REDUCED GRAPHENE OXIDE AND CALCIUM-DEFICIENT HYDROXYAPATITE COMPOSITES: SYNTHESIS, STRUCTURAL AND ELECTROCHEMICAL ANALYSIS

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Dopamine (DA) is one of the most important catecholamine neurotransmitters and deviations from its average dopamine concentration in blood are associated with Parkinson's and Alzheimer's diseases, depression, schizophrenia, hypertension, and heart failure [1]. Therefore, rapid and accurate determination of DA concentration is essential for the early diagnosis of these disorders. Electrochemical sensors are attracting increasing attention due to their high sensitivity, fast response, and relatively low cost, while their performance strongly depends on electrode surface properties [2]. Thus, electrode modification with graphene oxide (GO), combined with calcium-deficient hydroxyapatite (CDHA) due to its high ion adsorption capacity and biocompatibility, is expected to improve sensor stability, sensitivity, and selectivity [3].

The aim of this study was to synthesize GO/CDHA composites using wet and hydrothermal synthesis methods and to evaluate their structural and electrochemical properties for DA detection.

GO/CDHA composites were synthesized in two ways. By the wet synthesis method, a mixture of gypsum and GO (ratio 2:1) and disodium hydrogen phosphate was heated at 80 ℃ for 28 hours to obtain a CDHA rGO composite. By the hydrothermal synthesis method, a similar mixture of gypsum and GO (ratio 2:1) and disodium hydrogen phosphate was heated in a hydrothermal bomb at 180 ℃ for 12 hours to obtain a CDHA rGO hydr composite.

Structural and morphological characterization confirmed the successful synthesis of GO/CDHA composites. XRD analysis showed that the characteristic diffraction peaks of CDHA were preserved in the composite diffractograms. Raman spectroscopy revealed the presence of phosphate (PO_4^{3-}) bands of CDHA and the characteristic D and G bands of GO. Furthermore, XRD and Raman spectroscopy results indicated that samples synthesized by the wet synthesis method exhibited lower crystallinity and higher amorphousness compared to those synthesized under hydrothermal conditions. FTIR and XPS analyses confirmed the presence of functional groups and elements characteristic of both CDHA and GO in the composites.

Electrochemical studies were performed in a three-electrode cell using a phosphate buffer solution (pH 7.2). The GCE/CDHA rGO sensor demonstrated the highest sensitivity (11.11 μA $\mu M^{-1}\ cm^{-2}$) and the lowest limit of detection (LOD 100.35 nM) compared to the GCE/CDHA rGO hydr sensor. Also, this sensor showed good selectivity, as the DA current response changed slightly in the presence of other analytes, high stability – the current strength values almost did not change over 13 measurements and good repeatability – the relative standard deviation (RSD) was below 5 %. In the future, sensor performance could be further improved by expanding the linear range for analyte detection and reducing the LOD.

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