Making Endotoxins Visible with Engineered F/ZnO Nano-Bio-Interfaces

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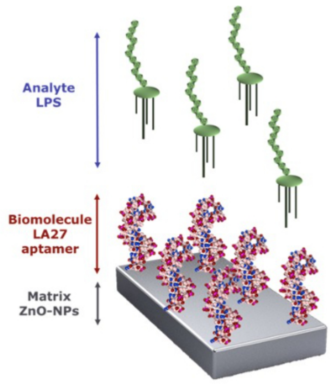
The development of rapid, sensitive, and selective platforms for endotoxin detection remains a critical challenge in biomedical diagnostics and environmental monitoring. Here, we present an innovative optical aptasensor based on engineered zinc oxide (ZnO) nano-bio interfaces, combining the outstanding photophysical properties of fluorine-doped ZnO quantum dots (QDs) with the high specificity of DNA aptamers for bacterial lipopolysaccharides (LPS).
Fluorine doping and controlled synthesis were strategically employed to tailor defect density and emission behavior of ZnO QDs. [1] These nanomaterials were then assembled into highly uniform and fluorescent thin films via an optimized spin-coating process, yielding robust nano-interfaces with finely tunable morphology and optical response. [2] The integration of the LA27 aptamer onto these platforms enabled selective recognition of LPS/LOS from Gram-negative bacteria.
Remarkably, the sensing mechanism exploits the interplay between nano-interface photoluminescence and aptamer–target interactions, which vary according to the structural complexity of the endotoxins. Distinct binding modes, ranging from deep membrane insertion to surface-level adhesion, translate into specific and measurable optical signatures, allowing not only sensitive detection but also discrimination among different LPS architectures. [3]
This work demonstrates how defect-engineered ZnO nano-interfaces can be transformed into powerful transduction platforms when coupled with biomolecular recognition elements. The proposed system offers a compelling alternative to conventional endotoxin assays, opening new avenues for the design of next-generation optical biosensors with enhanced performance, scalability, and application potential in healthcare and environmental safety.



Schematic representation of the aptasensor

References:

[1]. Noemi Gallucci, et al. *Materials Chemistry Frontiers* , **2024**
[2]. Noemi Gallucci, et al. *Nano Select* , **2025**
[3]. Alessandro Cangiano, et al. *Journal of Colloid And Interface Science* , **2026**

Acknowledgements:

The work was supported by Programma per il Finanziamento della Ricerca di Ateneo (FRA) 2020, detection-LipAptaNanoSens" (Cod. 000008 ALTRI_CdA_75_2021_FRA_LINEA_B-VITIELLO); Piano Nazionale di Ripresa e Resilienza (PNRR) BIOREB, CUP: F63C24000230006; the European Union's Horizon 2020 Research and Innovation Program under grant agreement No. 101007417