Chemosphere 308 (2022) 136450

Contents lists available at ScienceDirect

Chemosphere

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

Novel magnetic Fe@NSC nanohybrid material for arsenic removal from aqueous media

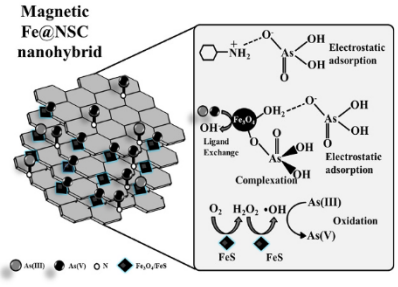
Pandi Kalimuthu [a], Youjin Kim [b], Muthu Prabhu Subbaiah [c], Byong-Hun Jeon [c], Jinho Jung [b,*]

[a] BK21 FOUR R&E Center for Environmental Science and Ecological Engineering, Korea University, 145 Anam-ro, Seongbuk-gu, Seoul, 02841, South Korea
[b] Division of Environmental Science and Ecological Engineering, Korea University, 145 Anam-ro, Seongbuk-gu, Seoul, 02841, South Korea
[c] Department of Earth Resources and Environmental Engineering, Hanyang University, 222 Wangsimni-ro, Seongdong-gu, Seoul, 04763, South Korea

HIGHLIGHTS

- Iron-modified carbon, nitrogen, and sulfur nanohybrids (Fe@NSC) were synthesized.
- The Fe_3O_4/FeS nanoparticles in the Fe@NSC play a key role in As adsorption.
- Electrostatic attraction, ligand exchange, and surface complexation are proposed.
- Arsenite oxidation to less toxic arsenate was identified on the Fe@NSC nanohybrid.
- The Fe@NSC nanohybrid is an efficient, safe, and magnetic adsorbent for As removal.

GRAPHICAL ABSTRACT



ARTICLE INFO

Handling Editor: Yasser Vasseghian

Keywords:
Adsorption
Arsenic
Magnetic nanohybrid
Polyaniline-derived carbon

ABSTRACT

Polymer-derived carbon nanohybrids present a remarkable potential for the elimination of water pollutants. Herein, an Fe-modified C, N, and S (Fe@NSC) nanohybrid network, synthesized via polymerization of aniline followed by calcination, is used for As removal from aquatic media. The Langmuir isotherm and pseudo-second-order kinetic models fit well the experimental data for the adsorptive removal of As(III) and As(V) by the as-synthesized Fe@NSC nanohybrid, indicating that adsorption is a monolayer chemisorption process. The maximum adsorption capacities of the fabricated Fe@NSC nanohybrid for As(III) and As(V) were 129.54 and 178.65 mg/g, respectively, which are considerably higher than those reported previously for other adsorbents. In particular, the Fe_3O_4/FeS nanoparticles (18.4–38.7 nm) of the prepared Fe@NSC nanohybrid play a critical role in As adsorption and oxidation. Spectroscopy data indicate that the adsorption of As on Fe@NSC nanohybrid involved oxidation, ligand exchange, surface complexation, and electrostatic attraction. Furthermore, the magnetic Fe@NSC nanohybrid was easily separated after As adsorption using an external magnet and did not induce acute toxicity (48 h) in *Daphnia magna*. Moreover, the Fe@NSC nanohybrid selectively removed As species in the presence of competing anions and was effectively regenerated for up to three cycles using a 0.1 M

Abbreviations: APS, ammonium persulfate; BET, Brunauer–Emmett–Teller; DI, deionized water; EDX, energy-dispersive X-ray spectroscopy; FTIR, Fourier-transform infrared; HRTEM, high-resolution transmission electron microscopy; MCL, maximum contaminant level; NSC, N-and-S-rich carbon; PANI, polyaniline; pH_{pzc}, point of zero charge; PTFE, polytetrafluoroethylene; PXRD, powder X-ray diffraction; SEM, scanning electron microscopy; XPS, X-ray photoelectron spectroscopy.

* Corresponding author.
E-mail address: jjung@korea.ac.kr (J. Jung).

https://doi.org/10.1016/j.chemosphere.2022.136450
Received 26 April 2022; Received in revised form 27 July 2022; Accepted 11 September 2022
Available online 14 September 2022