



Cellulose nanofibrils and iron oxide-based nanoparticles adsorbent for arsenic removal from drinking water

Md Musfiqur Rahman¹, Islam Hafez¹, Mehdi Tajvidi¹, Aria Amirbahman²

¹School of Forest Resources, University of Maine, Orono, ME 04469

²School of Engineering, Santa Clara University, CA 95053

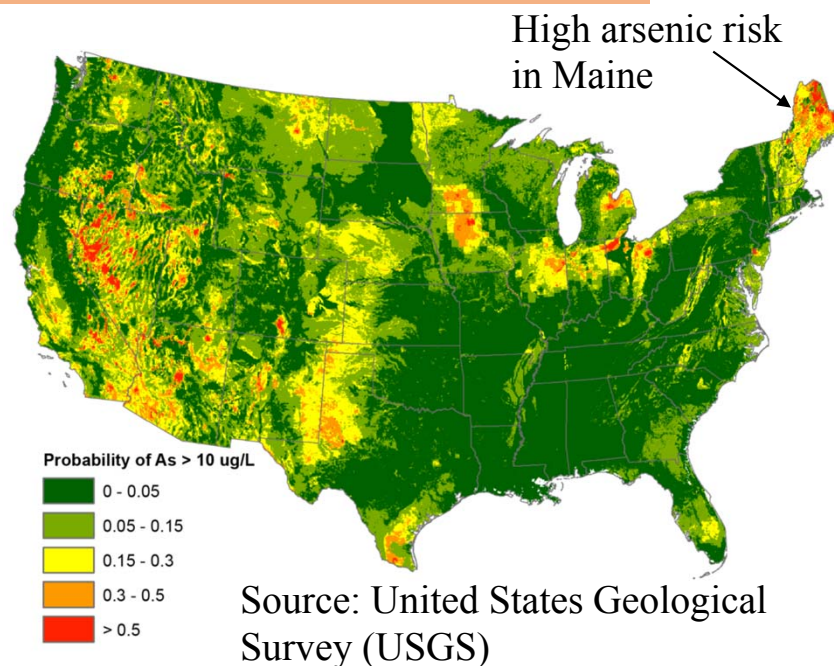
Presenter email: md.musfiqur.rahman@maine.edu

