Improvement of Voltammetric Detection of Sulfanilamide with a Nanodiamond-Modified Glassy Carbon Electrode

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Owing to its high hardness, high chemical inertness, and good biocompatibility, nanodiamond (ND) has recently been increasingly used in electrochemical analysis. In this work, a comparative study of voltammetric detection of sulfanilamide using a bare glassy carbon electrode (GCE) and ND-modified glassy carbon electrode (GCE-ND) was carried out. Scanning electron microscopy (SEM) and cyclic voltammetry (CV) analyses revealed that modification of a GCE with 100 μL of ND suspension (40 $\text{mg}\cdot\text{L}^{-1}$) was the optimum condition in this study. The results of CV analyses with the $[\text{Fe}(\text{CN})_6]^{3-}$ redox couple suggested the occurrence of a diffusion-controlled process on both electrodes. However, the GCE-ND exhibited a larger electroactive surface area and a higher heterogeneous electron transfer rate constant, which were approximately 2.11 and 5.05 times greater than those of the bare GCE, respectively. When applied to the detection of sulfanilamide solution using square wave voltammetry under the optimum conditions, the bare GCE showed a linear dynamic range of 1–80 $\text{mg}\cdot\text{L}^{-1}$ ($R^2 = 0.9994$) with a detection limit of 0.744 $\text{mg}\cdot\text{L}^{-1}$, by contrast, the GCE-ND showed a linear dynamic range of 0.2–100 $\text{mg}\cdot\text{L}^{-1}$ ($R^2 = 0.9949$) with a detection limit of 0.161 $\text{mg}\cdot\text{L}^{-1}$. The detection limit of the GCE-ND was as much as 78.4% lower than that of the bare GCE. Furthermore, interday detection experiments revealed that the GCE-ND had higher repeatability and accuracy than the bare GCE.

Keywords: nanodiamond, glassy carbon electrode, sulfanilamide, square wave voltammetry

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