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Localized Detection of D-Serine by Using an Enzymatic Amperometric Biosensor and Scanning Electrochemical Microscopy

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Abstract : D-serine acts as an endogenous co-agonist for N-methyl-D-aspartate receptors in neuronal synapses. This makes it a key component in the development and function of a healthy brain, especially given its role in several neurodegenerative diseases such as Alzheimer’s disease and dementia. Despite such clear research motivations, the primary site and mechanism of D-serine release is still currently unclear. For this reason, we are developing a biosensor for the detection of D-serine utilizing a microelectrode in combination with a D-amino acid oxidase enzyme, which produces stoichiometric quantities of hydrogen peroxide in response to D-serine. For the fabrication of a biosensor with good selectivity, we use a permselective poly(meta-phenylenediamine) film to ensure only the target molecule is reacted, according to the size exclusion principle. In this work, we investigated the effect of the electrodeposition conditions used on the biosensor’s response time and selectivity. Careful optimization of the fabrication process allowed for enhanced biosensor response time. This allowed for the real time sensing of D-serine in a bulk solution, and also provided in means to map the efflux of D-serine in real time. This was done using scanning electrochemical microscopy (SECM) with the optimized biosensor to measure localized release of D-serine from an agar filled glass capillary sealed in an epoxy puck, which acted as a model system. The SECM area scan simultaneously provided information regarding the rate of D-serine flux from the model substrate, as well as the size of the substrate itself. This SECM methodology, which provides high spatial and temporal resolution, could be useful to investigate the primary site and mechanism of D-serine release in other biological samples.

Keywords : D-serine, enzymatic biosensor, microelectrode, scanning electrochemical microscopy
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