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Historical Perspective

Graphitic carbon nitride-based electrochemical sensors: A comprehensive review of their synthesis, characterization, and applications

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ABSTRACT

Graphitic carbon nitride (g-C_3N_4) has garnered much attention as a promising 2D material in the realm of electrochemical sensors. It contains a polymeric matrix that can serve as an economical and non-toxic electrode material for the detection of a diverse range of analytes. However, its performance is impeded by a relatively limited active surface area and inherent instability. Although electrochemistry involving metal-doped g-C_3N_4 nanomaterials is rapidly progressing, it remains relatively unexplored. The metal doping of g-C_3N_4 augments the electrochemically active surface area of the resulting electrode, which has the potential to significantly enhance electrode kinetics and bolster catalytic activity. Consequentially, the main objective of this review is to provide insight into the intricacies of synthesizing and characterizing metal-doped g-C_3N_4. Furthermore, we comprehensively delve into the fundamental attributes of electrochemical sensors based on metal-doped g-C_3N_4, with a specific focus on healthcare and environmental applications. These applications encompass a meticulous exploration of detecting biomolecules, drug molecules, and organic pollutants.

1. Introduction

The rapid emergence and evolution of miniaturized devices such as electrochemical sensors with excellent sensitivity and performance have led to their utility in various fields such as environmental monitoring and food quality analysis [1,2]. Due to the rapid growth of the global economy, the exploitation of raw material resources and their effect on the environment has become a significant issue [3,4]. Mitigating these requires the ability to measure the levels of dangerous contaminants that can harm human health and the welfare of all life on earth. The early detection of these contaminants in the water bodies and the environment is crucial. This is currently conducted using traditional techniques such as high-performance liquid chromatography, gas chromatography–mass spectrometry, enzyme-linked immunosorbent assay, thin-layer chromatography, fluorescence microscopy, liquid chromatography-mass spectrometry, and electrochemical sensing [5–12]. Since real-time detection is expensive, time-consuming, and labor-intensive, new low-cost, low-energy technologies are needed. Electrochemical sensors have drawn considerable interest from scientists worldwide due to their low cost, real-time monitoring capability, and simple control. The catalytic conducting interfaces in an electrochemical sensor that interact with the target of interest significantly

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