Novel Graphene-Based Composite Materials for Management of HABs

Lead: Luke Gurtowski, ERDC, Luke.A.Gurtowski@usace.army.mil

USACE Harmful Algal Bloom Research & Development Initiative

Delivering scalable freshwater HAB prevention, detection, and management technologies through collaboration, partnership, and cutting-edge science.

Problem

Harmful algal blooms (HABs) caused by cyanobacteria and other algal species annually cause water quality concerns in domestic waterways throughout the Nation that damage human health, environmental security, and various industries, including tourism and fishing. Current solutions for HABs are limited. Therefore, sustainable technologies must be developed and tested to ensure management of HABs to protect water quality nationwide for prolonged use and welfare.

Objective

This effort aimed to evaluate the efficacy of a materials-based approach for management of HABs. Innovative polymer composites were fabricated using graphene-based materials and chitosan, a derivative of the world's second-most abundant biopolymer, chitin. Removal capacities and rates for various algal species and toxins related to HABs were analyzed following introduction to materials developed for this study to understand interactions and fully determine performance for this application.

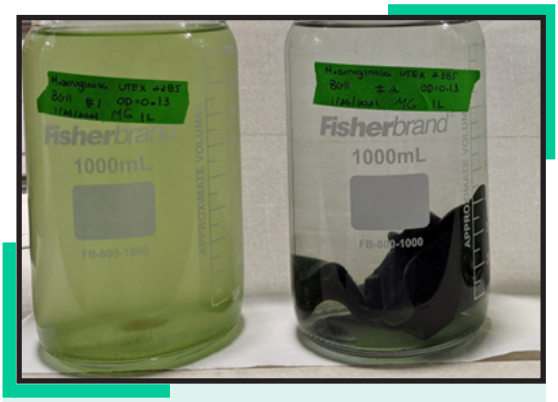

Figure 1. *(Left) Untreated sample, and (right) treated sample.*

Approach

Evaluations were conducted at various scales with novel technologies prepared for HAB management strategies. Individual solutions containing different algal monocultures, including freshwater species with varying degrees of toxicity, were assessed while in contact with composite materials developed utilizing a patented wet-casting technique in addition to related base materials as comparative treatment technologies. Toxins produced by certain algal cultures were also tested following introduction to the technologies included in this study to analyze their removal performances. These assessments were conducted initially at laboratory scale, and favorable technologies were further tested at small pilot scales.

Major Milestones

Deliverables	Description
Publications	**Journal Article:** Zetterholm, S.G. et al. 2022. "Graphene-Mediated Removal of Microcystin-LR in Chitosan/Graphene Composites for Treatment of HABs. *Chemosphere* 300:134583. **Master's Thesis:** Zetterholm, S.G. 2021. "Chitosan Graphene Composite Fabrication and Characterzation for Treatment of Harmful Algal Blooms and Toxins." University of Southern Mississippi.

Partnership/Leveraging Opportunities

This work leveraged multiple collaborations and other work units, including Rice University, the University of Southern Mississippi, and the University of Mississippi.

Value to USACE Mission

This project will ultimately provide cost-efficient technologies that can be deployed to manage HABs and mitigate their effects. Furthermore, this project will advance the knowledge base of capabilities for this application to promote further development efforts.