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Reduced graphene oxide field-effect transistor for biomolecule detection and study of sensing mechanism

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Graphene, two dimensional sheet of sp2-hybridized carbon, has attracted an enormous amount of interest due to excellent electrical, chemical and mechanical properties for the application of transparent conducting films, clean energy devices, field-effect transistors, optoelectronic devices and chemical sensors. Especially, graphene is promising candidate to detect the gas molecules and biomolecules due to the large specific surface area and signal-to-noise ratios. Despite of importance to the disease diagnosis, there are a few reports to demonstrate the graphene- and rGO-FET for biological sensors and the sensing mechanism are not fully understood. Here we describe scalable and facile fabrication of 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 sensing channel was simply formed by a uniform self-assembly of two-dimensional rGO nanosheets on aminated pattern generated by inkjet printing. Sensing characteristics of rGO-FET immunosensor showed the highly precise, reliable, and linear shift in the Dirac point with the analyte concentration of PSA-ACT complex and extremely low detection limit as low as 1 fg/ml. We further analyzed the charge doping mechanism, which is the change in the charge carrier in the rGO channel varying by the concentration of biomolecules. Amenability of solution-based scalable fabrication and extremely high performance may enable rGO-FET device as a versatile multiplexed diagnostic biosensor for disease biomarkers.

Keywords: prostate specific antigen/α 1-antichymotrypsin (PSA-ACT), Graphene, rGO-FET