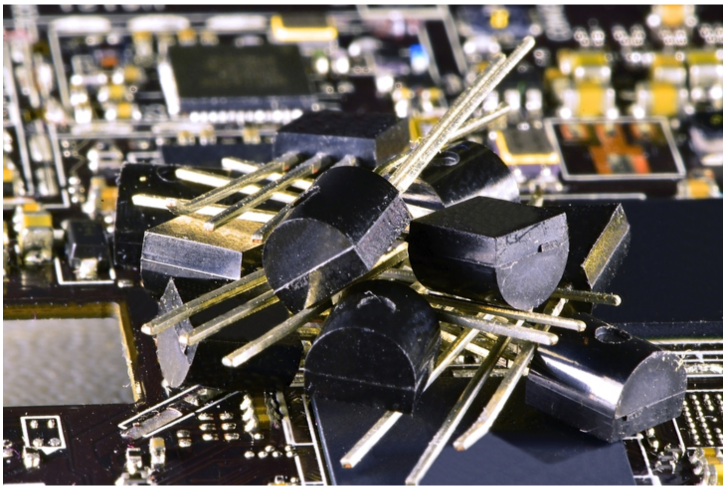
Two-Dimensional Material-Based Field-Effect Transistor Sensors

TECHNOLOGY NUMBER: 6781



Technology ID

6781

Category

Hardware
Engineering & Physical Sciences
Semiconductor, MEMS, and Electronics

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OVERVIEW

Transition Metal Dichalcogenide (TMDC) transistors for precise biosensing of biomolecule interactions.

- Achieves reliable, femtomolar-level biomolecule detection using TMDC transistors.
- Diagnostics, biomolecular research, pharmaceuticals, and environmental monitoring.

BACKGROUND

Field-effect transistor (FET) biosensors made from nanostructures like nanowires (NWs) and carbon nanotubes (CNTs) have shown promise in detecting nanomolar to femtomolar concentrations of biomarkers. However, their 1D structure brings fabrication challenges, requiring expensive and time-consuming processes. Atomically layered transition metal dichalcogenides (TMDCs), such as MoS_2 and WSe_2, offer advantages due to their 2D nature and compatibility with existing manufacturing processes. TMDC transistors benefit from low detection noise and high sensitivity due to their large On/Off current ratios. The hydrophobicity of TMDC allows for direct antibody functionalization, simplifying the fabrication process. This opens up opportunities for affordable, high-throughput biosensor arrays that can quantify biomolecule interactions and kinetics at femtomolar levels, addressing the limitations of current biosensor technologies.

INNOVATION

Researchers at the University of Michigan have developed transition metal dichalcogenides transistor biosensors to detect biomolecule interactions such as TNF-alpha with femtomolar sensitivity. The technology leverages two modes: linear and subthreshold, showing consistent sensor responses and enabling the determination of equilibrium constants and kinetics of molecular interactions. By integrating with PDMS-based microfluidic systems, these biosensors allow for both equilibrium and real-time kinetic analyses. This advancement not only simplifies sensor design but also significantly enhances sensitivity and precision, making it suitable for applications in diagnosing diseases, monitoring environmental pollutants, and drug development. This work serves as a foundation for leveraging the electronic properties of TMDCs in bio-assay applications.

ADDITIONAL INFORMATION

PUBLICATIONS

Nam, Hongsuk ; Oh, Bo-Ram ; Chen, Mikai ; Wi, Sungjin ; Li, Da ; Kurabayashi, Katsuo ; Liang, Xiaogan. "Fabrication and Comparison of MoS_2 and WSe_2 Field-Effect Transistor Biosensors." Journal of Vacuum Science and Technology. B, Nanotechnology & Microelectronics, vol. 33, no. 6, 2015, https://doi.org/10.1116/1.4930040

PATENTS

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