TECHNOLOGY

Transistor Sensors for Detection of Chemicals and Biomolecules

OVERVIEW

Background

Nanotechnology offers opportunities in developing the ability to utilize the exceptional electrical properties of nanomaterials in complex chemical environments such as solar cells, fuel cells, microprocessors, and sensors. The challenge of creating a sensor nanomaterial that is not only highly sensitive to extremely low concentrations of analytes but also highly selective still remains. In the context of sensor applications, it is anticipated that nanomaterials will allow for fabrication of electrical sensors that are capable of detecting ultralow concentrations of analytes like explosives (such as TNT, nitroglycerin, cyclotetramethylene-tetranitramine) and biomolecules (such as HIV or other pathegenic antigens or peptides), with ultrahigh selectivity such that trace interferents will not generate false positives. Among the various strategies that have been explored, Single Walled Carbon Nanotubes (SWCNTs) and graphene based sensors have an important attribute of being extremely sensitive but their ability to serve as ideal sensors are compromised by their disadvantages including low long-term stability, low on-off current ratios, and incomplete surface coverage of non-covalent coatings. Covalent functionalization offers a solution for improved chemical selectivity. However, the number of functional groups that may be attached to the SWCNT sidewall or graphene surface are limited since covalent modifications quickly destroy electrical properties.

Innovative Technology

Researchers at the University of Maryland have developed a method to create highly functionalized double walled carbon nanotubes (DWCNTs) with thin film field effect transistor (TFT) sensors that achieve simultaneous ultrahigh selective and sensitive detection of various analytes including chemicals and explosives at ultralow concentrations reducing chance of false positives that are likely to occur in a chemical sample. The functionalization of these DWCNTs TFTs with the carboxylic acid group for instance, obtained high ON current at low carbon nanotube (CNT) density demonstrating that functionalization does not destroy electrical/conductive properties of these CNTs. The DWCNTs TFTs were able to detect 60nM ammonia with a sensitivity equivalent to ~1 ppb.

Advantages

· Highly selective in detecting ultralow concentrations of analyte to be detected
· Highly sensitive detection of potential analytes capable of on-site detection
· Portable, simple, rapid cost-efficient device design
· The following table shows the chemical sensing characteristics of covalently functionalized DWCNT TFTs comparison towards other pristine and functionalized CNT TFTs.

On current On/off ratio selectivity
SWCNT Pristine Moderate High Low
DWCNT Functionalized Low N/A N/A
Pristine High High Low
MWCNT Functionalized High High High
Pristine High Low Low

Applications

· Extremely sensitive detection of chemicals, explosives and biomolecules in the vapor and aqueous phase

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Additional Information

INSTITUTION

University of Maryland, College Park

PATENT STATUS

Patent(s) pending

LICENSE STATUS

Available for exclusive or non-exclusive license

CATEGORIES

- Nanotechnology + Nanoparticles + Nanomaterials

EXTERNAL RESOURCES

- US Patent 9,739,741

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