Materials Chemistry and Physics 189 (2017) 12–21

Contents lists available at ScienceDirect

Materials Chemistry and Physics

journal homepage: www.elsevier.com/locate/matchemphys

Unprecedented nitrate adsorption efficiency of carbon-silicon nano composites prepared from bamboo leaves

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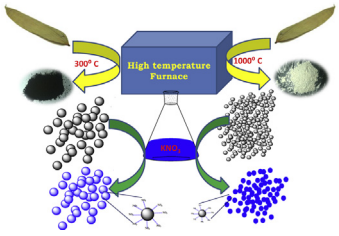
HIGHLIGHTS

- CSNCs prepared form Bamboo leaves were used for nitrate removal.
- CSNCs also efficient in removal of Cl^-, F^- and SO_4^- ions.
- Adsorption of nitrate on CSNCs was confirmed by FTIR RAMAN and XPS.
- Mechanism was confirmed by Raman Spectroscopy and XPS as physisorption.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 3 October 2016
Received in revised form
6 December 2016
Accepted 12 December 2016
Available online 18 December 2016

Keywords:
Carbon material
Nanocomposites
Carbonization
Nitrate removal
Bioresource
Eco-friendly

ABSTRACT

We report the effective synthesis of carbon-silicon nano composites (CSNCs) from silica rich bamboo leaves using the carbonization method and validate their nitrate adsorption ability. The indigenously synthesized carbon materials were characterized via FESEM and XRD analysis. Nitrate ion adsorption efficiency of CSNCs (45.35%) was 2.06 fold (45.35%) higher than their bulk counterparts. The nitrate adsorption mechanism on the CSNCs was further investigated using FTIR, RAMAN and XPS spectroscopic analysis and the results revealed that the CSNCs could adsorb nitrate ions onto their surfaces through physisorption. .

1. Introduction

Anthropogenic activity, quite often discharges numerous toxic chemicals along with other biologically essential life sustaining chemical compounds in excessive levels, causing a wide variety of adverse effects on environments which in turn ultimately affect human beings. Nitrogen based compounds, in particular nitrates, are one among them and they are released into the environment from various sources such as chemical fertilizers, discharge from farmlands, domestic and industrial waste water etc., [1,2]. At excessive levels, nitrate is a direct threat to human beings by causing diseases such as cyanosis and cancer of the

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http://dx.doi.org/10.1016/j.matchemphys.2016.12.032
0254-0584/

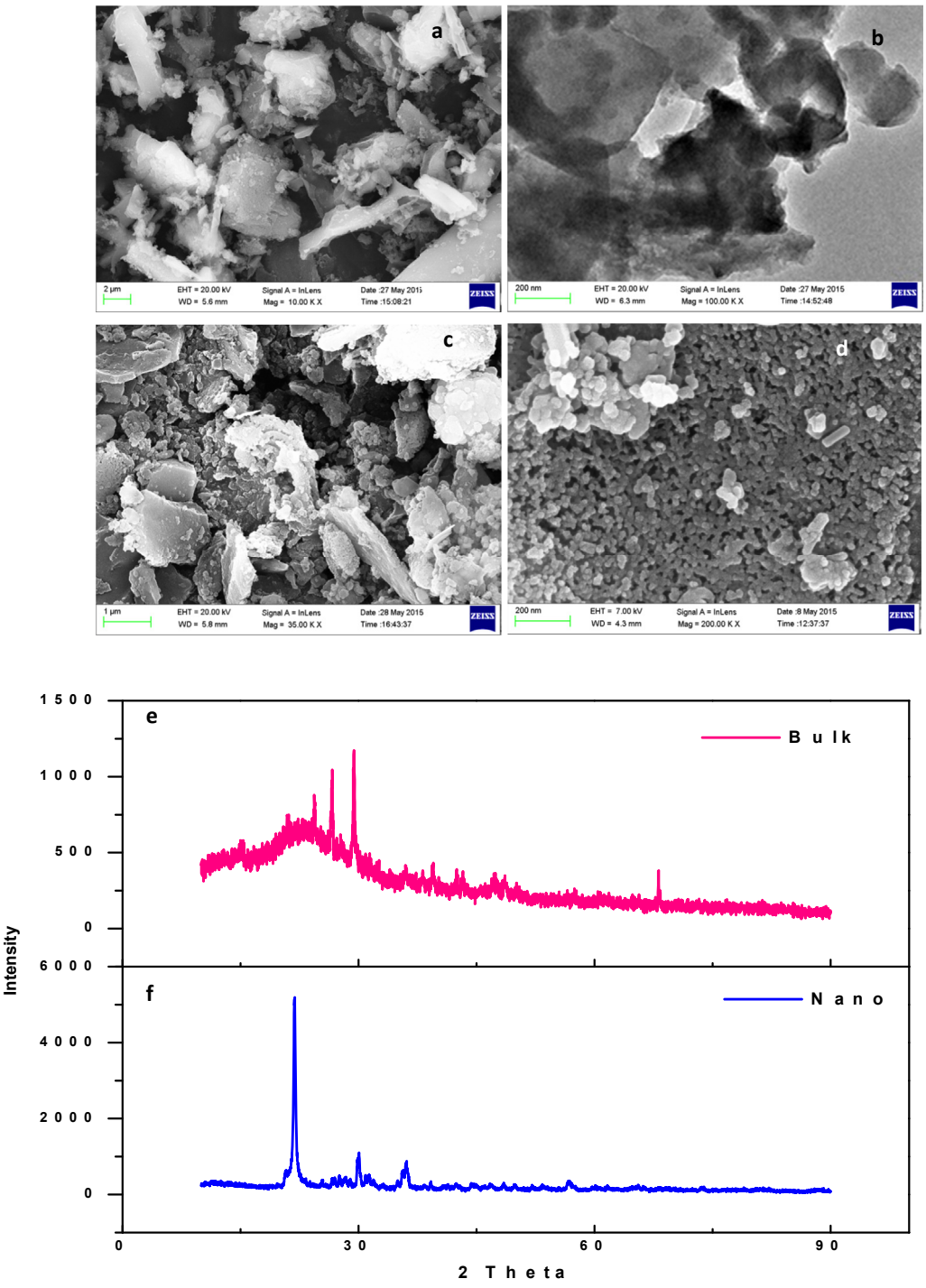

Fig. 1. FESEM images of carbon silicon composites obtained from leaves of *B. vulgaris* after carbonization. Morphology at (a) 300 °C for 4 h at micrometer scale (b) 300 °C for 4 h at nanometer scale; (c) 1000 °C for 4 h at micrometer scale; (d)1000 °C for 4 h at nanometer micro meter scale; (e) XRD analysis of CSBCs prepared at 300 °C; (f) XRD analysis of CSNCs prepared at 1000 °C.

alimentary canal [3,4]. In addition to that, nitrate pollution indirectly affects humans by causing eutrophication through which it depletes oxygen and causes the death of a variety of aquatic animals, as a result, the food web will be totally altered [3,5,6]. Therefore, to control the nitrate toxicity, either its usage should be minimized or the excess nitrate should be removed before it imposes its toxicity on human.

The toxicity of nitrate in water is a very serious concern due to its ability to contaminate various bio entities. Therefore, for the removal of nitrate from water, various techniques such as ion exchange, reverse osmosis and electro dialysis had been practiced [4]. Through the ion exchange process, along with nitrate, other anions also get removed and cause problems during the resin regeneration process. Although, reverse osmosis is considered to be advantageous over other methods of nitrate removal, since it separates and concentrates the nitrate ions without altering its molecular structure, cost effectiveness is its major limitation. Biological denitrification process is a superior