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Influence of Groundwater Inorganic Solutes on the Corrosion and Reactivity of Fe_XN Nanoparticles

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Partial or complete nitriding of nanoscale zero-valent iron (nZVI) particles has been shown to enhance their reactivity toward chlorinated ethenes while suppressing their corrosion in water [1]. In this study, we investigated the reactivity of iron nitride nanoparticles primarily composed of the face-centered cubic γ'-Fe_4N phase under realistic groundwater compositions. To this end, the nanoparticles were aged for one month in environments containing varying concentrations of inorganic solutes, and in two distinct groundwater samples, and subsequently exposed to trichloroethylene (TCE). Our findings demonstrated that aged γ'-Fe_4N nanoparticles effectively degrade TCE across a broad range of inorganic solute concentrations, including Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2-}, and HCO_3^{-}. X-ray diffraction (XRD) and scanning electron microscopy (SEM) analyses revealed that the predominant corrosion products were "white rust" and "green rust" minerals. In contrast, the presence of dissolved HPO_4^{2-} and NO_3^{-} substantially suppressed TCE degradation by promoting the formation of the minerals vivianite and magnetite, respectively, which passivated the nanoparticle surface. These findings highlight the potential of γ'-Fe_4N nanoparticles as a promising material for groundwater remediation, offering both enhanced reactivity toward contaminants and prolonged reactive lifetime under environmentally relevant conditions, especially in groundwaters not impacted by fertilizers [2].

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