Supplementary Information

Electronic sensitivity of single-walled carbon nanotube to internal electrolyte composition

Di Cao, Pei Pang, Hao Liu, Jin He, Stuart Lindsay

1. Control experiments of non-opened CNT

Two type of control devices were fabricated and tested. The first type of device is shown in Fig.S1. The SWCNT inside both reservoirs is not removed by oxygen plasma and will expose to solutions when the reservoirs are filled. The second type of device is shown in Fig. S2. A section of SWCNT between source and drain electrodes and inside the reservoir will expose to electrolytes (Fig S2). After adding electrolytes with different composition into the reservoirs, none of them change the transport characteristics of the SWCNT FET significantly for both control devices.

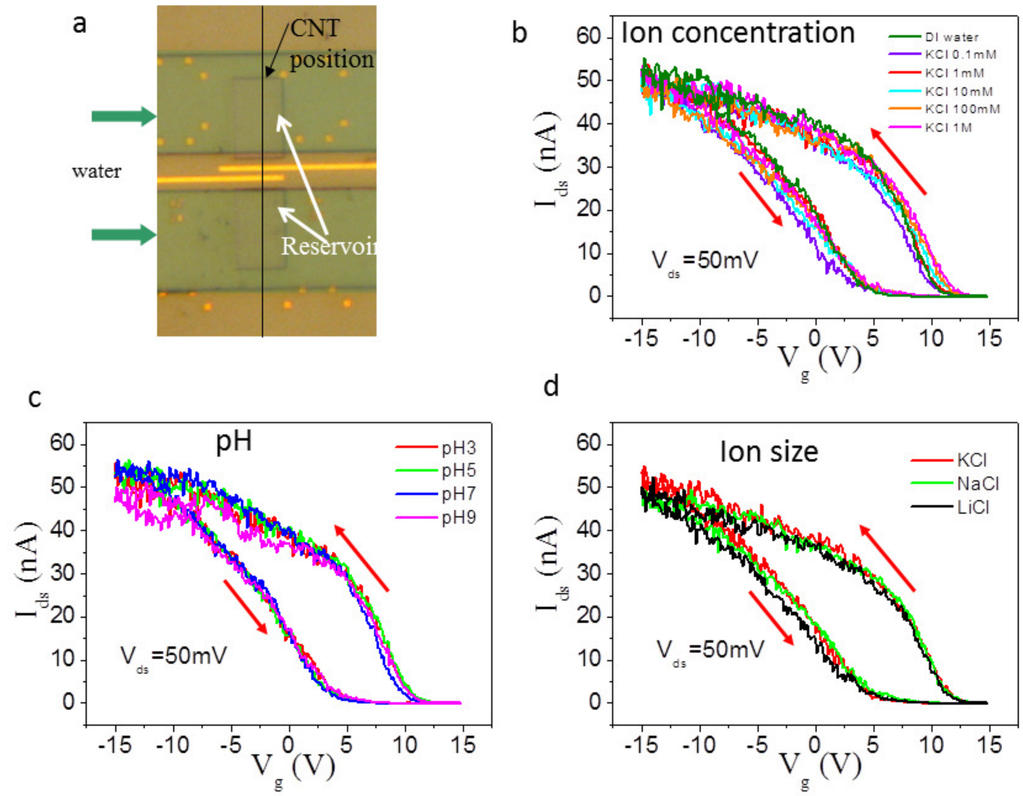

Figure S1. (a) An optical image for a control device. The CNT is not removed inside the reservoirs. (b) I_{ds}-V_g curves of the device when exposing to DI water (green), 0.1mM KCl (violet), 1mM KCl (red), 10mM KCl (cyan), 0.1M KCl (orange), and 1M KCl (magenta). The solution pH is always about 7. (c) I_{ds}-V_g curves of the device when exposing to pH=3 (red), pH=5 (green), pH=7 (blue) and pH=9 (magenta) solutions. The KCl concentration is always 1mM. (d) I_{ds}-V_g curves when exposing to 1mM KCl (red), NaCl (green) and LiCl (black). The V_{ds} is 50mV for all the measurements.

