Label-free detection of DNA sequences derived from avian influenza virus H5N1 using carbon nanotubes

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Avian influenza virus (AIV), especially highly pathogenic AIV H5N1 has become nowadays a very dangerous pathogen threatening not only for poultry but also for human [1]. In this study, we developed and tested chemiresistor type DNA sensors based on semiconducting single walled carbon nanotubes (sc-SWCNTs) as well as on nitrogen doped multi-walled carbon nanotubes (N-MWCNTs) for highly efficient and fast detection of AIV H5N1 DNA sequence. The sensors based on N-MWCNTs were fabricated with direct contact printing of vertically-grown nanotubes where both rigid and flexible target substrates were employed (Fig. 1a) whereas sc-SWCNTs were produced by epitaxial elongation of short fragments of selected sc-SWCNTs on quartz substrates (Fig 1b). Both N-MWCNTs and sc-SWCNTs were functionalized with single stranded DNA probe sequences, which were non-covalently attached to the nanotube sidewalls; the sensing is based on the resistance change after DNA probe detachment when hybridized with complementary DNA sequence (DNA T), see Fig. 1c. The sensors could reliably and quantitatively detect AIV H5N1 DNA in dry conditions and at room temperature. The lowest reliably detected concentration of DNA T sequence was 20 pM for N-MWCNT and 2 pM for sc-SWCNT sensor after 15 min of incubation (Fig. 1d and 1e, respectively). Our CNT based DNA sensors are small, flexible, easy-to-use as well as highly sensitive and selective that makes them promising in clinical diagnostics and for portable applications.

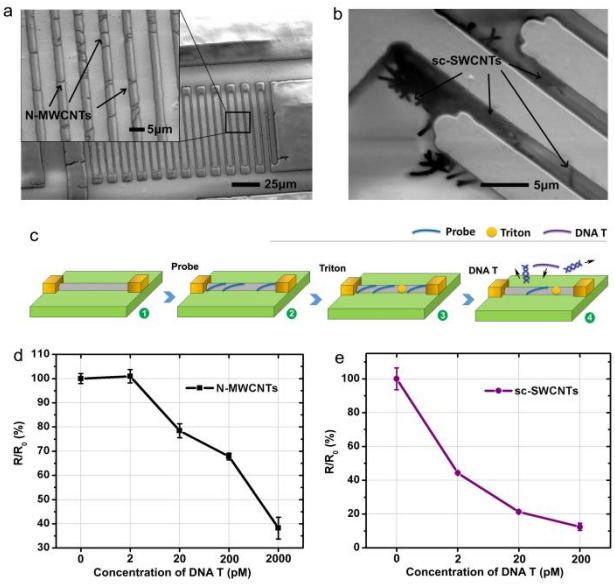

Figure 1. **(a)** SEM image of N-MWCNT based chemiresistor sensor device, the inset shows a regular array of horizontally aligned N-MWCNTs bridging interdigitated electrodes. **(b)** Low-voltage SEM image of patterned interdigitated electrodes bridged with sc-SWCNTs. **(c)** Schematic illustration of the CNT-based chemiresistor DNA sensor functionalization and sensing steps. Resistance change of **(d)** N-MWCNT and **(e)** sc-SWCNT based sensors as the response to increasing concentrations of DNA T (at V=2.0 V) count with respect to resistance value at 0 pM (no DNA T).

References

[1] WHO, Avian and other zoonotic influenza: fact sheet, (2016) http://www.who.int/mediacentre/factsheets/avian_influenza/en/