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Electrochemical biosensors based graphene for foodborne contaminants

The development of successful biosensing platforms is highly dependent upon the biorecognition properties of the recognition receptor and the sensitivity of the transducer of the binding signal. The integration of the high affinity and specificity of DNA aptamers, and the unique properties of the carbon nanomaterial based graphene, offers an excellent avenue for sensitive and selective biosensing architectures. In this work, novel microcystin-targeting DNA aptamers were successfully selected using systematic evolution of ligand by exponential enrichement (SELEX). Then, highly sensitive and selective aptasensor which utilizes an unlabeled aptamer noncovalently assembled on a graphene electrode was developed. Assembly of the DNA aptamer on the graphene-modified electrodes caused a marked drop in the square wave voltammetric reduction signal of the $[Fe(CN)_6]^{4-/3-}$ redox couple. A functionalization method of graphene electrodes was demonstrated by electrochemical reduction of in situ generated aryl diazonium salts in aqueous acidic solution. The electrochemical modification protocol was optimized in order to generate monolayer of aryl groups on the graphene surface without complete passivation of the electrode. Unlike the reported methods for graphene functionalization, we demonstrated here the ability of the electrografting of aryl diazonium salt to attach an organic film to the graphene surface in a controlled manner by choosing the suitable grafting protocol. This first attempt to use functionalized CVD graphene in biosensing represents a proof of concept that can be extended to other biosensing applications. Finally, for a better understanding of the behaviour of different graphene samples that can be used for biosensing, a systematic study have been performed in order to investigate to which extent the size of graphene oxide (GO) sheets influence their structural properties as well as their biosensing performance. Graphene oxide sheets with different size ranges were separated. The sheets were then characterized via atomic force microscopy (AFM), scanning electron microscopy (SEM), Raman spectroscopy and X-ray photoelectron spectroscopy (XPS). The biosensing performance of these samples was compared using DNA aptamer against

MC-LR toxin as well as an antibody against β-LG in label-free detection format. Our results demonstrate that controlling the size of GO sheets may have profound impact on their use in specific biosensing applications.