Removing Arsenic from Drinking Water Using Nanomaterials

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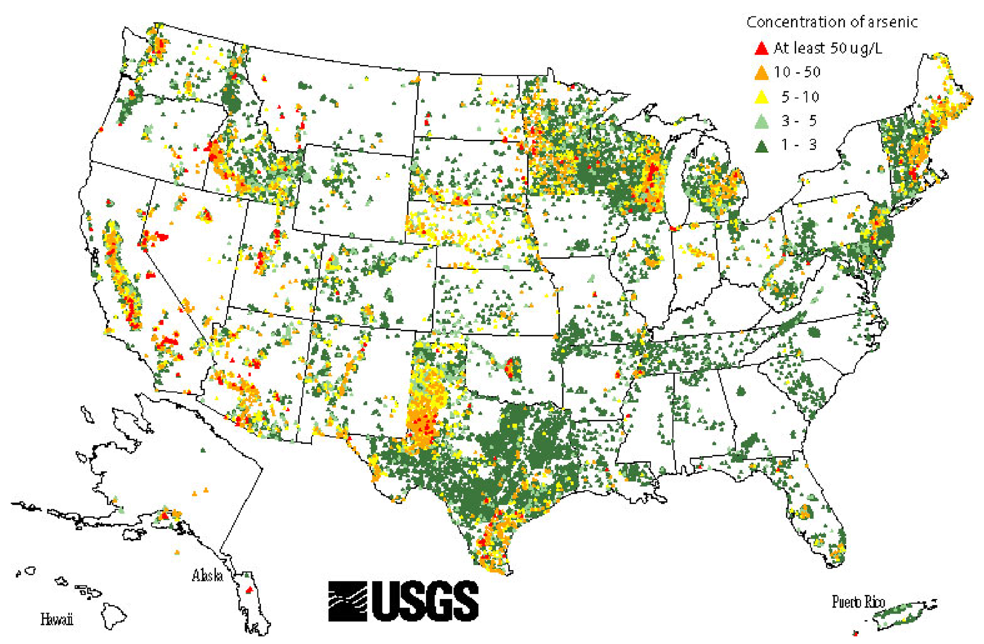
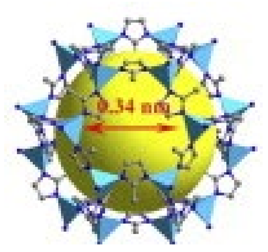
Introduction

- According to the World Health Organization, long-term exposure to arsenic from drinking-water is linked to: cancers, skin lesions, heart disease and diabetes.[1]
- Added to this, exposure to arsenic at low levels (<10ppb) during pregnancy and early childhood can interfere with cognitive development and increase mortality rates among young adults.[2]
- Millions of people worldwide are exposed to drinking water that is contaminated with Arsenic.[1]



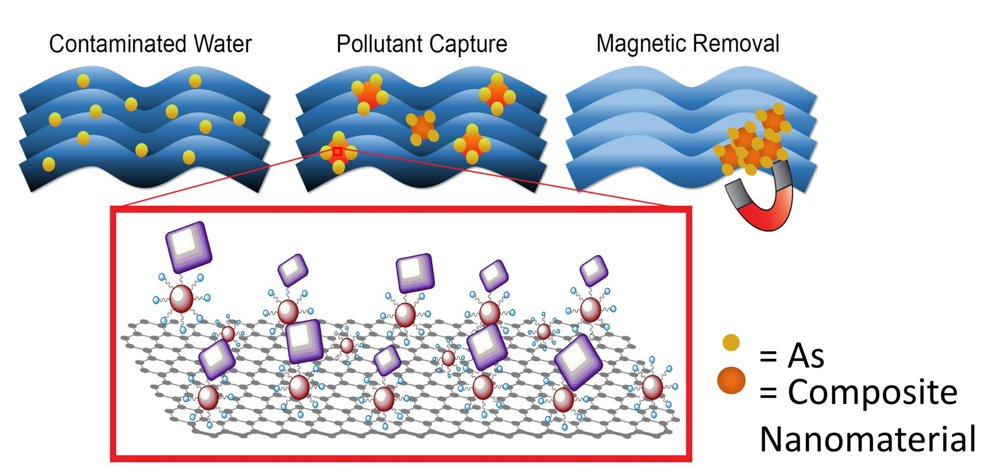
- Concentration of arsenic in groundwater exceeds 50ppb in many areas of West Texas and Southern Texas.
- EPA Standards for Arsenic in drinking water not to exceed 10ppb.

- Zeolitic imidazolate framework with a Zn core (ZIF-08) has shown high affinity and adsorption capacity (75.6 mg/g)[3] towards arsenic.

