ABSTRACT

Recently the fast-changing lifestyle and modern facilities are easing life on one side and pose threats in the form of different emerging contaminants from pesticides to personal care products, from industrial chemicals to pharmaceutical compounds and their associated diseases on the other side. Therefore, the need for a cost-effective, selective, sensitive, and user-friendly detection system has not been so prevalent before. In the quest to get a reliable alternative to the already existing detection and monitoring systems, researchers have tried various kinds of nanomaterials. The synthesis of nanomaterials-based artificial enzymes with high activity has recently gained enormous consideration worldwide because of their added advantages over the enzyme-based systems. Natural enzymes are expensive, sensitive to the reaction and environmental conditions, and difficult to handle; however, contrary to these nanomaterials are highly stable, cheap, and easy to prepare and easily customizable and very simple to handle.

Graphitic carbon nitride as being new material gained stupendous attention due to its polymeric structure, semiconducting-nature, photoresponsive properties, high stability, and good-biocompatibility. In the past, graphitic carbon nitride ($g-C_3N_4$) focus remained mainly on its photocatalytic applications, but recently $g-C_3N_4$ (GCN) has shown applications in the sensor and biosensor fields. Besides the remarkable properties of $g-C_3N_4$, there are some limitations as well, which compromise its use, such as surface defects, wide bandgap, and low-specific surface area, the high recombination rate of electron-hole pairs, poor light absorption, and electrical conductivity. Therefore, keeping in view these limitations, the structure of the graphitic carbon nitride requires improvement.

Hydrogen peroxide (H_2O_2) has vital importance due to its widespread use in daily life. Thus, the present study aims are to design and fabricate $g-C_3N_4$ based peroxidase-like catalyst with enhanced activity for hydrogen peroxide detection. Different strategies like soft templates, the influence of metal dopant, or composite formation with metal oxides are reported to improve its properties. During this present study, porous graphitic carbon nitride (PCN), crystalline graphitic carbon nitride (CCN), Zinc doped mesoporous graphitic carbon nitride (Zn-mpg-C_3N_4), tungsten doped graphitic carbon nitride nanoflakes (W/GCN), sponge-like silver oxide/graphitic carbon nitride nanocomposites (Ag_2O/GCN), and coral shaped tin oxide/graphitic carbon nitride nanocomposites (SnO_2/GCN) were prepared through nanostructuring of graphitic carbon nitride. Further, the composition, morphology, and optical properties of newly synthesized nanostructures of g-C_3N_4 were determined using different techniques such as SEM, EDX, TEM, XRD, XPS, FTIR, DRS, Raman, and PLS.

The catalytic activity of the nanostructures was determined by colorimetric and fluorescence quenching techniques. After modification with different dopants and nanomaterials, the synthesized nanostructures showed enhanced catalytic activity in terms of sensitivity, selectivity as compared to pure graphitic carbon nitride. These nanostructures of g-C_3N_4 have shown a lower limit of detection and wide linear ranges as compared to pure g-C_3N_4 based sensors. The present sensing system offers superior advantages like simple handling, facile synthesis, cost-effective precursors, good selectivity, high sensitivity, and rapid-response. Therefore, the synthesized nanostructures exhibit great potential as a promising candidate in enzyme-free detection and monitoring of H_2O_2 in the environmental and biological systems.

KEYWORDS: Graphitic Carbon Nitride; Tin Oxide; Silver Oxide; Tungsten; Zinc; Hydrogen Peroxide; 3,3′,5,5′-tetramethylbenzidine; Rhodamine B; Colorimetric; Fluorescence Quenching; Doping; Peroxidase-Like Activity; Sensor.