TAPPI Nano 2021 Virtual Conference
15-16 June 2021



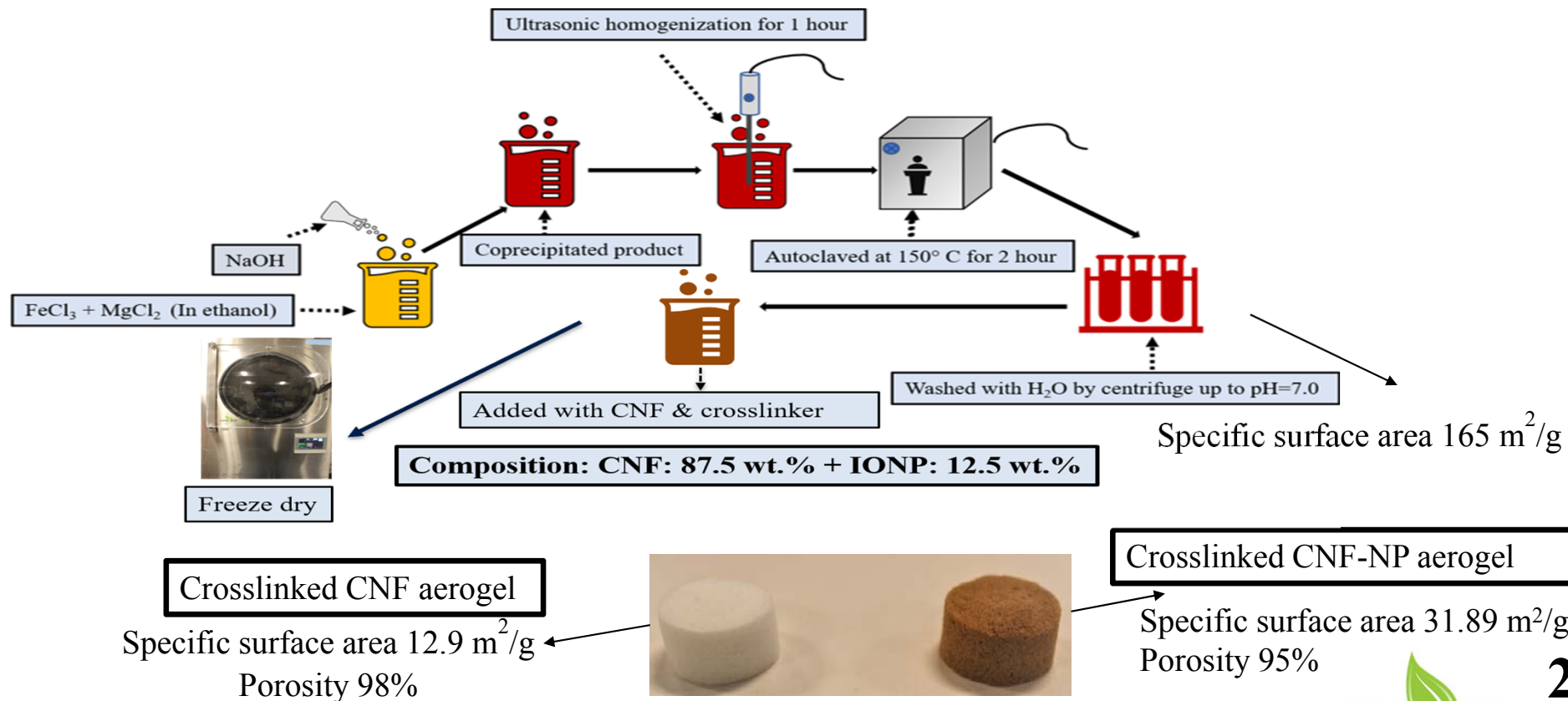
Background

- ❑ Arsenic is a highly toxic element occurring naturally in ground water and is associated with severe health effects.
- ❑ Maximum permissible limit: $10\text{ }\mu\text{g/L}$ (WHO & US-EPA)
→ Naturally-occurring arsenic is commonly found in Maine well water at concentrations higher than $10\text{ }\mu\text{g/L}$.
- ❑ Iron oxides have high affinity towards arsenic adsorption but the tendency to aggregation, problem of separation and large-scale application is the drawback

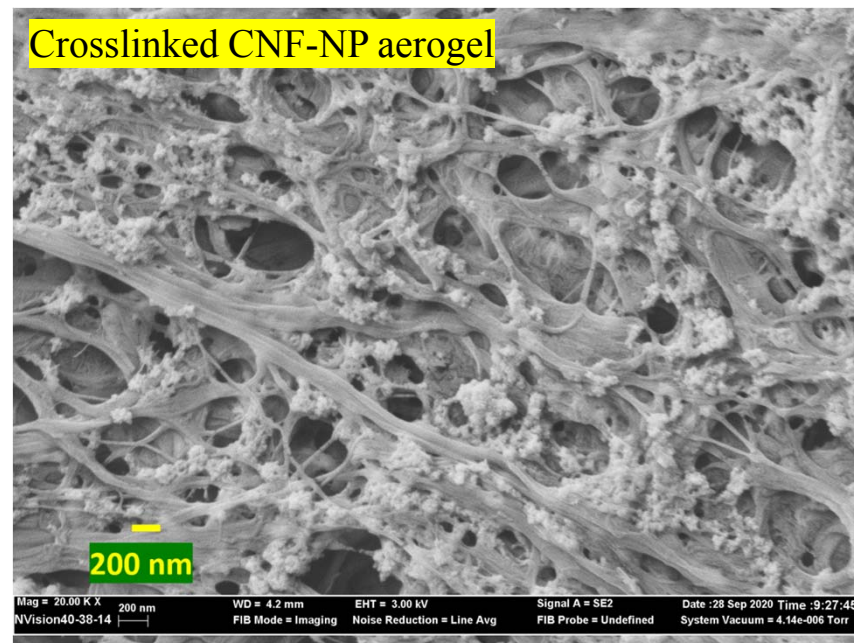
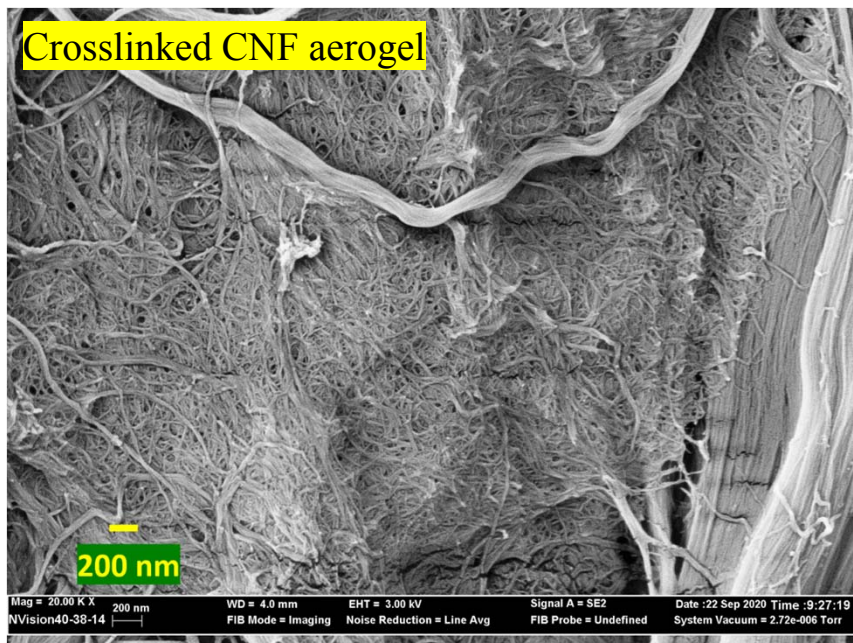


