# Electronic Supporting Information

# Sorting out semiconducting single-walled carbon nanotube arrays by preferential destruction of metallic tubes using water

Pan Li and Jin Zhang*
Center for Nanochemistry, Beijing National Laboratory for Molecular Sciences,
Key Laboratory for the Physics and Chemistry of Nanodevices,
State Key Laboratory for Structural Chemistry of Unstable and Stable Species, College of Chemistry and Molecular Engineering,
Peking University, Beijing 100871, P.R. China
*Correspondence Author. E-mail: jinzhang@pku.edu.cn

## Part I

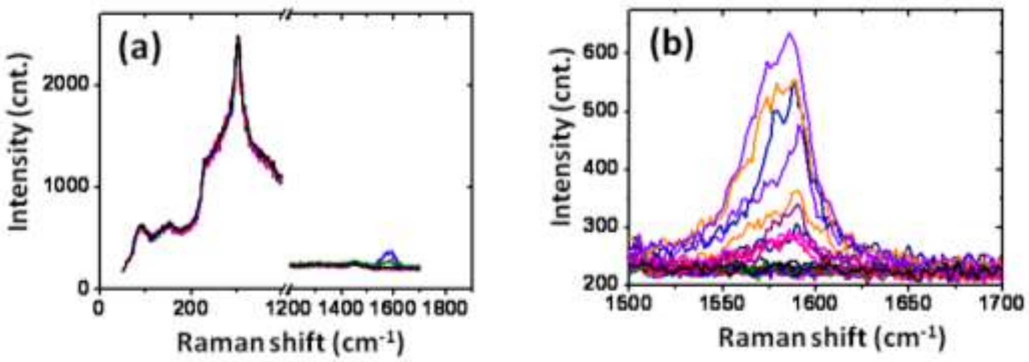



**Figure S1**. Typical Raman spectra of SWNTs grown with 2000 ppm water introduced (a) and G-band mapping result (b). Very weak G-band signals were detected but no obvious D-band was observed.

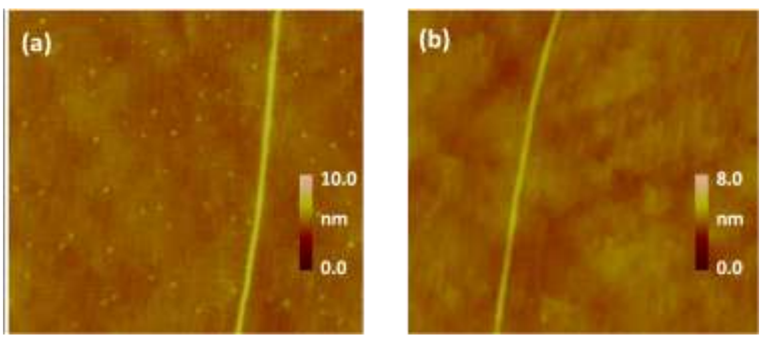
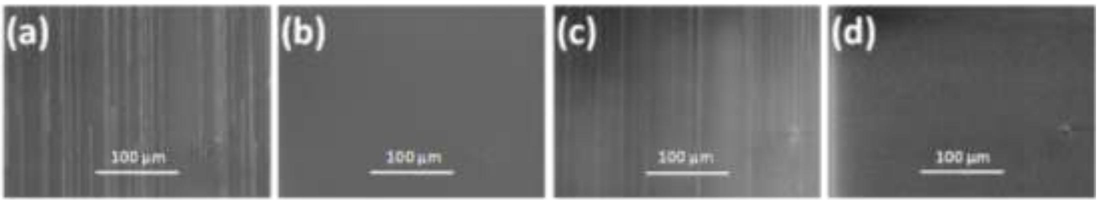



**Figure S2**. AFM images of SWNT grown without (a) and with (b) 1000 ppm water vapor introduced. Amorphous carbon is effectively removed by introducing water vapor into the CVD furnace.




