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Label-free Femtomolar Detection of Cancer Biomarker by Reduced Graphene Oxide Field-effect Transistor

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Early detection of cancer biomarkers in the blood is of vital importance for reducing the mortality and morbidity in a number of cancers. From this point of view, immunosensors based on nanowire (NW) and carbon nanotube (CNT) field-effect transistors (FETs) that allow the ultra-sensitive, highly specific, and label-free electrical detection of biomarkers received much attention. Nevertheless 1D nano-FET biosensors showed high performance, several challenges remain to be resolved for the uncomplicated, reproducible, low-cost and high-throughput nanofabrication. Recently, two-dimensional (2D) graphene and reduced GO (RGO) nanosheets or films find widespread applications such as clean energy storage and conversion devices, optical detector, field-effect transistors, electromechanical resonators, and chemical & biological sensors. In particular, the graphene- and RGO-FETs devices are very promising for sensing applications because of advantages including large detection area, low noise level in solution, ease of fabrication, and the high sensitivity to ions and biomolecules comparable to 1D nano-FETs. Even though a limited number of biosensor applications including chemical vapor deposition (CVD) grown graphene film for DNA detection, single-layer graphene for protein detection and single-layer graphene or solution-processed RGO film for cell monitoring have been reported, development of facile fabrication methods and full understanding of sensing mechanism are still lacking. Furthermore, there have been no reports on demonstration of ultrasensitive electrical detection of a cancer biomarker using the graphene- or RGO-FET. Here we describe scalable and facile fabrication of reduced graphene oxide FET (RGO-FET) with the capability of label-free, ultrasensitive electrical detection of a cancer biomarker, prostate specific antigen/α 1-antichymotrypsin (PSA-ACT) complex, in which the ultrathin RGO channel was formed by a uniform self-assembly of two-dimensional RGO nanosheets, and also we will discuss about the immunosensing mechanism.

Keywords: Reduced graphene oxide, Field-effect transistor, Biosensor, Immunosensing, Label-free detection