Abstract

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Graphene and beyond for Lab-on-chip biosensor: a beginning of a new More-than-Moore era in CMOS Si foundries?

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Abstract

Statement of the Problem: This pandemic has made clear that a much improved molecular and serological diagnostic testing solution is required for preventing the spread of infectious diseases. Most current testing for the virus requires analysis by trained technicians operating expensive equipment in centralized laboratory facilities. Therefore an immeasurable need for a point-of-care test solution with minimal user operation is needed to be deployed at scale. Methodology & Theoretical Orientation: The main components of a low-cost and disposable ADI biosensor are: (1) a protein-based recognition element, which selectively interacts with a target analyte, (2) a 2D material-based transducer element, which converts the interaction into a detectable signal, and (3) ADI read-out electronics, which further process the transducer signal and produce an intelligible sensor output. This full system can be integrated into a single chip, providing a robust platform for rapid detection and quantification of biological analytes for everyday diagnosis monitoring. Findings: Biosensor transduction elements are crucial in determining the ultimate sensitivity of the device. As such, atomically thin ("2D") material systems with extreme surface to volume ratios such as Graphene, CNTs, hBN, and MoS_2 have proven to be promising candidates. Due to the low dimensionality of 2D materials, their electrical properties undergo large responses to small changes in their local interfacial environment. When integrated into a biosensor, they provide significantly improved performance and allow for ultra-low limit of detection. Conclusion & Significance: A biosensor platform realized by a functionalized Graphene heterostructure-based field-effect transistor (G-FET) has been demonstrated with outstanding performance such as a limit of detection of ~200 ag/mL of SARS-CoV-2 spike protein S1 subunit, which is ~1-3 orders magnitude lower compared to golden standard techniques such as RT-PCR and ELISA. The G-FET device demonstrated here paves the path towards low-cost and disposable lab-on-chip biosensing platforms for Point-of-care diagnosis applications.

Biography

Prof.Dr. Mohamed Azize received his M.S. and Ph.D. (2006) degrees in Physics from University of Montpellier II and University of Sophia-Antipolis in France, respectively. His expertise is around semiconductor material processing & devices for micro-& opto-electronic and sensors. He has been working in world-class research laboratories since 2002: CQD Northwestern University (USA), CRHEA-CNRS and CEA labs in France, and MTL lab at MIT (Cambridge, MA USA). He has authored more than 47 scientific articles and more than 10 granted patents. He has been involved in multiple start ups at C- and director levels and his groundbreaking work on wide-band gap semiconductor used in HEMT and LEDs devices that have been converted to commercial products by French and US start ups. Currently he is a technical leader/manager in the Biosensor group at ADI and also is adjunct research assistant professor at Boston University in the division of Material Science and Engineering.

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