The motivation is to overcome these challenges through using cellulose nanofibrils (CNF) for continuous fixed-bed columns in large-scale applications of **iron oxide NP adsorbents**.

Preparation of CNF-IONP composite aerogel



Scanning Electron Microscopy (SEM)



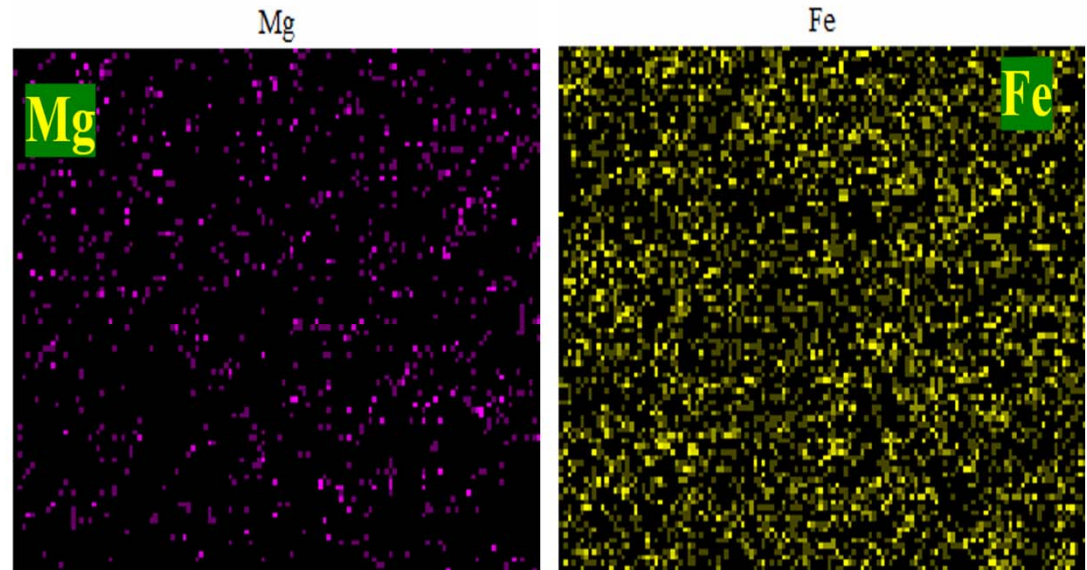
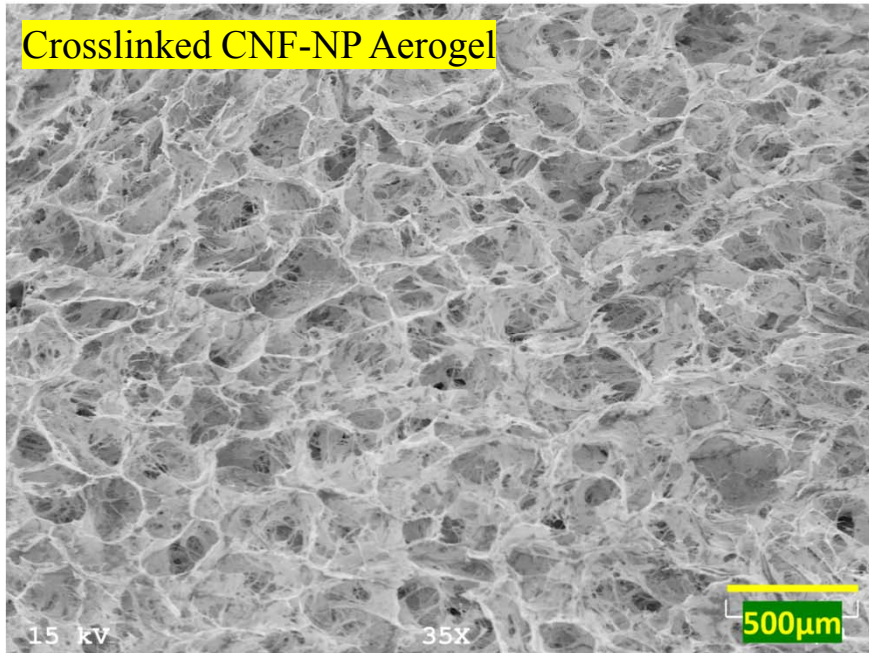
Homogeneous distribution of NPs on CNF surface

