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techlicensing@gatech.edu

770.658.8820

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High Sensitivity Stable Sensors and Methods for Manufacturing Same

Category: Sensor Technology

Contact: Gennaro Gama, PhD Phone: 470-936-4641

Summary

This technology introduces a cutting-edge method for manufacturing dual-gate field-effect transistor sensors. By ingeniously separating the sensing and amplifying functionalities across two gate dielectrics, the technology achieves unparalleled stability and sensitivity in detecting physical, chemical, or biological agents. This breakthrough addresses the common challenges faced by single-gate FET sensors, such as performance degradation, slow response times, and limited engineering optimization opportunities.

Development Stage

Prototype complete

Problem Statement & Solution

Single-gate silicon FET sensors are typically used to amplify small electrical signals that result from physical or chemical interactions. However, they have several limitations. The performance of these sensors can degrade irreversibly over time, and there are limited engineering approaches for optimizing sensing functionality. Low-power signal amplification and detection can result in inefficiencies, and there have been challenges in fabricating sensors on flexible or unconventional substrates. Finally, existing sensor technologies for large-area deployments are high-cost and complex, making wide-scale production difficult.

Researchers at the Georgia Institute of Technology have developed a method for manufacturing dual-gate FET sensors that improve drastically on the sensitivity, selectivity, and dynamic range of the sensor. It allows for longevity of the device as well as the ability to measure cumulative effects of exposure to signals to transient carriers.

Advantages

- High sensitivity and stability in sensor operation.
- Low-voltage operation enabled through advanced engineering of the first gate dielectric layer.
- Optimization of sensing mechanisms via the second gate, enhancing detection capabilities.
- Compatibility with non-conventional substrates, allowing for diverse applications.
- Cost-effective production suitable for large-area fabrication.
- Flexibility and low processing temperature requirements, broadening the scope of usable materials.

Commercial Applications

- Wearable electronics and health monitoring devices.
- Internet of Things (IoT) connectivity sensors.
- Environmental monitoring through chemical and biological sensors.
- Radiation sensing for safety and medical applications.
- Large area imaging arrays for both ionizing and non-ionizing radiation sources.

- Advanced pressure, temperature, and pH sensors for diverse industries.

Lead Inventor: Bernard Kippelen, PhD

Intellectual Property Status: US Patent Filed – US20220123240A1

Scientific Publication(s):

M. Yun et al: Stable Organic Field-Effect Transistors for Continuous and Nondestructive Sensing of Chemical and Biologically Relevant Molecules in Aqueous Environment. ACS Appl. Mater. Interfaces 2014, 6, 3, 1616–1622

Canek Fuentes-Hernandez et al.: Large-area low-noise flexible organic photodiodes for detecting faint visible light. Science 370, 698–701 (2020)