Supplementary Data

1. Structural characterization - Fourier transform infrared (FT-IR)

Supplementary Fig. 1 shows the FT-IR spectra of (a) PDDA, (b) PDDA-SWCNT, and (c) PDDA-SWCNT-Avidin-biotinylated antibody. Spectrum a shows the characteristic absorption bands of PDDA such as the CH$_2$ asymmetrical and symmetrical stretching frequencies at 2927 cm$^{-1}$ and C=C stretching vibrations at 1639 and 1469 cm$^{-1}$.

Supplementary Fig. 1 FT-IR spectra of (a) PDDA, (b) PDDA-SWCNT, and (c) H1N1 antibody immobilized PDDA-SWCNT.
There is a corresponding increase in the peak of 1639 cm\(^{-1}\) along with an intensity decrease of the peaks at 1469 cm\(^{-1}\), and the decreased peaks are attributed to carbon-carbon double bonds indicating PDDA-SWCNT layer formation (spectrum b).\(^2\) Spectrum c shows the antibody immobilization onto the avidin functionalized SWCNT surface, and the bands at 1665 and 1545 cm\(^{-1}\) exhibited due to the primary amide and secondary amide linkages. The band at 3282 cm\(^{-1}\) is associated with the combination of the amide and amine N-N frequencies and corresponds to N-H stretching vibrations.\(^3\)

2. I-V measurements for various channel lengths

The current-voltage (I–V) measurements for the SWCNT immunosensors were performed in the voltage range from −1.0 to +1.0V. Supplementary Fig. 2 shows the I-V characteristic graphs of the SWCNT immunosensors with various channel lengths of (a) 2 μm, (b) 5 μm, and (c) 10 μm and a constant width of 100 μm for cases of (i) PDDA-SWCNT, (ii) PDDA-SWCNT-Avidin, (iii) PDDA-SWCNT-Avidin-biotinylated antibody, and (iv) PDDA-SWCNT-Avidin-biotinylated antibody-influenza virus. The measurements showed high linearity between current and voltage,\(^4\) implying an ohmic contact between the SWCNT channel and gold electrodes as well as among the SWCNTs. The functionalization of PDDA-SWCNT with avidin, biotinylated antibody, and influenza viruses increased the channel resistance, indicating successful immobilization.
Supplementary Fig. 2  I-V characteristic graphs of the SWCNT immunosensor with various channel lengths (a) 2 μm, (b) 5 μm, and (c) 10 μm with constant width of 100 μm (i) PDDA-SWCNT, (ii) PDDA-SWCNT-Avidin, (iii) PDDA-SWCNT-Avidin-biotinylated antibody, and (iv) PDDA-SWCNT-Avidin-biotinylated antibody-H1N1 virus.

References


