

Magnetic Nanosorbents Prepared from Quaternary Chitosan for the Removal of Glyphosate from Water

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Glyphosate (GLY) is a non-selective and broad-spectrum type of organophosphorous herbicide used worldwide. Water resources contamination with GLY is a threat to public health and ecological systems [1]. Thus, there is an urgent need for efficient procedures capable of purifying contaminated water and meeting quality standards. Here we describe magnetic bio-hybrids prepared from trimethyl chitosan (TMC), which is a quaternary chitosan scarcely studied for environmental applications. Core@shell composite colloidal particles comprising a core of magnetite (Fe_3O_4 , ~50 nm) uniformly coated with TMC-siliceous hybrid shells ($\text{Fe}_3\text{O}_4@\text{SiO}_2/\text{SiTMC}$) were successfully prepared using a one-step sol-gel coating procedure [2]. Adsorption experiments were conducted to investigate the potential of the coated particles for the magnetically assisted removal of GLY from ultra-pure water and wastewater samples. For the synthetic water samples, the magnetic nanosorbents decreased realistic environmental concentrations of GLY to values that are below the maximum permissible value ($0.1 \mu\text{g/L}$) set out in the European Drinking Water Directive. When spiked wastewater samples were used, the magnetic nanosorbents at a dose of 2.5 mg/ml removed 76.8% of the GLY (initial concentration of $3.0 \mu\text{g/L}$), demonstrating the potential application of these particles in aqueous matrices of complex nature. A more systematic investigation was conducted to study the adsorption performance towards GLY by varying several operational parameters in ultra-pure water, such as initial pH, contact time, sorbent dose and initial GLY concentration. The good adsorption capacity of the magnetic nanosorbents was ascribed to the presence of trimethylammonium groups from trimethyl chitosan that interact electrostatically with carboxylate and phosphonate groups of GLY molecules (Figure 1). Our results indicate that assisted magnetic water remediation using recyclable trimethyl chitosan surface modified magnetic nanoparticles is an efficient method for the removal of glyphosate from real water samples and artificial water to meet water quality standards.

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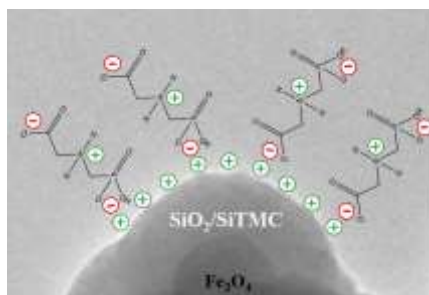


Figure 1: Schematic illustration of glyphosate species adsorbed onto $\text{Fe}_3\text{O}_4@\text{SiO}_2/\text{SiTMC}$ nanosorbents dispersed in water.

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