Abstract

Project Code: TRG5980010

Project Title: Development of Highly Sensitive Top-Down Fabricated Indium Oxide Nanoribbon Field Effect Transistor Biosensor Chips with Integrated the On-Chip Gate for Early Disease Diagnosis and Prognosis

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We report a scalable, uniform, and sensitive top-down fabricated indium oxide (In_2O_3) nanoribbon biosensor platform with integrated on-chip gate electrodes using two photolithographic masks. The purpose of this on-chip gate electrode is to control the operational point of the sensor during biomolecular detection replacing the cumbersome external Ag/AgCl electrode. It exhibits excellent capability in gating transistors in an aqueous condition and high stability during the sensing experiment, which is similar to the Ag/AgCl electrode. Its compactness increases the portability and pushes this platform toward a practical use. To demonstrate its capability for detection of biomolecules, we combine this platform with the electronic enzyme-linked immunosorbent assay (ELISA) technique to amplify the signal and to bypass limitation of the Debye screening effect from high salt concentration of physiological samples. Troponin I, a cardiac marker for diagnosis of acute myocardial infarction (AMI), was selected as the target molecule in this study. The In_2O_3 nanoribbon device offers a high response of 30% toward 0.1 pg/mL troponin I concentration and a lower detection limit than that of the commercial ELISA kit on the market by 5 orders of magnitude. The total assay time from the sample collection to the data acquisition is about 45 minutes, which is within the constraint of the emergency care application. With the demonstrated sensitivity, uniformity, scalability, quick turn-around time and ability to be integrated, our In_2O_3 nanoribbon biosensor platform has high potential toward clinical tests for early diagnosis of AMI.

Keywords: In_2O_3 nanoribbon, FET biosensors, ELISA, on-chip gate electrode, acute myocardial infraction