SUPPORTING INFORMATION FOR "Quantitative detection of protein using a top-gate carbon nanotube field effect transistor"

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1. Characterization of the CNT channel: A scanning electron microscope image of typical CNT-FET is shown in Fig. 1S(a). The source and drain electrodes are connected to each other by a bright curved line (i.e, a CNT). Raman spectra for our CNT-FET were measured with a laser Raman spectrophotometer (Jobin Yvon: HR800UV). Laser excitation was performed at 633 nm. The Raman spectra of our typical CNT-FET device are shown in Fig. 1S(b). Two peaks appeared near 1345 and 1597 cm^{-1}, which corresponds the D- and G-bands, respectively. The appearance of these peaks is a typical characteristic of the spectrum of graphitic carbon materials. Furthermore, a peak appeared clearly near 200 cm^{-1}, which corresponds to radial breathing mode. These results suggest that a single wall CNT with a diameter of about 0.8 nm exists between the drain and the source electrodes of the CNT-FET.

2. Experimental details of the determination of equilibrium concentration: the PSA test solution was poured onto the top-gate as follows. First, buffer without PSA was poured onto the PSA sensor. Drain current was sampled every 1 second. When the drain current had become constant, PSA solution was poured onto the PSA sensor and the PSA concentration in the solution in the silicone rubber pool was fixed [Fig. 2S(a)] The antigen-antibody reaction reached equilibrium [Fig. 2S(b)]. After that, the PSA test solution was removed [Fig. 2S(c)] and the PSA solution in the silicone rubber wall was

exchanged with a new solution whose concentration was the same as the fixed PSA solution before the reaction [Fig. 2S(d)]. With repeated exchanges of solution, drain current became constant [Fig. 2S(e)]. Then, the equilibrium concentration of PSA became same as that of the poured PSA concentration [Fig. 2S(f)]. The drain current was then sampled every 1 second for 10 minutes. The average of these samples was determined as drain current in its PSA concentration.

3. Confirmation of the stability of the CNT-FETs: The electron conduction property of a bare CNT-FET was demonstrated under the constant bias condition (Fig. 3S). Both the drain-source voltage and top-gate voltage were kept at +1.0 V. Drain current was sampled every 1 second. The drain current was normalized by the average of the drain current of I_{Dav} = 23.0 nA. The fluctuations of the drain current are within a range of 0.3 %, indicating the present CNT-FET had high stability and high sensitivity.

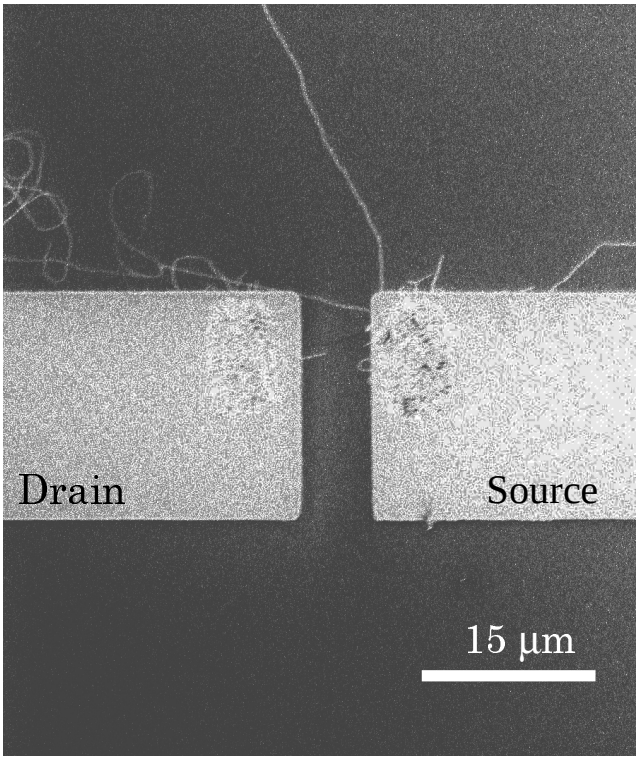

Figure 1S Characterization of CNT channels.

