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The valorisation of grass waste for the green synthesis of graphene quantum dots for nonlinear optical applications

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Abstract

Electrochemically exfoliated functionalized graphene flakes: Facile synthesis, 3rd order optical nonlinearity and optical limiting response

Abu Bakar, M.A. , Danial, W.H. , Norhisham, N.A.
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The recent years have seen an increase in efforts to develop a simple and less complex method of converting waste materials into graphene nanomaterials. Herein, we present the valorisation of grass waste for the green synthesis of graphene quantum dots (GQDs) using hydrothermal technique. The efficacy of using three different precursors that had been sourced from green waste materials to produce GQDs was investigated; namely, grass waste , and grass waste-derived cellulose, and cellulose nanocrystals. The resulting GQDs were characterised using UV–Vis spectroscopy, fluorescence spectroscopy, Fourier transform infrared (FTIR) spectroscopy, Raman spectroscopy, transmission electron microscopy (TEM), atomic force microscopy (AFM), and X-ray photoelectron spectroscopy (XPS). The UV–Vis analysis revealed the existence of π-π* transition of the C[dbnd]C bond of the GQDs samples while the FTIR results showed the samples contained typical functional groups; such as O–H, C[dbnd]O, and C–O. The surface functionalisation of the GQDs was further corroborated by the XPS analysis. The Raman analysis indicated that the structure of the GQDs was highly functionalised, with a more prominent D-band than G-band indicating a high I_D/I_G ratio. The morphological analyses, which were conducted using TEM and AFM, showed that the particles of the samples were uniform in size and circular in shape. The AFM analysis found that the thickness of the GQDs samples ranged between 0.5 and 2.6 nm, implying that the samples contained 1–3 layers of GQDs. Further analysis using the Z-scan technique indicated that the GQDs exhibited strong nonlinear refraction and nonlinear absorption which holds great promise for nonlinear integrated applications such as optical limiting, optical switching, image transmission, logic devices and mode-locked laser system, and so on. © 2022 Elsevier B.V.

Author keywords

Cellulose; Cellulose nanocrystals; Graphene quantum dots ; Grass waste ; Green synthesis ; Z-scan

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