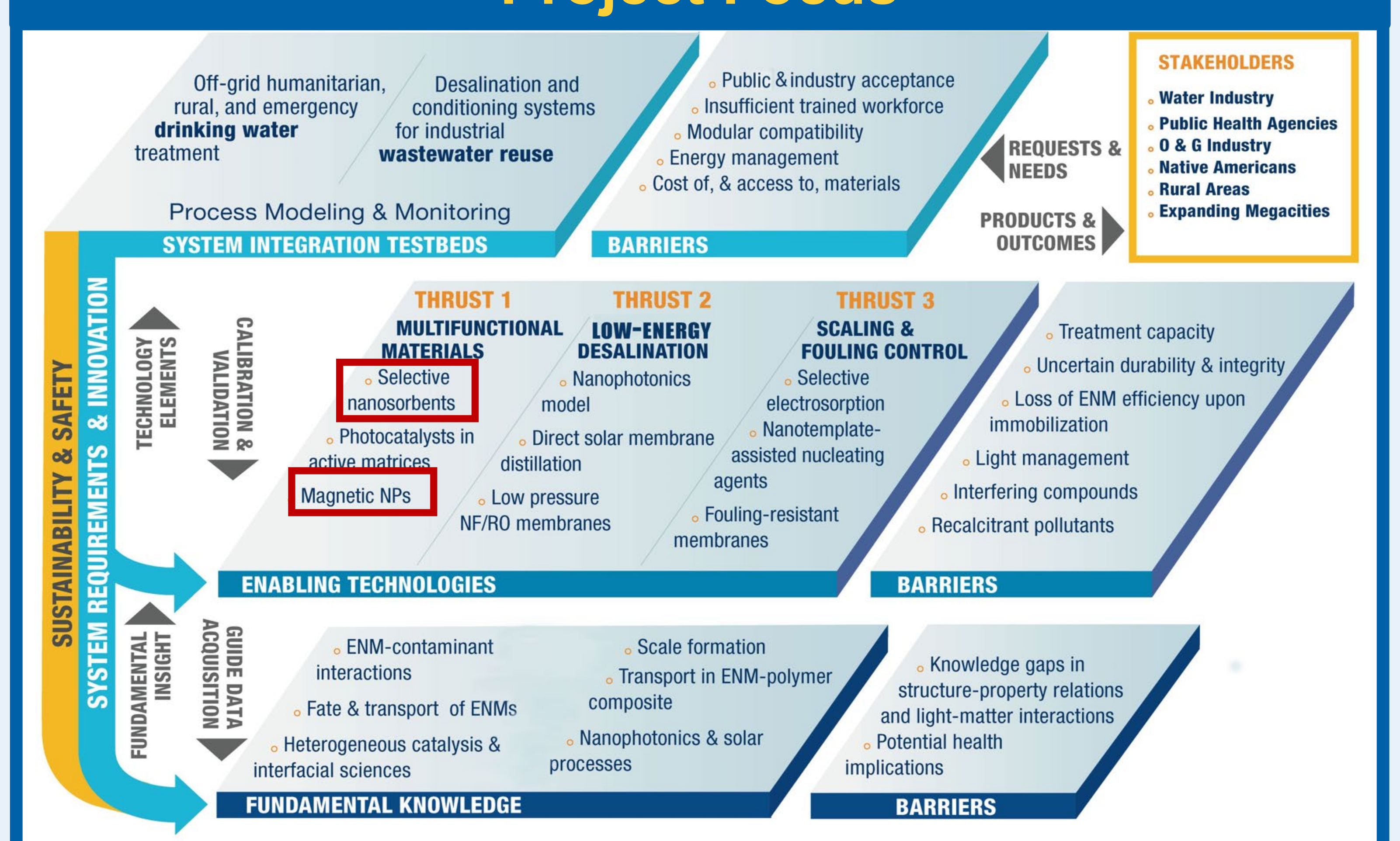


Experimental Design

Facilitating recovery post-adsorption treatment remains a challenge, therefore, supporting the ZIF-08 in a magnetically recoverable platform (graphene oxide + Fe_3O_4 nanoparticles) and testing its arsenic adsorption capacity is the aim of the present work.



