High Performance and Flexible Chemical And Bio Sensors Using Metal Oxide Semiconductors

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SUMMARY

UCLA researchers in the Department of Materials Science and Engineering have developed a simple method producing thin, sensitive In_2O_3-based conformal biosensors based on field-effect transistors using facile solution-based processing for future wearable human technologies as well as non-invasive glucose testing.

BACKGROUND

The development of wearable sensors for in situ, rapid, and low-cost detection of various targets (e.g., heart rate and glucose levels) that are lightweight, comfortable, and small scale would be useful for many applications. Nanomaterials-based field-effect transistors (FETs) have been investigated for this sensor application due to its high sensitivity and response. However, the major challenge is obtaining both the required conformality and reproducibility with simple and large-scale processing.

INNOVATION

UCLA researchers proposed and demonstrated a new simple method of one-step spin coating of aqueous In_2O_3 solution for fabricating ultrathin, sensitive In_2O_3 semiconductor-based FETs for use as chemical biosensors. The In_2O_3-based FETs had mobility and on/off ratios of ~20 $cm^2 \cdot V^{-1} \cdot s^{-1}$ and over 10^7, respectively. Specific chemical treatment and enzyme immobilization of the FETs facilitated pH and glucose detection, respectively, in real-time with linear and fast responses. The devices had excellent contact on highly rough artificial skin surfaces and an artificial eye surface.

APPLICATIONS

- Non-invasive glucose level test using saliva or tear
- Wearable biosensors for various targets such as heart rate and pH
- Electronic skin
- Disease diagnosis
- Thermal regulation
- Communication

ADVANTAGES

- High sensitivity for non-invasive glucose level testing and other chemical and bio signals
- Good FET device performance with mobility and on/off ratios of ~20 $cm^2 \cdot V^{-1} \cdot s^{-1}$ and over 10^7
- Real-time pH and glucose detection with linear and fast responses
- Compatible with flexible and wearable bio medical application on rough surface and skin
- Low processing temperature (250^oC)
- Compatible with large area processing that be integrated to roll-to-roll mass production for low cost process

STATE OF DEVELOPMENT

Researchers have manufactured ultrathin, sensitive In_2O_3 semiconductor-based FETs for use as chemical biosensors. Glucose and pH detection has been demonstrated. Also the device shows excellent contact on artificial rough skin surfaces and eye surfaces.

RELATED MATERIALS

CONTACT

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INVENTORS

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OTHER INFORMATION

KEYWORDS

Biosensor; aqueous process; In2O3; metal oxide semiconductor; conformal; flexible; field-effect transistor; wearable electronics; glucose; non-invasive; large area; roll-to-roll

CATEGORIZED AS

- **Environment**
  - Sensing
- **Materials & Chemicals**
  - Thin Films
- **Medical**
  - Diagnostics
  - Disease: Metabolic/Endocrinology
- **Nanotechnology**
  - Electronics
  - Materials
  - NanoBio
- **Semiconductors**
  - Design and Fabrication
  - Materials
  - Processing and Production
- **Sensors & Instrumentation**
  - Biosensors
  - Environmental Sensors

▶ Jaemyung Kim, You Seung Rim, Huajun Chen, Huan H. Cao, Nako Nakatsuka, Hannah L. Hinton, Chuanzhen Zhao, Anne M. Andrews, Yang Yang, and Paul S. Weiss. Fabrication of High-Performance Ultrathin In2O3 Film Field-Effect Transistors and Biosensors Using Chemical Lift-Off Lithography. ACS Nano, 9 (4), pp 4572–4582 (2015)

▶ Medical

RELATED CASES

2016-090-0

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	10,436,746	10/08/2019	2016-090

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- ▶ Titanium Oxide as the Window Layer for Metal Chalcogenide Photovoltaic Devices
- ▶ Two-Step Processing With Vapor Treatment Of Thin Films Of Organic-Inorganic Perovskite Materials
- ▶ Efficient and Stable Perovskite Solar Cells with All Solution Processed Metal Oxide Transporting Layers
- ▶ Design of Semi-Transparent, Transparent, Stacked or Top-Illuminated Organic Photovoltaic Devices
- ▶ Novel Polymers for Polymer Solar Cells, Transistors, and Sensors

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