



Quick and low cost synthesis of sulphur doped carbon dots by simple acidic carbonization of sucrose for the detection of Fe³⁺ ions in highly acidic environment



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ABSTRACT

An easy, facile, low cost and quick synthesis of sulphur doped carbon dots (S-C-dots) was carried out by acidic carbonization of sucrose (carbohydrate) without using any sophisticated instrument. The resultant S-C-dots shows excellent photoluminescent behaviour in highly acidic media with a quantum yield of 5.77%. Moreover, the as synthesized S-C-dots can be used as a dual probe for selective detection of Fe³⁺ ions in highly acidic conditions by Fluorescence as well as UV–vis spectroscopy. Also, the residual waste generated during the synthesis of S-C-dots can be used as an activated carbon (AC) for the application in dye adsorption from aqueous solutions.

1. Introduction

Carbon nanomaterials (CNM's) have a unique place in nanoscience owing to their optical [1,2], electronic [2,4], and biocompatible properties [5,6]. Fluorescent carbon nanoparticles or carbon dots are a new class of carbon nanomaterials that have emerged recently which can act as potential competitors to conventional semiconductor quantum dots [1]. The synthesis of carbon dots is simple, cost effective and environment friendly which avoids the use of toxic materials and complex reaction conditions. Besides that, nature provides us countless sources for the synthesis of new carbon nanomaterials with splendid properties. Carbon dots show promising applications in the fields of chemical sensing [1,7], bio-sensing [6], bio-imaging [8], photocatalysis [2] and electrocatalysis [9,10] due to their comparable optical properties, low toxicity, environmental friendliness, low cost and simple synthetic routes [1–3]. Furthermore easy surface passivation, functionalization [11] and doping of carbon dots with heteroatoms such as sulphur, nitrogen and phosphorus [12,13] allow for the control of their physico-chemical and optical properties.

In the area of sensing, it is very important to develop cost effective nanodevices with novel properties. Due to importance of metal ions fundamental role in a wide range of biological processes and aquatic environment, the development of metal ion sensors with high

sensitivity and selectivity is necessary. A good sensor should have the ability to sense with least possible error irrespective of the external environment in which it is placed.

In this work we focus on the development of sulphur doped carbon dots (S-C-dots) as a fluorescent as well as UV–Vis spectrophotometric probe for the sensing of Fe³⁺ ions in highly acidic environment and application in pH sensing. Along with that, we additionally report the concurrent preparation of activated carbon as an adsorbent material for the adsorption of dye in aqueous solutions. The proposed method is simple, cost effective and environmental friendly where residual waste that is activated carbon formed during the synthesis of S-C-dots can be utilized in the process of water purification. This strategy does not require any complex instruments for the synthesis of S-C-dots in brief timeframe.

2. Experimental

2.1. Chemicals and reagents

Sucrose was purchased from Molychem, Mumbai. Boric acid, citric acid, trisodium orthophosphate, MgCl₂, KCl, NaCl, AlCl₃, FeCl₃, FeSO₄, NiCl₂, Pb(NO₃)₂, CoCl₂, CuCl₂, BaCl₂, CaCl₂, quinine sulphate, sulphuric acid were received from s d fine-chem, Mumbai. All chemical

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