| **e** | Temperature& duration / Etching degree | **650 °C 1h** | **650 °C 2h** | **680 °C 1h** | **710 °C 1h** | **740 °C 1h** |
|---|---|---|---|---|---|---|
| Area 1 Density: 1 SWNT/10 μm | Fracture appeared | **1** | **3** | **0** | **0** | **0** |
| | Fracture expanded | **0** | **0** | **0** | **1** | **2** |
| | SWNT invisible | **0** | **0** | **0** | **1** | **2** |
| Area 2 Density: 1 SWNT/4 μm | Fracture appeared | **3** | **2** | **0** | **0** | **1** |
| | Fracture expanded | **0** | **2** | **1** | **2** | **0** |
| | SWNT invisible | **2** | **3** | **0** | **4** | **0** |
| Area 3 Density: 1 SWNT/2 μm | Fracture appeared | **2** | **1** | **2** | **2** | **0** |
| | Fracture expanded | **0** | **12** | **6** | **3** | **0** |
| | SWNT invisible | **0** | **6** | **0** | **3** | **0** |

**Figure S3**. (a-d) SEM images of SWNT array before and after water etching. The SWNTs in Figure (a) were destroyed completely after etching of 1000 sccm of water for 5 min at 950 °C as shown in Figure (b); The SWNTs in Figure (c) were destroyed completely after etching of ~500 sccm of water for 5 min at 850 °C as shown in Figure (d); Table (e) shows the results of the experiment designed to elucidate the etching effect of water to carbon nanotubes. The temperatures vary from 650 °C to 740 °C (water at temperatures lower than 600 °C had no obvious etching effect on the SWNTs), and the duration is either 1 hour or 2 hours. Three areas of the same sample with different SWNT densities were examined. When water was introduced, the SWNTs can be etched into discontinuous fragments (defined as 'fracture appeared'), and then the fragments were further etched (defined as 'fracture expanded'); finally some SWNTs were etched away and disappeared (defined as 'SWNT invisible'). The numbers in Table is the number of carbon nanotubes.

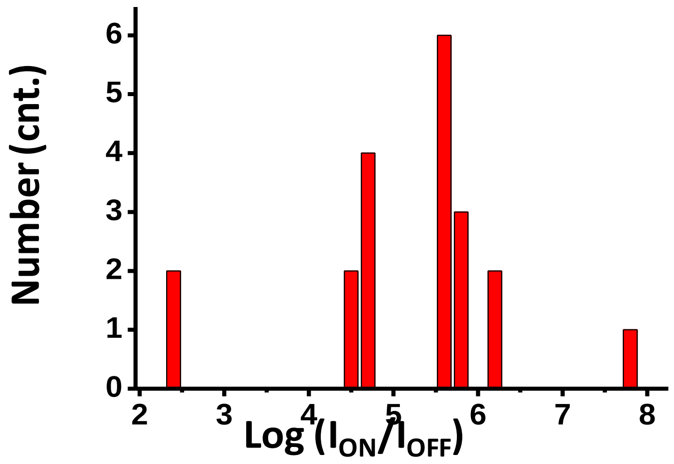



**Figure S4**. Statistics of the log ($I_{ON}/I_{OFF}$) of 30 single-tube FET devices which was etched by water (3000ppm, 20min, 720 $^oC$).

