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Thesis: "GRAPHENE OXIDE-BASED BIOSENSING SYSTEMS FOR THE ANALYSIS OF PATHOGEN-RELATED ANALYTES"

Summary:

Biosensors are modern devices that can be employed in several contexts, such as health care, clinical diagnosis, food quality control, and environmental monitoring, among others. As a matter of fact, biosensors are convenient tools for infectious diseases diagnostics, because some of them meet the REASSURED (Real-time connectivity, Ease of specimen collection and environmental friendliness, Affordable, Specific, Sensitive, User-friendly, Rapid and robust, Equipment-free, and Delivered to the end-users) characteristics. Hence, biosensors represent as a powerful alternative to conventional diagnostic methods, such as microscopy, cell culture, immunoassays and nucleic-acid amplification. In this dissertation, a biosensing system targeting pathogen-related analytes was developed. The biosensing system comprises 96 microwell plates coated with graphene oxide, which performs as quencher of fluorescence from a specific immunoprobe. Such an immunoprobe is integrated by a fluorophore conjugated with a biorecognition element. The fluorescence of the immunoprobes that do not experiment immunoreactions (antibody-antigen) are deactivated by graphene oxide via nonradiative energy transfer, whereas those immunoprobes undergoing immunoreactions preserve its photoluminescence due to the distance and the low affinity between the immunocomplex and the graphene oxide-coated surface. This biosensing system was proven effective in the detection of (i) E. coli, to determine contamination in industrial food samples. (ii) Sialidase, to diagnose bacterial vaginosis and (iii) antibodies against SARS-CoV2 to determine COVID 19 seroconversion. The biosensing system was also proven useful with different matrixes (cauliflower extracts, vaginal swabs and human serum) to demonstrate that the overall approach is able to operate in real settings or realworld applications, proving to be highly sensitive, efficient, rapid and cost-effective, as well. Additionally, based on the same biosensing strategy, it was developed a paper-based disposable test for bacterial vaginosis detection. Our paper-based test is carried out within 20 minutes and the sample volume was 6 µL. Besides, it was tested with 14 vaginal swabs specimens to discriminate clinical samples of women with normal microbiota from those undergoing bacterial vaginosis. All in all, the development of this biosensing principle based on optically active nanomaterials, as well as all the potential applications, both as platform and disposable device, have significant impact in food industry for prevention of gastrointestinal diseases that may lead even to death due to the consumption of contaminated E. coli food, determination of COVID-19 seroconversion for clinical and health services purposes, and clinical diagnosis of Bacterial Vaginosis avoiding the consequences of misdiagnosis of this disease.