ABSTRACT

The research communities, unanimously, have developed a scientific consensus on the teeming multidisciplinary applications of nanosized materials owing to their exceptional optical, antimicrobial, catalytic, cytotoxic and enzyme inhibition properties. Ordinarily, in order to be applied for bio-specific applications, the conventionally prepared nanostructures are subjected to post synthesis functionalization *via* a variety of methods, such as ligand exchange, covalent or non-covalent conjugation. Nevertheless, solvent toxicity, combined with the high temperature and pressure conditions during the preparatory stage and the low product yield due to multiple steps in the functionalization, limit their overall use. Therefore, the biosynthesised nanomaterials are considered as the quintessentially biocompatible and ubiquitously appealing materials.

In this study, cadmium sulphide and molybdenum disulphide quantum dots (CdS and MoS_2 QDs) were prepared anaerobically using soil bacteria, *P. aeruginosa*, where the biomechanism of QDs fabrication revealed the synthesis process to be impacted by cysteine desulfhydrase enzyme expression which catalyses the sulphide synthesis from cysteine, reducing agent in the bacterial growth media. Bacterially prepared CdS QDs were found to exhibit excitation wavelength dependent photoluminescence properties while organically modified MoS_2 QDs were explored in biosensing for ultralow H_2O_2 and glucose detection in picomolar levels.

For carbon based nanomaterials' preparation, methane producing syntrophic anaerobic consortium was utilized for fabricating carbide nanosheets. Here, niobium chloride ($NbCl_5$) was incubated with anaerobic consortium containing *Methanosarcina barkeri* as methanogen. The stepwise preparation of NbC was comprehended using characterization techniques (XRD and UV-Vis absorption spectroscopy). The structural characterization revealed the synthesis of strained sheets which were further examined for their flexoelectric potential for green energy harnessing with a maximum power output of 2.6 mW/m^2 for 8.8 N applied force.

Further, microbially-driven exfoliation of graphite was attempted using Baker's yeast (*Saccharomyces cerevisiae*) for the formation of few layer graphene structure. The exfoliation was studied schematically using microscopic tools where SEM and TEM micrographs revealed the yeast cells attachment to the graphite. The exfoliated structure was further examined using Raman spectroscopy to fathom out the structural characteristics of the prepared graphene structure. The bio-prepared graphene was further applied for ammonium ions sensing where it exhibited a limit of detection up to ~20 ppm.

Keywords: Microbes, green synthesis, nanomaterials, graphene, niobium carbide, sulphide QDs, glucose sensing, flexoelectricity, ammonium ions detection