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Ultrathin Graphitic Carbon Nitride Nanosheet as Highly Effective Adsorbent for Calcium Ion: Adsorption Kinetics and Equilibrium Studies

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ABSTRACT

Ultrathin graphitic carbon nitride (g-C_3N_4) nanosheets, due to their interesting two-dimensional graphene-like structure and unique physicochemical properties, have attracted great research attention recently. Here, we develop a new approach to prepare ultrathin g-C_3N_4 nanosheets by sonication-exfoliation of bulk g-C_3N_4. Calcium is an essential macronutrient required for healthy human life. It is abundantly present in water. Efficiency of ultrathin graphitic carbon nitride nanosheet in removal of calcium is not known. Hence, the present work analysed adsorption kinetics of calcium from aqueous solution by using ultrathin graphitic carbon nitride nanosheet in batch culture methods.

The effect of initial calcium concentration, temperature, and adsorbent mass on calcium removal was tested. The process of calcium adsorption followed pseudo second-order rate expression and obeyed the Langmuir's model with high correlation coefficient. The results indicate that ultrathin graphitic carbon nitride nanosheet is a potential adsorbent for calcium, as evident by its high calcium adsorption value under optimal culture conditions.

Keywords: Adsorption, Isotherms, Graphitic carbon nitride nanosheet, Calcium ion

1. INTRODUCTION

Intensive research on carbon nitride materials has been arisen since the prediction drawn by Liu and Cohen that carbon nitrides have potential to be the ultra-hard materials. With a wealth of attractive properties such as reliable chemical and thermal endurance, super hardness, low density, wear resistance, water resistivity and biocompatibility, carbon nitrides become one of the most promising materials for surface modification, light emitting device, photo catalysis, etc. Among various analogues, graphitic carbon nitride (g-C_3N_4) constructed via tri-s-triazine units is considered as the most stable allotrope in ambient environment. However, low energy conversion efficiency still restricts its further development. There-fore, carbon nitrides, an analogue of graphite with special electronic properties, have been a candidate of new photo catalyst in recent years.

Nanosheets obtained by the delamination of layered compounds have been recognized as a novel class of nanostructured materials due to their unique structural feature of ultimate two-dimensional anisotropy with extremely small thickness in nanometer and even sub nanometer scale [1].

As for photocatalysts, nanosheets are extremely advantageous for promoting photocatalysis efficiency. The apparent advantages associated with nanosheets include large specific surface area for providing abundant reactive sites and short bulk diffusion length for reducing the recombination probability of photoexcited charge carriers. The effectiveness of these advantages in improving photocatalytic activity has been primarily demonstrated in several photocatalysts such as ZnO, TiO_2, $Ba_5Ta_4O_{15}$ [2]. Therefore, it is worth anticipating that the nanosheets of g-C_3N_4 will give excellent photocatalytic activity. Bulk g-C_3N_4 has been historically considered to have a similar layered