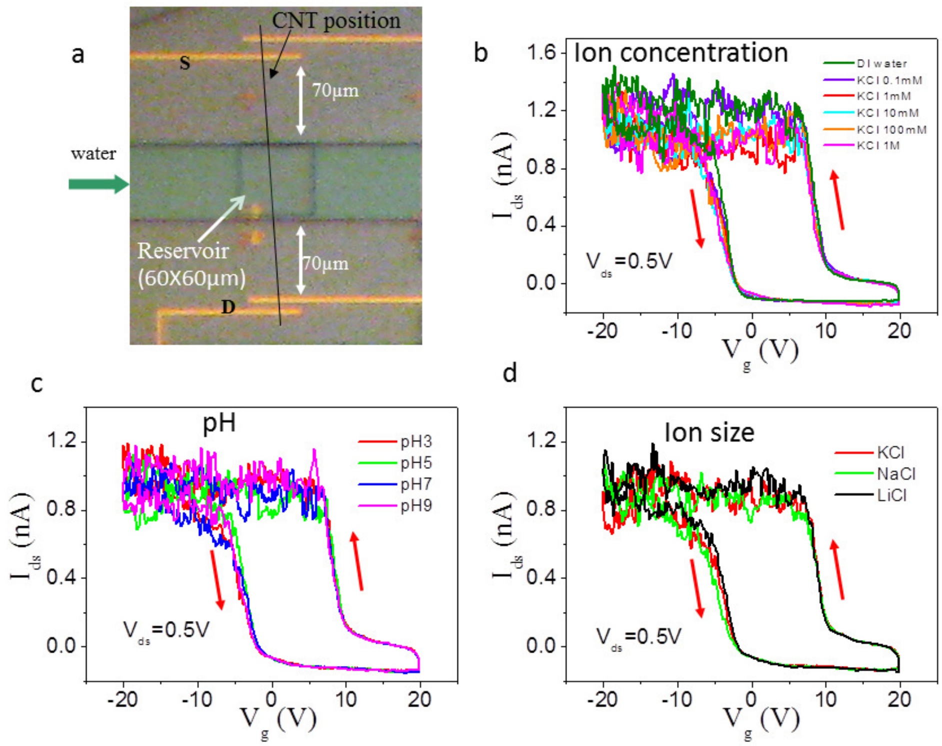

Figure S2. (a) An optical image for a control device. A section of the SWCNT(between two electrodes and inside the reservoir) is exposed to solutions. (b) I_{ds}-V_g curves of the device when exposing to DI water (green), 0.1mM KCl (violet), 1mM KCl (red), 10mM KCl (cyan), 0.1M KCl (orange), and 1M KCl (magenta). The solution pH is always about 7.(c) I_{ds}-V_g curves for the device when exposing to pH=3 (red), pH=5 (green), pH=7 (blue) and pH=9 (magenta) solutions. The KCl concentration is always 1mM. (d) I_{ds}- V_g curves when exposing to 1mM KCl (red), NaCl (green) and LiCl (black). The V_{ds} is 0.5V for all the measurements.

2. Metallic SWCNT results

The electrical response of metallic SWCNT to electrolyte with different composition is shown in Fig. S3. The device geometry and the measurement procedure are the same as the semiconducting CNT devices. For different KCl concentration and different pH, no obvious change was observed in I_{ds}-V_g characteristics and gating efficiency.

