PHYSICOCHEMICAL STUDY OF HIGHLY POROUS g-C_3N_4 NANOSHEETS WITH SUPERIOR ADSORPTION CAPACITY

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ABSTRACT

Graphitic carbon nitride (g-C_3N_4) has been considered as a promising metal-free semiconductor for sustainable environmental applications due to its unique physicochemical properties [1]. The classic thermal condensation of low-cost carbon and nitrogen-based precursors results in the production of bulk g-C_3N_4, which however displays several shortcomings for environmental remediation, including low specific surface area, insufficient visible light utilization, and more importantly, rapid recombination of photogenerated charge carriers as a result of bulk structural defects due to layers' stacking [2]. So, in order to diminish these setbacks, the stacked layers are separated through exfoliation processes. An effective method of transforming bulk g-C_3N_4 into thin-layer g-C_3N_4 nanosheets could lead to increased specific surface area, enhanced physicochemical properties and high adsorption capacity [3].

In the present work, highly porous g-C_3N_4 nanosheets were prepared via thermal polycondensation of melamine followed by thermal exfoliation. A comparative study of bulk g-C_3N_4 and porous g-C_3N_4 nanosheets was carried out by employing extensive characterization tools to probe their structural, optical and physicochemical properties, namely, N_2 adsorption at –196 °C, TGA, AFM, XRD, SEM/ TEM, UV–Vis DRS, XPS, Raman and FTIR spectroscopy. The results revealed the formation of highly porous g-C_3N_4 nanosheets with a well-oriented structure and above-average chemical stability. The as-synthesized g-C_3N_4 nanosheets possess a large surface area of 212 m^2/g as opposed to 10 m^2/g of the respective bulk material. Both bulk and porous g-C_3N_4 nanosheets were evaluated as adsorbents using cationic methylene blue (MB), with the latter exhibiting ca. 2 times higher adsorption capacity at alkaline pH. The superior adsorptive properties of the as-prepared material can be well interpreted on the basis of their improved physicochemical and structural properties as compared to the bulk g-C_3N_4.

KEYWORDS: g-C_3N_4 nanosheets, thermal exfoliation, ζ potential, adsorption capacity

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