Iron oxide NPs are nano sized – aggregated but still good distribution throughout the fibrils

TAPPI Nano 2021 Virtual Conference
15-16 June 2021

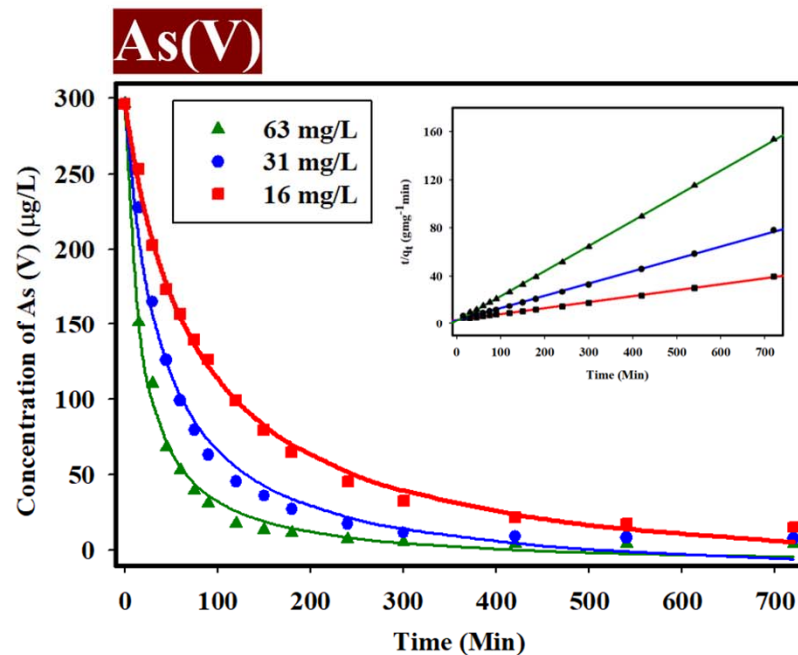
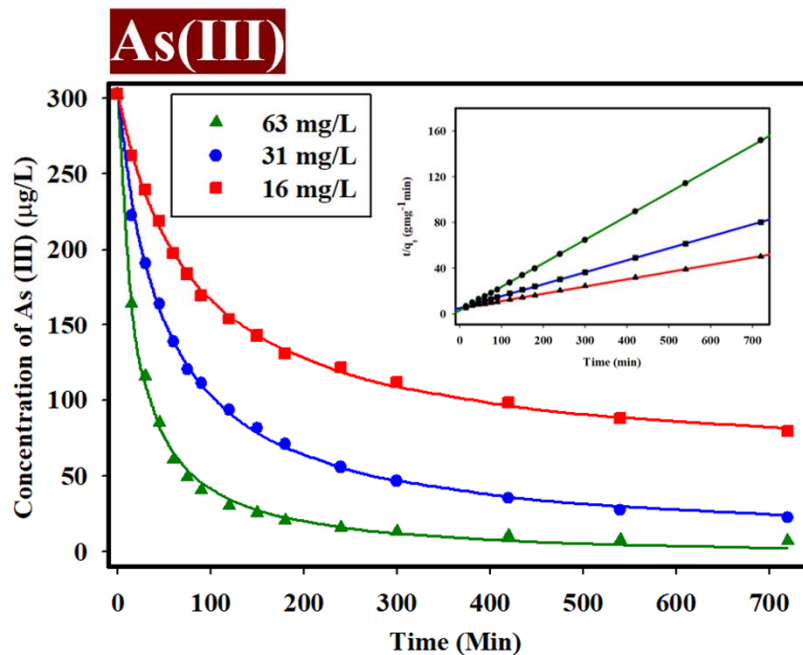