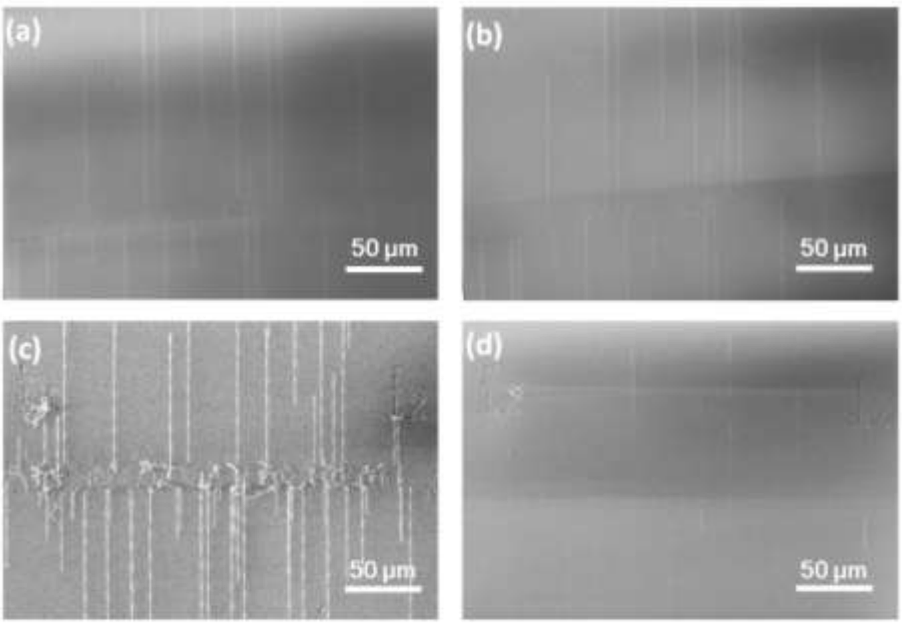



**Figure S5**. (a,b) SEM images of the SWNT arrays before (a) and after the sample was located in the furnace with a flow of 100 sccm Ar at 950 $^oC$ for 20min as shown in Figure (b). No obvious damage to the nanotubes; (c,d) SEM images of the SWNT arrays before (c) and after the sample was located in the furnace with stationary air in it at 400 $^oC$ for 5 min as shown in Figure (d). Most of the SWNTs disappeared and others destroyed to discontinuous fractions. Oxiability as strong as oxygen's can etch the carbon nanotubes even at 400 $^oC$, therefore it can be concluded from the two experiment results that there is no oxygen leakage during the etching process.

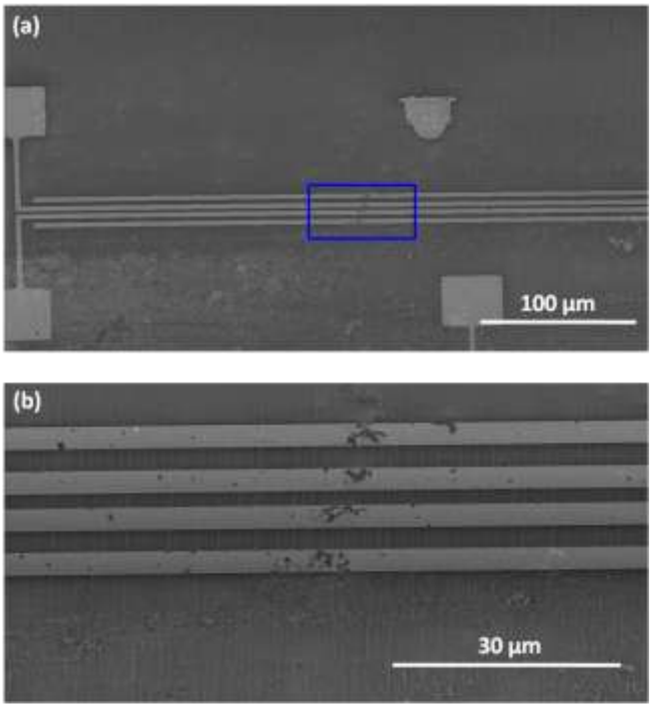



**Figure S6**. SEM images of the FET devices comprising large scale arrays. (a) Low-magnification image of part of the devices; (b) High-magnification image of part of the device (The marked part in Fig. S6 (a)).

**Part II: Calculations about the selective reaction of m- and s- SWNTs**

For the reaction

$$C(s) + H_2O(g) \rightarrow CO(g) + H_2(g)$$

From two classical formulas

$$\Delta G = \Delta H - T\Delta S \qquad (1)$$

$$-\Delta G^{\ominus}(T) = 2.30\, RT \lg K_p^{\ominus} \qquad (2)$$

where R is the gas constant.

We can deduce that

$$\Delta H_f(s) - \Delta H_f(m) = \Delta G^{\ominus}(T, s) - \Delta G^{\ominus}(T, m)$$

$$= 2.30\, RT \lg K_p^{\ominus}(m) - 2.30\, RT \lg K_p^{\ominus}(s)$$

For simplicity, we set the temperature T at 298 K, and estimate the differences of the standard reaction equilibrium constant for water with *m*-SWNT ($K_p^{\ominus}(m)$) and *s*-SWNT ($K_p^{\ominus}(m)$) by substituting $\Delta H_f(s) - \Delta H_f(m)$ with 0.15eV x 6.02 x$10^{23}$ $mol^{-1}$. We approximately calculated the value of $K_p^{\ominus}(m) / K_p^{\ominus}(s)$ as ~100.