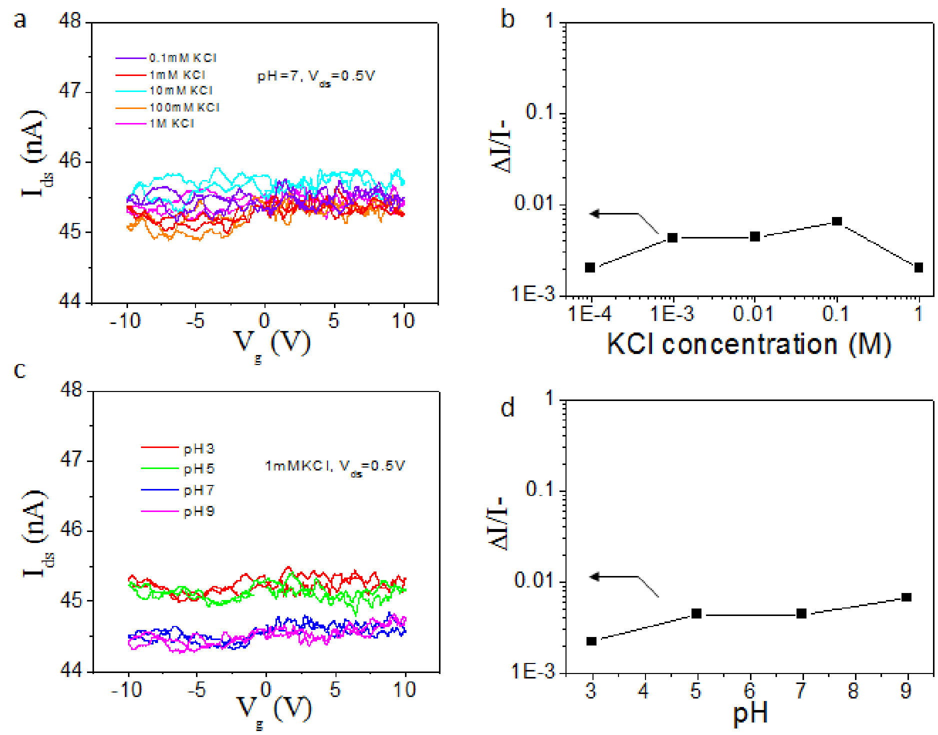

Figure S3. (a) I_{ds}-V_g curves for a metallic CNT device when exposing to 0.1mM KCl (violet), 1mM KCl (red), 10mM KCl (cyan), 0.1M KCl (orange), and 1M KCl (magenta) solutions. (b) Gating efficiency ΔI/I- vs. KCl concentration semilog curve (black). (c) I_{ds}-V_{gs} curves for the metallic CNT device when exposing to pH=3 (red), pH=5 (green), pH=7 (blue) and pH=9 (magenta) solutions with 1mM KCl. (d) Gating efficiency ΔI/I- vs. pH semilog curve (black). V_{ds}=0.5V for all the measurements.

3. Electronic response of opened semiconducting device to pH at high KCl concentration

As shown in Fig. S4, at high salt concentration, the gating efficiency is small.

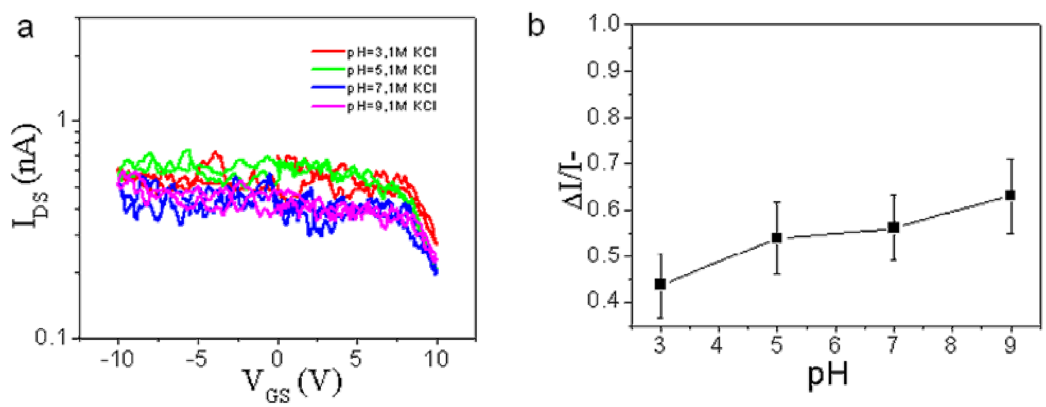

Figure S4. The electrical response of an opened semiconducting SWCNT to pH at 1M KCl. (a)Typical I_{ds}-V_g semilog curves when the device is filled sequentially with solutions with pH=3 (red), pH=5 (green), pH=7 (blue) and pH=9 (magenta). (b) Gating efficiency ΔI/I- for different pH (black solid squares). V_{ds}= 0.1V.