Muhammad Omar Shaikh

Tunghai University
Taiwan

Multiplexed Nanocomposite Immunosensor for Point-of-Care Cancer Diagnostics

Abstract:

Early detection and monitoring of cancer remain a major global health challenge, as existing point-of-care (POC) diagnostic tools often suffer from qualitative outputs, high false-positive rates, and limited multiplexing capabilities, restricting their clinical utility. To address these limitations, we present a multiplexed electrochemical immunosensor engineered for the simultaneous detection of clinically relevant cancer biomarkers in complex biological fluids. The platform leverages a novel multifunctional 3D nanocomposite coating, composed of a porous bovine serum albumin (BSA) matrix integrated with highly conductive carbon nanotubes (CNTs). This nanostructured interface enables oriented antibody immobilization, suppresses nonspecific adsorption, facilitates unhindered analyte diffusion, and enhances electron transfer, thereby achieving high sensitivity and specificity in complex sample environments. As a demonstrator for clinical translation, the immunosensor was validated for bladder cancer biomarkers—APO-A1, VEGF, and IL-8—showing broad dynamic ranges (0.1–1000 ng/mL) and ultralow limits of detection (22–44 pg/mL). The sensor exhibited excellent reproducibility (n = 5, RSD = 2.2%), robust antifouling properties against common urinary interferents, and remarkable stability after one month of storage in serum and urine. Implemented on a low-cost, disposable screen-printed platform, this approach enables rapid, non-invasive biomarker profiling directly at the POC. These findings highlight the transformative potential of multiplexed nanocomposite immunosensors for cancer diagnostics, offering a viable alternative to invasive procedures and paving the way toward accessible, sensitive, and specific early-stage cancer detection at the point of care.

Biography

Muhammad Omar Motamid Shaikh is Associate Professor of Sustainability Science and Management at Tunghai University, Taiwan, and Director of the Advanced NanoTech Laboratory (ANT Lab). He holds an MEng in Materials Science and Engineering from Imperial College London and a PhD in Mechatronic Science and Engineering from Southern Taiwan University of Science and Technology. His interdisciplinary research integrates nanotechnology, electrochemistry, flexible electronics, and AIoT, with a focus on developing high-performance functional nanomaterials for applications in medical diagnostics, sustainable energy, and carbon-neutral technologies. He previously served as Chief Technology Officer at BiTAPE Logistics, a university spin-off that pioneered smart printed tape technology for real-time supply chain visibility and AI-enhanced logistics services.