POLYSTYRENE CONTROLLED FORMATION OF CARBON NANOCOMPOSITES FOR ENVIRONMENTAL REMEDIATION

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ABSTRACT

With increasing awareness of environmental sustainability in the modern society, reduction of pollution emissions and remediation of polluted natural resources are common challenges faced by both developed and developing countries in the world. Hexavalent chromium (Cr(VI)) ions and tetrabromobisphenol A (TBBPA) are widespread in environment coming from the industrial and agricultural activities of human being. Chromium (Cr) is a common contaminant in surface and ground water in the world due to its wide applications in electroplating, leather tanning, printing and other metallurgy industries. Cr(VI) is considered as a priority hazardous pollutant since it can cause severe diseases such as dermatitis and lung cancer. The US Environmental Protection Agency (EPA) has issued a maximum concentration of 100 $\mu g\ L^{-1}$ for total Cr in drinking water according to the national primary drinking water regulations (NPDWRs). Tetrabromobisphenol A (TBBPA) is one of the most widely used brominated flame retardants (BFRs) in the world ranging from 120,000 to 150,000 tons per year,[1] which covers about 60 % of the total BFRs market share. TBBPA is immunotoxic and neurotoxic, which can act as a thyroid hormone and estrogen agonist to inhibit triiodothyronine and transthyretin binding and disrupt cellular signaling pathways. Even though TBBPA is currently unregulated worldwide, it's urgently needed to remove it from the aquatic environment due to its extensive usage, persistence and toxicity. The scientists and engineers in all countries have been seeking for efficient and economical methods to remove them from polluted water systems. Generally, there are different methods to remove TBBPA from wastewater system such as oxidation, photocatalytic degradation, membrane, and adsorption. Among these methods, adsorption process is more popular due to its easy handling process and high efficiency. Recently, magnetic carbon nanoadsorbents, as one of the promising wastewater treatment materials, have attracted scientific interests because of their high specific surface area, fast recycle process from wastewater system by an external magnetic field, and easy regeneration and reusage for economic and practical applications. In this work, the polystyrene controlled formation of different carbon structure nanocomposites have been prepared by calcination of the epoxide group-functionalized polystyrene as the carbon source under the different atmospheres. These carbon nanocomposites have been evaluated for the environmental remediation including the toxic Cr(VI) removal and TBBPA adsorption. Various factors influencing the Cr(VI) removal and TBBPA adsorption efficiency, such as treatment time, and initial pollutants concentration have been systematically studied. The removal kinetics and thermodynamics was determined. The results showed that these carbon nanocomposites showed a unique capability to remove pollutants from polluted water over a wide pH range. The Cr(VI) removal and TBBPA adsorption kinetics was followed the pseudo-first-order behaviour and pseudo-second-order behaviour, respectively. The calculated thermodynamic parameters suggested that the Cr(VI) removal and TBBPA adsorption process is spontaneous. These pollutants removal mechanism was also explored.

Figure and Figure Captions:

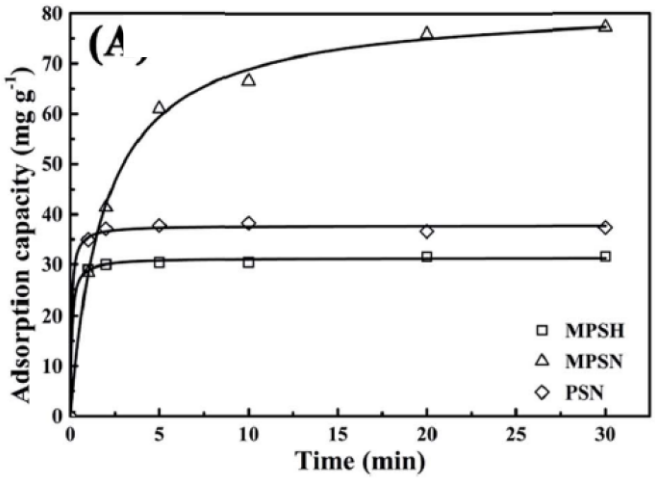

Figure 1 Effect of contact time on TBBPA adsorption by the as-received PS under nitrogen condition (PSN), modified PS under nitrogen condition (MPSN) and modified PS under hydrogen condition (MPSH).

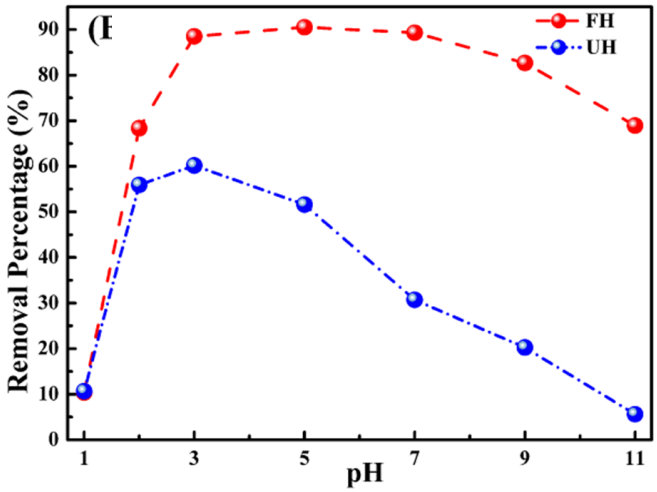

Figure 2 Removal percentage of 1.0 g L^{-1} as-received PS under hydrogen condition (UH) and functionalized PS under hydrogen condition (FH) at different pH values of 20.0 mL Cr(VI) solutions with an initial concentration of 5.7 mg L^{-1} after 5 min treatment time at room temperature.

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