Silicon transistors with virtual buried nanochannels for ultrasensitive gas detection (Ramot)

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Technology

A new device where the active nanowire is not hard coded into the silicon but electrostatically engineered post fabrication. Schematically, the buried nanowire (BN) is a field effect device composed of a silicon region surrounded by gates. Correct voltage application at the gates enables the creation of depletion zones at the gate/silicon interfaces and an un-depleted silicon region for conduction. This un-depleted silicon region could be electrostatically shaped into a wire of several nm in diameter. The BN device can be realized with a conventional low cost HVM CMOS processing, as no low–dimensional design rules are needed. In the current application the BN device is used as a gas senor (BNGS) where the gate dielectric, either chemically modified or not, is the active sensing area. Chemical reaction with the required analytes will yield shift in threshold voltage.

The BNGS sensor offers advantages over conventional nanowire such as increased SNR, enhanced gain, faster device characterization and development, and potentially enhanced resolution.

The Need

Gas sensors based on nanowire of various materials (e.g. Si, ZnO, SnO) exhibit exceptional resolution. However, the realization of commercial gas sensors based on such nanowires is not realistic as the fabrication (e.g. VLS method) of these structures cannot accommodate high volume manufacturing (HVM). Alternatively, high volume CMOS manufacturing of nanowires could be realized in the future but with a substantial increase in cost (several orders of magnitude).

The market for biosensors is projected to experience solid growth during the next few years with increasing disease incidences and technological advances that increase the reliability and reduce cost of more sensitive detection platforms that currently remain in early stage development.

The invention offers several features that offer major medical device manufacturers integration of the invention into a medical device.

Potential Applications

The invention enjoys a diversity in applications across health, drug discovery, environment, food, security, and defense, with integration across a wide product range as a core component of various hand-held and bench top devices. The invention can be offered in the form of a biosensing medical device (point-of-care, at home) or analytical instrument (mobile or bench-top).

Stage of Development

A prototype has been fabricated and demonstrated exceptional sensitivity (even without surface chemical modification) for Ethanol detection in the low ppm regime. To the best of our knowledge no ethanol detection has been demonstrated with any NW based device (a bulk transistor device has demonstrated only 500 ppm sensitivity).

Patents

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