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# Preparation of graphene oxide/chitosan/FeOOH nanocomposite for the removal of Pb(II) from aqueous solution

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ABSTRACT

In the present study, a graphene oxide/chitosan/FeOOH (GO/Ch/FeOOH) nanostructured composite was prepared and used as an adsorbent for the removal of Pb(II) ions from aqueous solution. The nanocomposite was characterized by FT-IR, XRD, and SEM techniques. Several important parameters influencing the adsorption of Pb(II) ions such as pH (3–7), temperature (25–80 °C), shaking speed (150–800 rpm), contact time (10–70 min), and sorbent mass (10–100 mg) were studied. The results showed that, benefiting from the surface property of graphene oxide, the abundant amino and hydroxyl functional groups of chitosan, the adsorbent provides adequate and versatile adsorption for the Pb(II) ions under investigation. The batch adsorption experiments showed that the adsorption of the Pb(II) is considerably dependent on pH of milieu, amount of adsorbent, and contact time. The Freundlich and Langmuir adsorption models were used for the mathematical description of adsorption equilibrium and isotherm constants. Both models were applicable for the description of Pb(II) adsorption isotherm in the concentration range studied. However, Langmuir model showed higher correlation coefficient ($R^2$) than Freundlich model. The study suggests that the GO/Ch/FeOOH is a promising nano adsorbent for the removal of Pb(II) ions from aqueous solution.



## 1. Introduction

Lead is one of the most useful metals due to its wide distribution and its easiness to be extracted and to work with [1]. However, lead ions present in industrial and agricultural wastewater and acidic leachate from landfill sites are threats for human beings as well as ecosystem [2]. Long-term drinking water containing high level of lead ion would cause serious disorders, such as nausea, convulsions, coma, renal failure, cancer, and subtle effects on metabolism and intelligence [3]. Lead is released into the aqueous system from pulp and paper industries, lead smelter, boat and ship fuels, battery manufacturers and ammunition industries [4]. Due to the importance of lead as a heavy metal ion contaminant in geochemical systems and its high toxicity, many techniques have been applied for the removal of Pb(II), such as flocculation, membrane filtration, solvent extraction, biosorption, chemical precipitation, reverse osmosis, adsorption, etc. [5]. Among these technologies, the adsorption method is considered to be highly effective and economical at present [6]. However, the conventional adsorbents have disadvantages such as low adsorption efficiency, small capacity, and poor selectivity. Therefore, it is important to develop new low-cost and efficient adsorbents in order to improve adsorption [7]. In recent years, large numbers of adsorbents, such as carbon nanotubes, activated carbon, clay minerals, microorganisms, and plant wastes were investigated, among which graphene oxide (GO) has been in the center of attention [8–11]. Because of its unique two-dimensional structure and large specific surface area (theoretically 2630 $m^2/g$), it is an ideal material to adsorb metal ions [9]. Chitosan (Ch) has been reported to be a suitable biopolymer for the removal of metal ions from industrial wastewater, due to its high amino and hydroxyl functional group content, low toxicity, biocompatibility, and biodegradability [3]. Based on favorable adsorption properties of chitosan and inherent properties of GO, some researchers have explored the possibility of GO/Ch composite as bioadsorbents [8,10], where the carboxyl group of GO chemically reacts with the amine group of chitosan with consequent formation of chemical bond between GO and biopolymer (chitosan). However, hardly has anyone used the derivatives of chitosan linked with graphene oxide as adsorbents for the adsorption of metal ions [12].

In recent years, Fe(III) based sorbents have received particular attention because of their strong affinity toward metal ions and

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