Project Focus



Nanomaterials and Syntheses

1. Magnetite (Fe_3O_4)

$$FeCl_3 \cdot 6H_2O + FeCl_2 \cdot 4H_2O + 8NH_4OH \longrightarrow Fe_3O_4 + 8NH_4Cl + 20H_2O$$

2. Graphene Oxide (GO)

$$\text{Graphite} + 6KMnO_4 \longrightarrow \text{Graphene Oxide}$$

3. Zeolitic imidazolate framework-8 (ZIF-08)

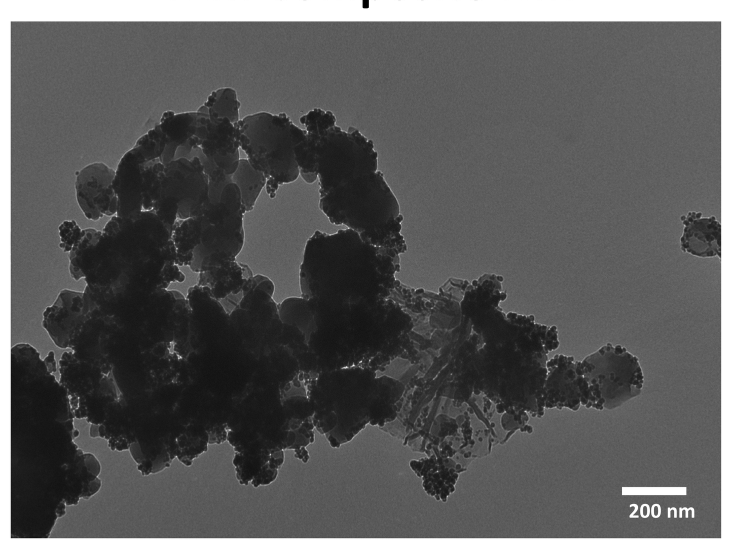
$$Zn(NO_3)_2\ 6H_2O + 2\ \text{MIM} \longrightarrow \text{ZIF-08}$$

4. Nanocomposite

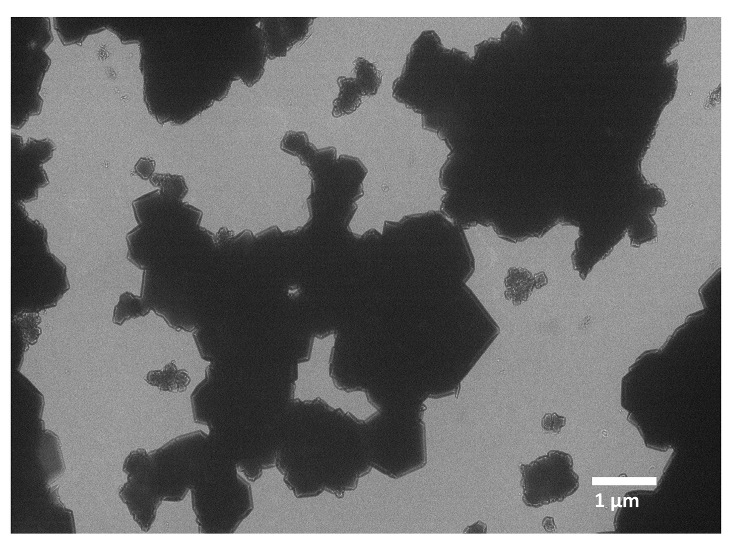
$$Fe_3O_4/GO + \text{ZIF-08} \longrightarrow Fe_3O_4/GO/ZIF\text{-}08$$

