Enhancement of sensitivity and specificity by surface modification of carbon nanotube in cancer diagnosis based on CNT-FET

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This paper presents a simple and sensitive method for the real-time detection of a prostate cancer marker (PSA-ACT complex) through label-free protein biosensors based on a carbon nanotube-field effect transistor (CNT-FET). Herein, the CNT-FET was functionalized with a solution containing various linker to spacer ratios, the binding event of the target PSA-ACT complex onto the receptor detected by monitoring the gating effect caused by charges in the target. Since the biosensors were used in a buffer solution, it was crucial to control the distance between the receptor through introduction of a linker and spacer so that the charged target PSA-ACT complex could easily approach the CNT surface within the Debye length to give a large gating effect. The results show that CNT-FET biosensors modified with only a linker could not detect target proteins unless a very high concentration of the PSA-ACT complex solution (~500 ng/ml) was injected, while those modified with a 1:3 ratio of linker to spacer could detect 1.0 ng/ml without any pretreatment. Moreover, our linker and spacer-modified CNT-FET could successfully block non-target proteins and selectively detect the target protein in human serum.