Smart Nanoplatforms for Multiplexed Diagnostics and Targeted Therapy

Suna Timur[1,2]
Emine Guler Celik[2,3], Kerem Tok[1], Figen Zihnioglu[1], Tuncay Goksel[2,4], Kutsal Turhan[2,5]

[1]*Ege University, Faculty of Science, Department of Biochemistry, Bornova, Izmir, Türkiye*
[2]*EgeSciencePro Scientific Research and Corporation, IdeEGE Technology Development Zone, EBILTEM Facility, No172/14, Bornova, Izmir, Turkiye*
[3]*Department of Bioengineering, Faculty of Engineering, Ege University, Bornova, Izmir, Turkiye*
[4]*EGE SAM, Faculty of Medicine, Ege University, Bornova, Izmir, Turkiye*
[5]*Faculty of Medicine, Izmir University of Economics, Balcova, Izmir, Turkiye*

suna.timur@ege.edu.tr

Nanotechnology has revolutionized the development of next-generation diagnostics and therapeutics by enabling highly functional, miniaturized, and integrative platforms. Our work focuses on the design of smart nanostructures for multiplexed biosensing and personalized treatment approaches. We employ a wide range of nanomaterials—including gold, magnetic, carbon-based, and polymeric nanoparticles—to construct advanced biosensors and nanocarriers with enhanced sensitivity, tunability, and biocompatibility. In diagnostics, we have engineered electrochemical and paper-based biosensors integrated with smartphone-assisted readout systems for the rapid detection of biomarkers, viral pathogens, and illicit substances. These systems offer portability, affordability, and ease of use—ideal for point-of-care (PoC) applications. Moreover, we demonstrate wearable prototypes that translate biosensing into real-time, on-body analytics. In parallel, we develop smart nanocarrier systems for targeted drug delivery and theranostics. These platforms provide selective delivery to disease sites while minimizing systemic toxicity, thereby enhancing treatment efficacy. Our results underscore the potential of such nanoplatforms in bridging diagnostics and therapy, paving the way for precision nanomedicine. This contribution emphasizes the convergence of nanotechnology, digital tools, and clinical needs—positioning our innovations at the forefront of next-generation biomedical solutions for the region and beyond.

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