

DEVELOPMENT OF AN ELECTROCHEMICAL SENSOR WITH TITANIUM DIOXIDE INCORPORATED GRAPHENE QUANTUM DOTS TO DETECT PHENOXYACETIC ACID HERBICIDES

S.D. Rajapaksha^{*} and S. Jayawardena

College of Chemical Sciences, Institute of Chemistry Ceylon, Sri Lanka
**stu205581@student.ichemc.edu.lk*

Graphene quantum dots (GQDs) are well-known for enhancing electrochemical properties. Therefore, GQDs are used in electrochemical sensors for various applications. In this study, a titanium dioxide-graphene quantum dots (TiO₂-GQD) hybrid nanocomposite was developed to detect phenoxyacetic acid (PAA) herbicides. To enhance the electrochemical properties of GQDs, TiO₂ nanorods were incorporated with GQDs. Phenoxyacetic acid herbicides are used to control broadleaf weeds in agriculture. Common PAA herbicides widely used in agriculture include 2-methyl-4-chlorophenoxyacetic acid, 2,4 dichlorophenoxyacetic acid, and 2,4,5-trichlorophenoxyacetic acid. Exposure to PAA herbicides increases the risk of certain cancers, Hodkin's disease and soft-tissue sarcoma. Graphene Oxide (GO) was synthesised via the modified Hummer's method. The GO was subjected to hydrothermal treatments to obtain GQDs. The synthesis of GQD was confirmed by the emission of blue luminescence under UV light. The band gaps for GO and GQD were calculated as 3.9 eV and 4.5 eV. The reduction in particle size from GO to GQD leads to an increase in the band gap due to the quantum confinement effect. The TiO₂ nanorods were synthesised via solvothermal method using titanium tetraisopropoxide as a precursor. The obtained material was characterized using scanning electron microscopy. The average width and length of TiO₂ nanorods are 55.0 nm and 2.5 μm. The sensor was fabricated by modifying a glassy carbon electrode (GCE) using TiO₂-GQD hybrid nanocomposite. Cyclic voltammograms obtained from modified GCE showed sharp and distinct oxidation peaks, while the oxidation peaks in unmodified GCE were either absent or indistinct. The peak current of both modified and unmodified GCE increased with the increasing concentration of PAA. The modified GCE exhibited enhanced sensitivity, stability, and concentration-dependent behaviour for PAA compared to the unmodified GCE, with detectable sensitivity observed at a minimum concentration of 1.30 mM.

Keywords: Electrochemical sensor, Graphene quantum dots, Phenoxyacetic acid herbicides, Titanium dioxide