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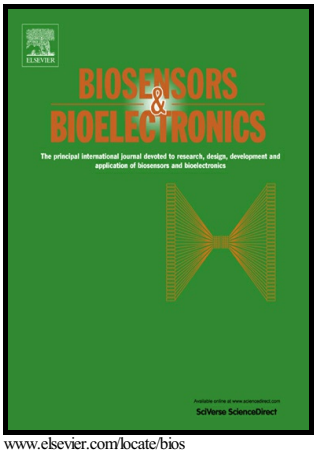

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Amyloid-like protein nanofibrous membranes as a sensing layer infrastructure for the design of mass-sensitive biosensors

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Abstract

Quartz crystal microbalances (QCMs) have been used in the literature for mass sensitive biosensor applications. However, their performance, reliability and stability have been limited by the chemical treatment steps required for the functionalization and activation of the QCM surface, prior to antibody immobilization. Specifically, these steps cause increased film thickness, which diminishes performance by mass overload, and create a harsh environment, which reduces biological activity. In this work, we eliminated this chemical step by introducing a sensing layer modification using electrospun amyloid like-bovine serum albumin (AL-BSA) nanofibers on QCM surfaces. Owing to the self-functionality of AL-BSA nanofibers, these modified QCM surfaces were directly activated by glutaraldehyde (GA). To assess the performance of these modified electrodes, a model protein, lysozyme (Lys), was selected as the biological agent to be immobilized. Frequency measurements were performed in batch (dip-and-dry) and continuous (flow-cell) processes, and binding performances were compared.

AL-BSA modified surfaces were characterized by X-ray photoelectron spectroscopy (XPS), scanning electron microscope (SEM), quartz crystal microbalance (QCM), contact angle (CA) and attenuated total reflectance-Fourier transform infrared spectroscopy (ATR-FTIR). Protein detection was measured based on the frequency shift before and after the covalent bonding of Lys. Under optimized conditions, the proposed immobilization platforms could bind 335 ng/mL and 250 ng/mL of Lys for batch and continuous processes, respectively. Our results demonstrate the potential usage of these self-functional electrospun AL-BSA infrastructure sensing layers on QCM surfaces. This modification enables the direct immobilization of bioactive agents by eliminating any surface functionalization process for further mass-sensitive biosensor applications.

Keywords: Amyloid-like protein; Bovine serum albumin; Lysozyme; Electrospinning; Quartz crystal microbalance; Protein immobilization.