Non-Confidential Description

Novel Polymer Modified Iron Nanoparticles for Environmental Remediation

Technology Case: RFT-247

Invention Summary

Scientists at NDSU have recently invented a novel polymer-coated nanoparticle delivery system that has been shown to be highly effective in performing various environmental (underground decontamination/detoxification) remediation processes.

The innovation pertains to the discovery of a new amphiphilic polysiloxane graft copolymer (APGC) based metal nanoparticle delivery vehicle. This delivery vehicle has enormous potential in environmental remediation. For example, in association with zero-valent iron (Fe°) nanoparticles (nZVI), the delivery system can effectively remediate contaminants such as chlorinated aliphatic hydrocarbons, toxic metals, and explosives.

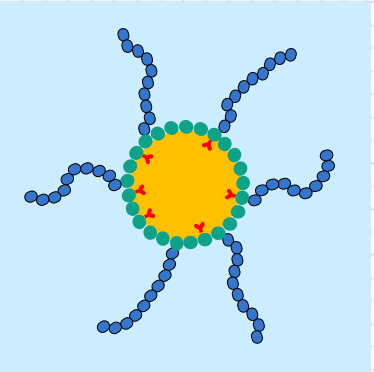
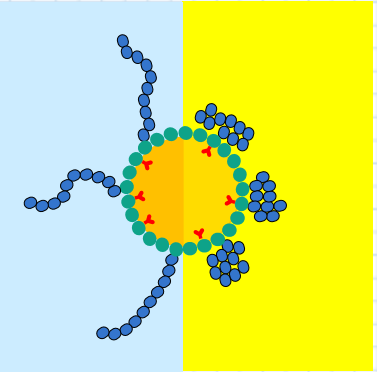


Figure 1, Top Graphic: A schematic representation of amphiphilic polysiloxane graft copolymers (APGCs)



Figures 2A and 2B, Bottom Graphics: A schematic representation of the polymer coated Fe nanoparticles both in water (left) and at the water/contaminant interface (right).

Benefits

- Increases colloidal stability
- Reduced oxidation by non-target compounds
- High affinity towards water/contaminant interface

Invention Premise

While nanoparticles have been shown to be attractive for remediation of various contaminants because of their unique physiochemical properties, the effectiveness for groundwater remediation depends upon the effective delivery of the nanoparticles to the water/contaminate interface without flocculation and severe oxidation. Various contaminants have been remediated using metal nanoparticles such as zero-valent iron (Fe°) nanoparticles (nZVI). However, effective delivery of such nanoparticles into the subsurface remains a major challenge. Considering the requirements of an effective delivery system for nZVI, the invented functionalized amphiphilic polysiloxanes are an ideal class of polymers for the application (see Figure 1). The hydrophobicity of the polysiloxane polymer backbone protects the nZVI from excessive oxidation by creating a barrier to water while also

creating an affinity of the coated nanoparticles for the water/contaminant interface as illustrated schematically in (Figures 2A and 2B). Since polysiloxanes have a very low glass transition temperature (-120°C) and are highly soluble in most hydrocarbons, they readily allow permeation of organic contaminants such as trichloroethene (TCE) to the Fe° nanoparticle surface providing fast, efficient contaminant remediation with considerable specificity. The hydrophilic poly ethylene glycol (PEG) graft used in the system allows for dispersibility and colloidal stability of the nanoparticles in an aqueous medium (e.g., groundwater). Each nanoparticle suspends independently because of the PEG graft and better efficiency in remediation is achieved because of higher reactive surface area (of the nanoparticles) availability.

Patents

This technology is patent pending with fully preserved U.S. patent rights and is available for licensing/partnering opportunities.

The Department of Coatings and Polymeric Materials at NDSU

This NDSU invention was created at the Department of Coatings and Polymeric Materials, an academic department within the College of Science and Mathematics at NDSU. The department provides the only academic research focused on polymer organic coatings in North America, and is one of only very few such departments in the world. The focus on polymer coatings at NDSU goes back to 1905, when many paints were based on vegetable oils and lead pigments. Research specialties include:

- Polymer, organic chemistry, responsive/structured polymers, nano-material synthesis
- Corrosion science, protective coatings, conductive polymers, electrochemistry
- Physical properties of coatings, polymer physics of cross-linked systems
- Computer modeling, service lifetime prediction

The Department of Coatings and Polymeric Materials has world class polymer, coating and corrosion characterization equipment in 20,000 square feet of the Research 1 building in the NDSU Research and Technology Park.

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