Energy Dispersive Spectroscopy (EDS)



Elemental analysis that proves the presence of Fe, Mg with homogeneous distribution of NP throughout CNF surface

Arsenic adsorption kinetics and Fe leaching



Both As(III) and As(V) follows Pseudo 2nd Order kinetic model where a very insignificant amount of Fe was leached from the CNF-NP aerogel.

pH effect and adsorption Isotherm

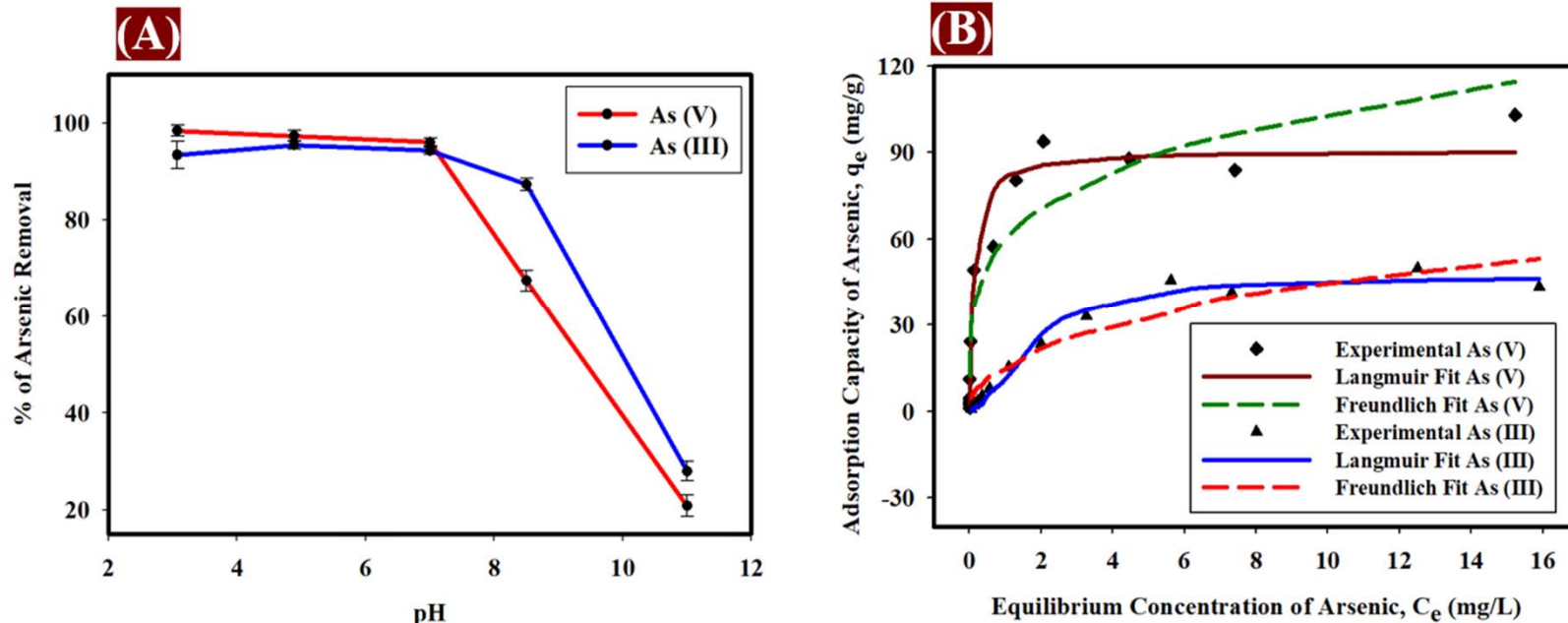


Figure (A): Both arsenic species showed high removal efficiency in a wide range of pH

Figure (B): Maximum adsorption capacity of As(III)~ 48 mg and As(V)~ 91 mg per gram of iron oxide NPs in CNF-NPs aerogel



Field demonstration

- ❑ Ongoing work involves the preparation of a prototype to be tested on site at our industrial collaborator (A.O. Smith Corp., WI, USA)
- ❑ Preliminary experiments on the column study have shown promising results.

Acknowledgement



United States
Department of
Agriculture



THE UNIVERSITY OF
MAINE

Thank you !

Questions?

TAPPI Nano 2021 Virtual Conference
15-16 June 2021

