Supporting Information 1

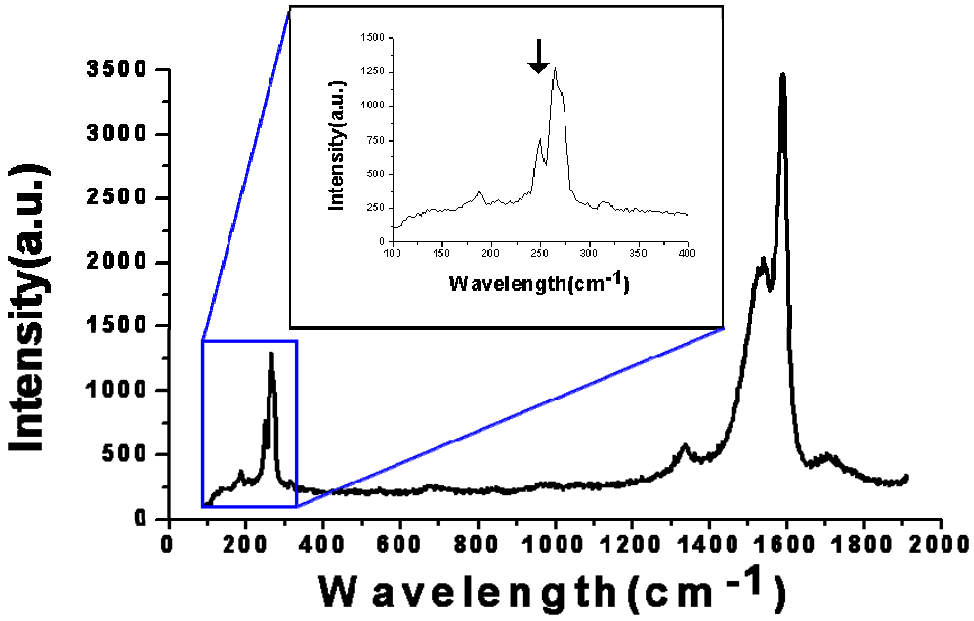

Figure 1. Raman spectrum of the SWNTs used (The peak between 218~280 cm^{-1} shows metallic behavior of the SWNTs)

Figure 1 shows the Raman spectra of a pristine SWNT. The diameters d of the SWNTs were determined to be 1.1 ± 0.2 nm according to the equation $d = c_1/(\omega_{RBM} - c_2)$, where ω_{RBM} is the frequency of the radial breathing mode (RBM) of the SWNTs, and $c_1 = 223.5\,\mathrm{nm\,cm^{-1}}$ and $c_2 = 12.5\ \mathrm{cm^{-1}}$ have been predetermined for typical SWNTs [1]. The tangential G mode also shows metallic characteristics, with a broad and asymmetric BWF line shape.

Supporting Information 2

We developed a nano-scale fabrication process by using nano imprint lithography (NIL) with an aluminum sacrificial layer, which created a well-defined negative slope useful for lift-off process. A mold and a nano electrode were created in a few steps. The mold was fabricated by electron-beam lithography (Lion-LV1, Leica) with reactive ion etching (RIE, P-5000, Applied Materials). A

hydrophobic self assembled monolayer (SAM, Heptadecafluoro-1, 1, 2, 2-Tetrahydrodecyl Trichlorosilane, Gelest) coating was used to make the mold-releasing occur readily. For the pattern transfer step, aluminum was thermal deposited on a Si substrate with a silicon dioxide dielectric layer on top. Poly methyl methacrylate (PMMA, MicroChem) was then spin-coated and baked, followed by the spin-coating and baking of MR I-8010 thermoplastic polymer (MicroChem). Imprinting was carried out at 190 ℃ under 40 bar of pressure for 20 min (Nanosys 420, Nano and Device). Reactive ion etching (RIE, RIE 80 Plus, Oxford) with oxygen gas was performed at a power of 50 W and a pressure of 50 mTorr for 30 sec to remove the residual layer. A lift-off process was used for the fabrication of the electrodes. Isotropic aluminum wet etching with AZ MIF 300K (AZ electronic materials, Clariant) was carried out to obtain a clear negative slope for the ease of lift-off. After exposing the substrate, 5 nm of chromium and 20 nm of gold were deposited using a thermal evaporator at a rate of 0.4 Å/s (MHS-1800, Muhan). After fabricating the nano gap electrode, a probe pad and interconnect line between the pad and the nano gap were added through a general lift-off process using photolithography. The completed device was obtained through the removal of the polymer and aluminum using acetone and AZ MIF at 300K, as shown in Figure 2-2.

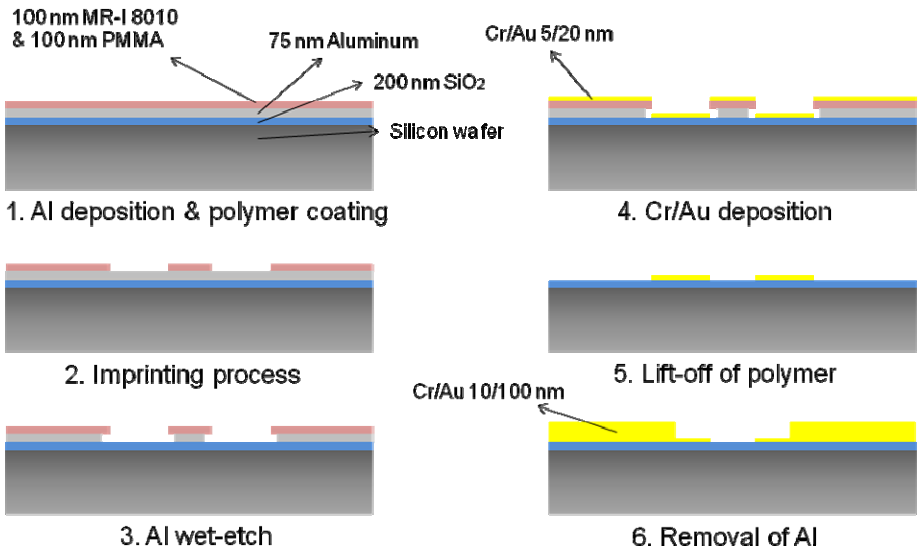

Figure 2-1. Process flow of nano-size electrode fabrication with aluminum sacrificial layer using nanoimprint lithography

