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Revolutionary Microfluidic Immunosensor with Magnetofluidic and Capacitive Technologies for Real-Time Proinflammatory Pathology Monitoring

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Abstract : This research introduces an integrative microfluidic immunosensor, ingeniously conceived for the real-time surveillance of proinflammatory conditions. By harnessing the potential of COMSOL Multiphysics for intricate 3D modelling, this study signifies a notable leap in the domain of biomedical diagnostics. Our development, akin to a patch, fulfills the growing demand for non-intrusive monitoring apparatuses, and inaugurates innovative approaches for the identification and quantification of biomarkers in sweat. This is achieved through a synergistic approach of magnetofluidic manipulation and capacitive detection methodologies. Central to the device's architecture is the employment of magnetic nanoparticles (MNPs) tagged with biomarkers. The apparatus is composed of two fundamental segments: the primary segment includes a series of microcoils for enhanced MNP entrapment and microfluidic blending, while the secondary segment comprises a stratified arrangement of a microcoil alongside copper electrodes, serving as a capacitor for capacitive measurement. Our findings reveal the immunosensor's formidable detection capabilities, exhibiting a sensitivity scope of 60% to 75% with 70% MNP saturation. These results underscore its potential to surpass the boundaries of traditional biosensors, offering improved consistency and precision. Moreover, the immunosensor is adept at identifying a wide array of pathogens, encompassing bacteria, and is compatible with other diagnostic methods for concurrent detection of multiple biomarkers. This versatility renders it an invaluable asset in both clinical and research environments.

Keywords : COMSOL Multiphysics 3d simulation, microfluidic immunosensor, magnetofluidic manipulation, magnetic nanoparticle (MNP)trapping, laboratory-on-patch technology
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