Enhanced voltammetric detection of hydrogen peroxide using a glassy carbon electrode modified with reduced graphene oxide and TiO_2

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Hydrogen peroxide (H_2O_2) is important in various fields such as environmental monitoring, clinical diagnostics, and industrial processes due to its omnipresence. Additionally, hydrogen peroxide is a by-product in reactions catalysed by numerous oxidase enzymes, making it a valuable reporter molecule for the electrochemical detection of non-electroactive compounds (1). This detection is made possible through electrodes modified with substrate-specific oxidative enzymes, leveraging intermediary role of H_2O_2 in these enzymatic reactions. The accurate and sensitive analysis of H_2O_2 is imperative in understanding its dynamics and impacts in these diverse domains. Conventional methods for hydrogen peroxide determination, such as titration and spectrophotometry, have provided valuable insights into its concentration levels. Nonetheless, these methods often suffer from limitations such as low sensitivity, interference from other substances, and the requirement for complex sample preparation procedures. However, electroanalytical techniques have emerged as promising alternatives for the sensitive and selective detection of hydrogen peroxide. Electroanalytical methods offer distinct advantages for H_2O_2 analysis, enabling rapid, selective, and cost-effective detection with high sensitivity and low detection limits. Usually, determination of hydrogen peroxide relies on its electrochemical oxidation or reduction at suitable electrode materials. Typically, in electrochemical processes hydrogen peroxide yields oxygen gas and protons, accompanied by the transfer of electrons, which can be detected as a current response. The choice of electrode material plays a crucial role in determining the sensitivity and selectivity of the electroanalytical method.

In this study, the modification of a glassy carbon electrode (GCE) with reduced graphene oxide (rGO) and titanium dioxide (TiO_2) is reported for improved electrochemical detection of hydrogen peroxide. The modification was done to enhance electrochemical properties and sensitivity of bare GC towards H_2O_2. The detailed preparation procedure and characterization of this modified GCE-rGO-TiO_2 electrode will be presented. By modification, the GC electrochemical properties can be enhanced, primarily affording improved sensitivity and selectivity towards H_2O_2. The synthesis and characterization of the modifiers will be discussed, elucidating the integration of rGO and TiO_2 to the electrode surface. Through comprehensive characterization, including cyclic voltammetry and chrono-amperometry, the electrochemical behaviour and sensing capabilities of the modified electrode will be presented. Additionally, the analytical performance of the sensor will be assessed, demonstrating its applicability for real sample analysis. The proposed electrochemical sensor exhibits promising characteristics for H_2O_2 detection, offering improved performance in terms of sensitivity, selectivity, and stability.

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References

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