(a) (b)

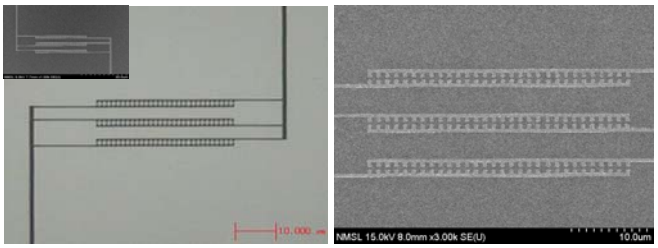

Figure 2-2. (a) Image of mold shape transferred substrate after NIL (inset: mold image), (b) SEM image of nano-size electrode after lift-off

Supporting Information 3

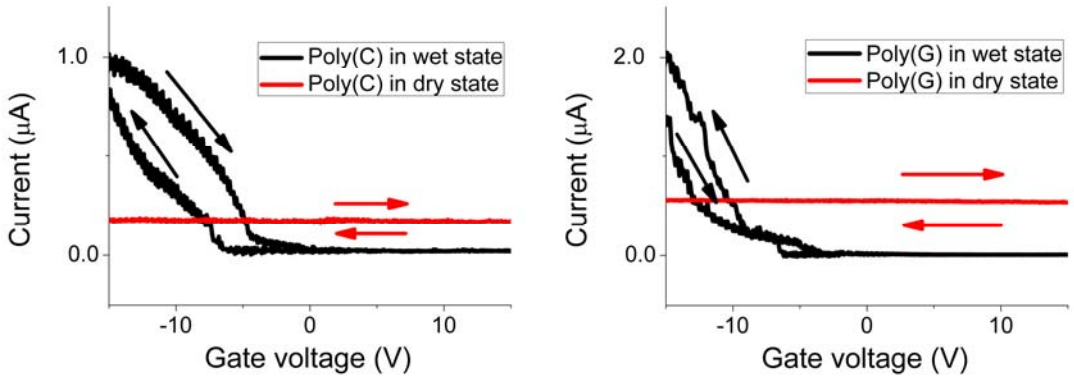

Figure 3. Raw data of FET characteristic of ssDNA-SWNT hybrids; (a) poly(C)-SWNT (b) poly(G)-SWNT in The voltage bias between source and drain was 100 mV. Hysteresis of the devices with I-Vg curves is clearly shown for wet states.

Supporting Information 4

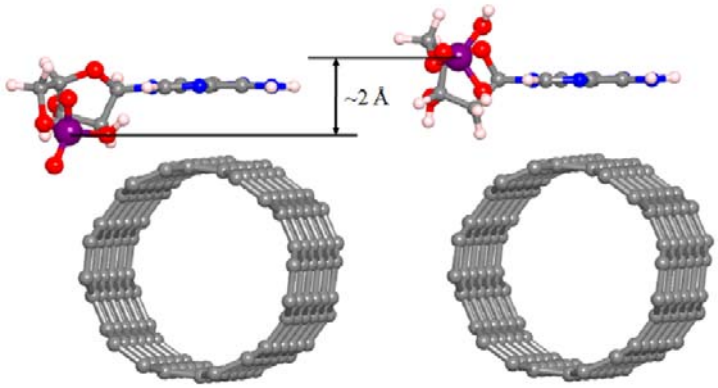

Figure 4-1: Displacement of the phosphate group in AMP for hydration. The left figure represents a wet state and the right figure represents a dry state. For visual clarity, water molecules are omitted in the left figure.

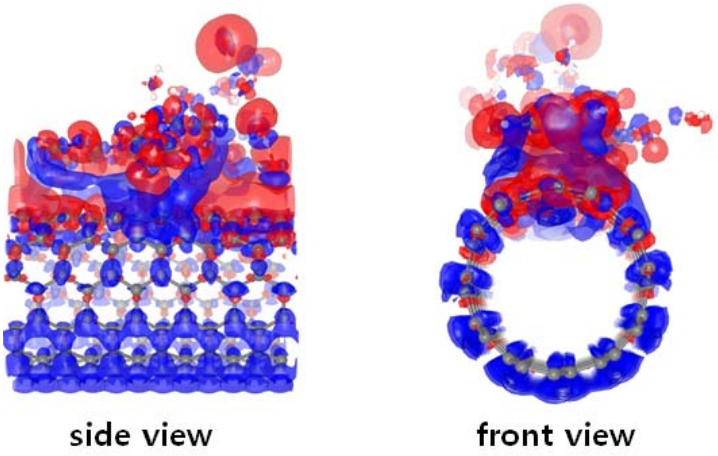

Figure 4-2: Figure 4-2: Isodensity surface plots of electron accumulation (red) and depletion (blue) of AMP-CNT hybrid with H_2O molecules near a phosphate group, which show the electron transfer from the (6,6) CNT to AMP. The values for the red and blue surfaces in are ± 0.024 e $Å^{-3}$.

References

[1] R. Krupke, F. Hennrich, H.V. L o¨hneysen, M.M. Kappes, SCIENCE 301 (2003) 344.