Graphene nanoribbon devices for indirect sucrose detection and measurement

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Abstract
Label-free sensors that are capable of detecting low concentrations of biologically significant molecular substances, such as proteins (including antibodies and antigens), viruses and bacteria, and different metabolites, are useful for simplifying and reducing the costs of experiments, minimizing detection errors, and improving real-time observations, since no fluorescent nor radioactive labels are required. This work presents low-voltage sensor device solutions for the detection and measurement of low-concentration sucrose in plants (in the pico Molar range) through immobilization of UDP-glucose, an intermediate reactant in the synthesis of sucrose and an indirect/proportional indicator of sucrose production within a plant's cell cytoplasm. Designs are based on graphene nanoribbon (GNR) setup in two different configurations: 1) a two-terminal, semiconducting channel, back-gated field-effect device, and 2) a four-terminal, near-metallic channel, single-layer crossbar device. In both cases, the devices' channel is functionalized with a self-assembled monolayer of 1-pyrenebutyric acid (PyBA) linkers, that noncovalently bond to graphene's surface on one end and enables binding of target UDP-glucose molecules through the carboxylic end. We expect these designs will be useful for detecting and measuring a wide range of target biomarkers by tuning the self-assembled functional linkers; thus, finding multiple applications in agriculture, healthcare, industry and many other fields with emerging needs for high throughput, in-field diagnosis, real-time analysis, low power, small form factor, minimal cost, high mobility, and minimal calibration requirements.