

ABSTRACT:

The discharge of synthetic dyes from industrial effluents into water bodies poses a significant risk to ecosystems and human health due to their toxicity, carcinogenicity, and resistance to natural degradation. This work explores the development and use of a unique, sustainable nanocomposite for the efficient photocatalytic elimination of these organic pollutants. The composite material was created by combining biochar derived from discarded eggshells with graphene oxide (GO), which is well-known for its enormous surface area and strong charge transfer capabilities. To prevent GO from accumulating, the biochar provides a dispersing support and a porous structure. This combination creates a very effective composite that efficiently breaks down dye molecules using GO photocatalysis after first concentrating them through ESB adsorption. The methyl orange dye is our primary emphasis here. Methyl Orange was 98% degraded by UV-visible spectroscopy, and FTIR verified that azo linkages were broken and that surface carbonyl/hydroxyl groups were involved. Pilot-scale applications using actual wastewater, the creation of immobilized reactor systems, and a thorough toxicity investigation of degradation byproducts should be the top priorities of future research.