Advanced Sensing Platforms Based on Laser-Engineered rGO and 2D Materials

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The combination of two-dimensional materials with metal nanoparticles (MNPs) offers significant advancements in sensing technologies, enabling the creation of high-performance smart devices and biosensors. This presentation delves into a novel one-step laser nanostructuring method to fabricate reduced graphene oxide (rGO) films embedded with noble MNPs, resulting in highly effective and scalable sensing platforms. This versatile, surfactant-free approach facilitates the instantaneous laser-induced co-reduction of graphene oxide and metal cations, producing conductive rGO nanosheets with embedded gold, silver, and platinum nanoparticles. These hybrid nanosheets have shown exceptional sensitivity and selectivity, applicable to the detection of caffeic acid, nitrite, and hydrogen peroxide, as well as the quantification of clinical biomarkers like CA-19-9 glycoprotein and pathogenic Escherichia coli. The sensors developed through this technique exhibit sub-micromolar limits of detection, excellent reproducibility, and high accuracy in real sample analysis. Moreover, the seamless integration of rGO electrodes into lateral flow assays (LFAs) and the creation of capacitive immunosensors demonstrate the versatility and potential of these materials for point-of-care diagnostics. The streamlined fabrication process, coupled with proven performance across various analytical applications, highlights the transformative potential of laser nanostructured rGO films in advancing the field of biosensing technologies.

The ICN2 is funded by the CERCA programme / Generalitat de Catalunya. The ICN2 is supported by the Severo Ochoa Centres of Excellence programme, Grant CEX2021-001214-S, funded by MCIN/AEI/10.13039.501100011033. This project is funded by the European Union's Horizon Europe programme under the grant agreement number 101059266 (SUSNANO). This project has received funding from the European Union's Horizon Europe – the Framework Programme for Research and Innovation (2021–2027) under grant agreement No 101120706 (2D-BioPAD). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them

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