(a) SEM image of typical CNT channel

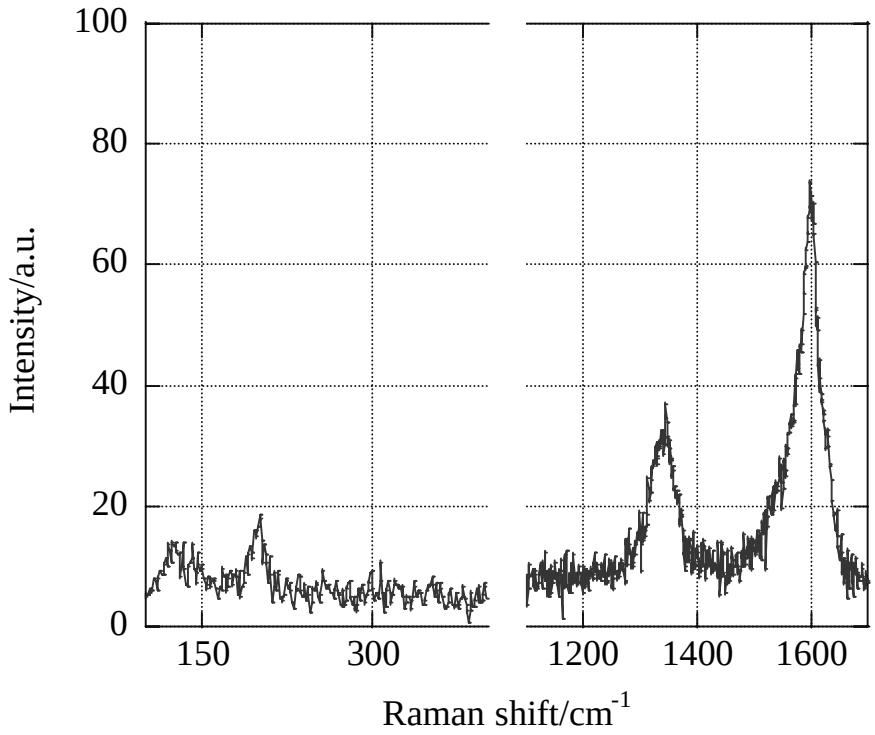

Figure 15 Characterization of CNT channels.

(b) Raman spectrum of a CNT-FET.

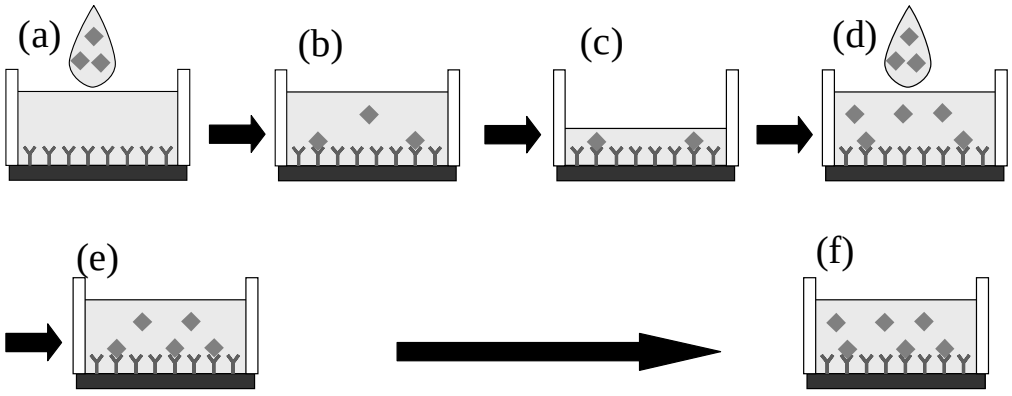

Figure 2S. Schematic image showing how the PSA equilibrium concentration was kept constant when the PSA solution was poured onto the PSA biosensor.

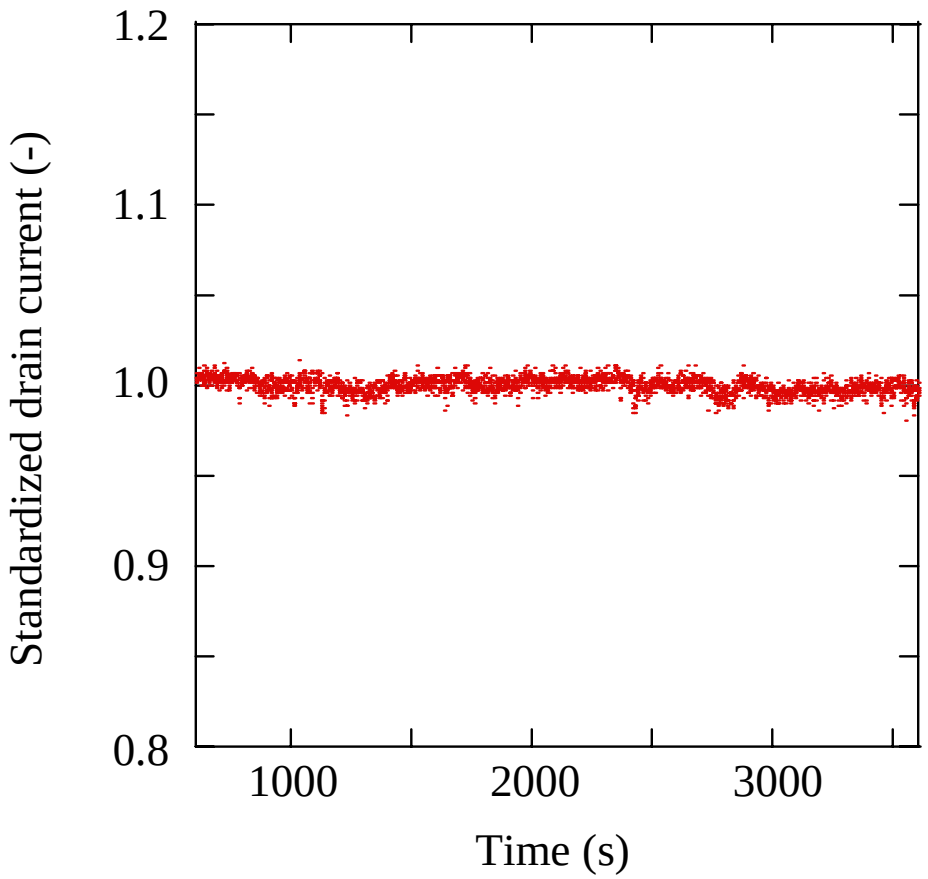

Figure 3S. Time dependence of drain current of the PSA sensor. Drain voltage and top gate voltage were set at +0.1 and +1 V, respectively. Sampling time was 1 second.