Formation of carbon quantum dots and graphene nanosheets from different abundant carbonaceous materials

Monikankana Saikia; Tonkeswar Das; Nikalabh Dihingia; Xing Fan; Luis F. O. Silva; Binoy K. Saikia.

Abstract

Carbon quantum dots (CQDs) and graphene nanosheets (GNs) are one of the most attractive fluorescent carbon nano-sized materials with unique features of optical and physico-chemical properties having various applications in chemical sensing, biomedicine, semiconductor devices, photo-catalyzing, and electrocatalysis. The primary purpose of this preliminary work is the feasibility study for synthesis of nano-structured value-added carbon products i.e., CQDs and GNs from cheap and abundant carbon sources, such as coal, petroleum coke, graphite, and coal-based humic acid by hydrothermal techniques. The physico-chemical properties of the raw precursors were evaluated by proximate and ultimate analysis. High resolution-transmission electron microscopy (HR-TEM), Raman spectroscopy, X-ray photoelectron spectroscopy (XPS), Fourier transforms infrared (FT-IR) spectroscopy, X-ray powder diffractometer (XRD), UV–visible (UV–vis), and fluorescence (FL) spectrophotometer were used to achieve physico-chemical parameters of carbon nanostructures, to better comprehend the development of carbon quantum dots and graphene nanosheets. HR-TEM analysis indicates that the dimensions of the synthesized CQDs from different carbon sources exist in the range of 3–6.5 nm. The approximate quantum yields (QY) of the synthesized carbon nanomaterials were found to be about 2–22%. The synthesized carbon based nanomaterials (i.e. CQDs and GNs) have been efficiently used in the photo-degradation of harmful 2-nitrophenols (2-NP) with the efficiency of 80.79% for CQDs and 82.53% for GNs, respectively. The present study provides a simple and environmentally-sound technique for large-scale fabrication of typical CQDs and GNs from abundantly available low-grade coal and other carbonaceous materials for photo-catalysis application.

Keywords

Carbonaceous materials; Carbon dots; Graphene nanosheet; Fluorescent materials; Hydrothermal treatment; Photocatalytic degradation