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Reduced Graphene Oxide Field Effect Transistor for Detection of H+ Ions and Their Bio-sensing Application

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Recently, graphene based solution-gated field-effect transistors (SGFETs) have been received a great attention in biochemical sensing applications. Graphene and reduced graphene oxide (RGO) possess various advantages such as high sensitivity, low detection limit, label-free electrical detection, and ease of fabrication due to their 2D nature and large sensing area compared to 1D nanomaterials-based nanobiosensors. Therefore, graphene or RGO -based SGFET is a good potential candidate for sensitive detection of protons (H+ ions) which can be applied as the transducer in various enzymatic or cell-based biosensing applications. However, reports on detection of H+ ions using graphene or RGO based SGFETs have been still limited. According to recent reports, clean graphene grown by CVD or exfoliation is electrochemically insensitive to changes of H+ concentration in solution because its surface does not have terminal functional groups that can sense the chemical potential change induced by varying surface charges of H+ on CVD graphene surface. In this work, we used RGO -SGFETs having oxygen-containing functional groups such as hydroxyl (OH) groups that effectively interact with H+ ions for expectation of increasing pH sensitivity. Additionally, we also investigate RGO based SGFETs for bio-sensing applications. Hydroloytic enzymes were introduced for sensing of biomolecular interaction on the surface of RGO -SGFET in which enzyme and substrate are acetylcholinesterase (AchE) and acetylcholine (Ach), respectively. The increase in H+ generated through enzymatic reaction of hydrolysis of Ach by AchE immobilized on RGO channel in SGFET could be monitored by the change in the drain-source current (Ids).

Keywords: reduced graphene oxide, solution gated FET, pH sensor, enzyme sensor