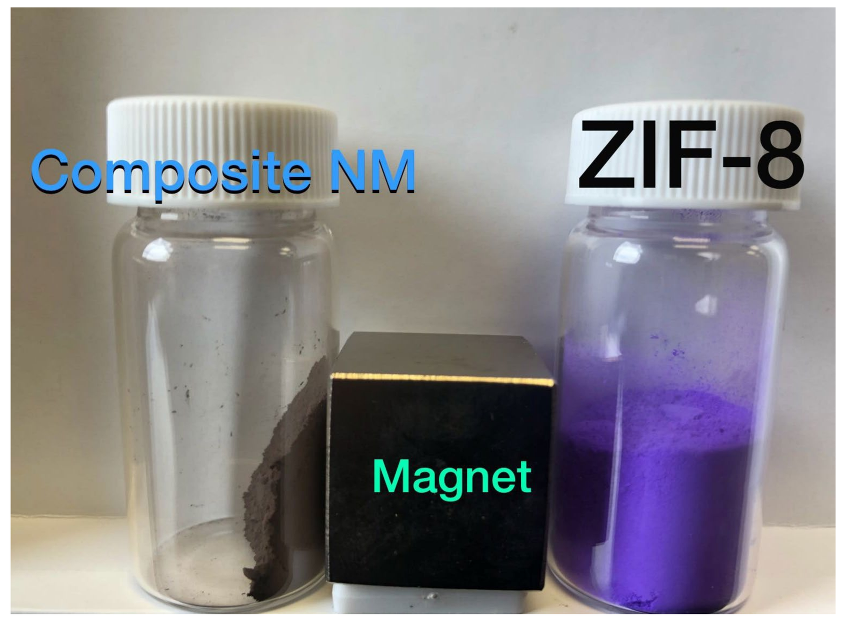
Characterization

TEM Composite NM



TEM ZIF-8

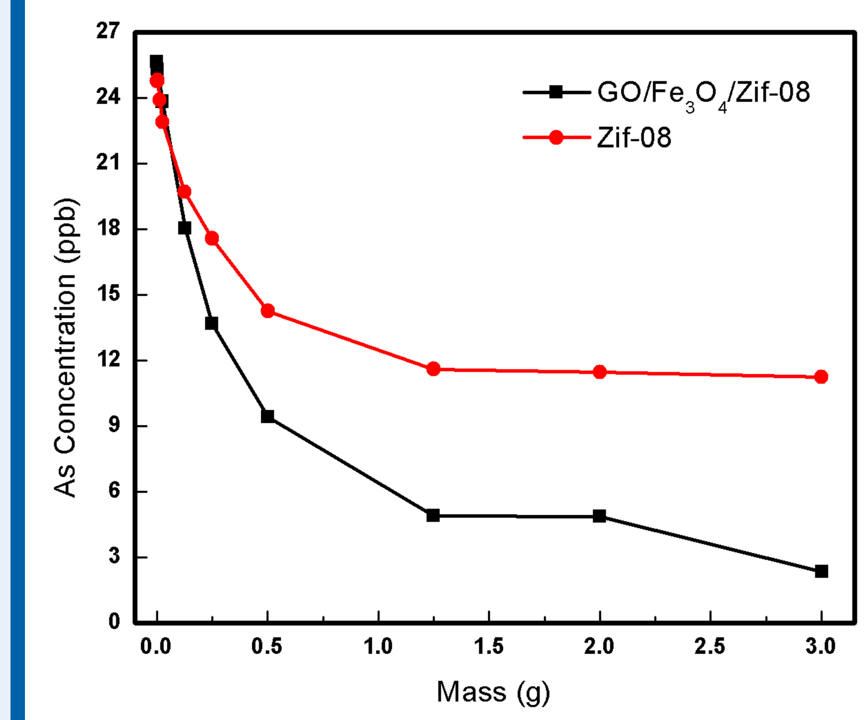




Experimental Procedure

1. Challenged "NEWT fresh water" matrix of 35 ppb As was prepared.
2. A range of 10 different masses of both materials were tested in 0.5 L of As contaminated fresh water.
3. Samples were left to reach equilibrium for 3 days.
4. Arsenic concentration was evaluated through ICP-MS.

Results: Comparison of Adsorption Capacity of Composite Material vs ZIF-08

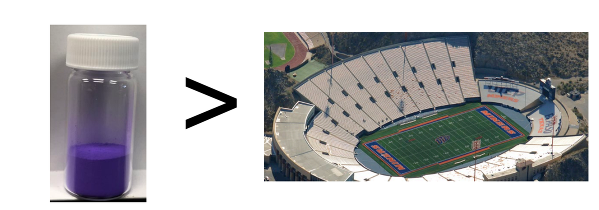


The adsorption graph shows a comparison of the arsenic adsorption of both materials at masses ranging from 0.00125 g to 3.0 grams.

Arsenic concentration (ppb) vs. mass (g) of composite nanomaterial (GO/Fe_3O_4/ZIF-08) (black) and ZIF-08 (red).

Nanomaterial	BET Surface Area (m^2/g)
GO	600
Fe_3O_4	112.2470
ZIF-08	2011.4757
Composite nanomaterial	1476.6804

The surface area of 5g of composite nanomaterial (7,480 m^2)is greater than the area of a football field (5,351 m^2).



Conclusion

- TEM images show how ZIF-08 was successfully immobilized in a GO/Fe_3O_4 platform.
- The composite nanomaterial removed 91.42% of the arsenic in "NEWT fresh water" matrix while ZIF-08 removed 60.7%. This shows a significant difference which we attribute to the enhanced surface area of the composite obtained from both the GO and the Fe_3O_4 nanoparticles. Added to this the composite shows a magnetic recovery functionality due to the superparamagnetic character of the nanoparticles.
- In conclusion, adsorption results show that supporting ZIF-08 in a magnetic platform (GO/Fe_3O_4) not only facilitates recovery of the post-adsorption treatment material but also enhances the adsorption capacity towards arsenic around 30%

References

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Acknowledgements

I would like to thank Dr. Ariel Atkinson, and National Science Foundation, funding code EEC-1449500