Graphene Quantum Dot Based Nanomaterials for Environmental Sensing and Pollutant Photodegradation

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Carbon based nanomaterials such as graphene family and graphitic carbon nitride (g-C_3N_4) are novel materials which can not only serve as a photoelectrochemical catalyst but also act as optical and electrochemical electrode materials for sensing purposes because of their suitable band gap, high surface area, large pore size/volume, and good electrical conductivity. Herein, we report the possible fabrication and application of 0-dimensional graphene quantum dots (GQDs) for sensing, environmental and energy application. GQDs can be fabricated from naturally occurring carbon products like passion fruit juice and citric acid under hydrothermal conditions. The homogeneous and well distributed 5 – 10 nm GQDs can provide both strong fluorescent property as well as accessible electroactive sites and low resistance to accelerate the electrons and electrolyte ions transport, resulting in the excellent performance on optical and electrochemical detection of a wide variety of chemicals like Fe^{3+}, Hg^{2+}, nitrophenols, antibiotics and cancer cells. The combination of GQDs with g-C_3N_4 and Bi_2MoO_6 (NCD@BMCN) exhibits advanced advantages on high photocurrent density and low impedance to facilitate the excellent charge transfer efficiency for the enhanced photodegradation of ciprofloxacin (CIP) via indirect Z-scheme mechanism with GQD as a mediator to transfer electrons from the conduction band of Bi_2MoO_6 to the valence band of g-C_3N_4. Moreover, the influence of environmental parameters like pH, co-ion, and initial concentration on the photocatalytic degradation efficiency was investigated. The possible reaction mechanism as well as degradation pathways was also proposed. Results clearly signify that GQD-based nanomaterial is a promising carbon material with a great application potential in sensing, environmental and energy areas.