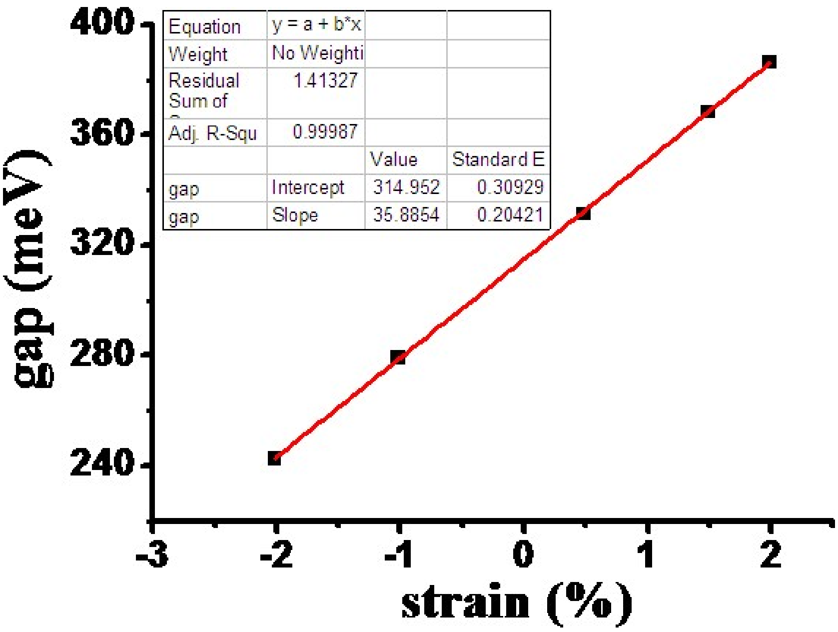

Figure S2. DFTB calculation results for (19, 12) SWCNT.

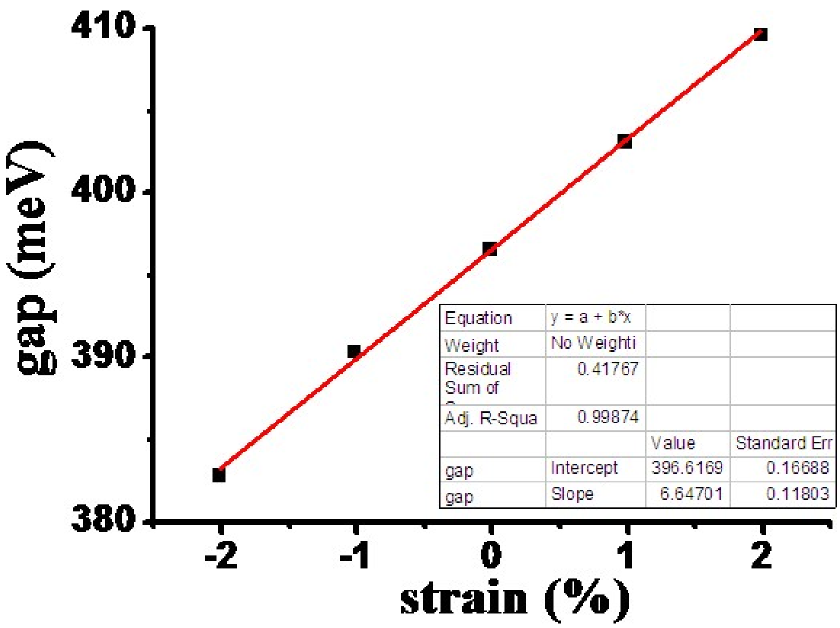

Figure S3. DFTB calculation results for (13, 12) SWCNT.

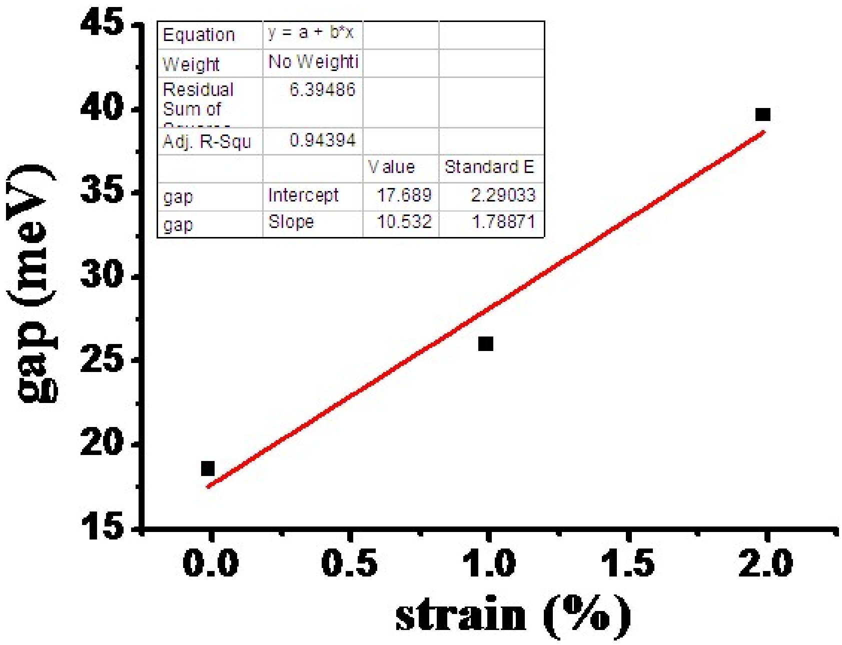

Figure S4. DFTB calculation results for (15, 12) SWCNT.