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Biomimetic fabrication of hierarchically structured LDHs/ZnO composites for the separation of bovine serum albumin

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HIGHLIGHTS

- ▶ Preparation of hierarchically structured LDHs/ZnO composites derived from cotton fibers.
- ▶ The biomorphic composites are quite effective in BSA separation.
- ▶ The Dubinin–Radushkevich model fitted the adsorption best.
- ▶ The kinetic data were well described by intraparticle diffusion kinetic model.
- ▶ Desorption process can be controlled via the addition of salt solution.

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ABSTRACT

Hierarchically structured layered double hydroxides (LDHs), with special surface structural and positively charged layer, are of great interest due to their potential applications in bioseparation and catalysis. Herein this work presents a novel method for fabricating Zn—Al LDHs/ZnO composites derived from cotton fibers, as well as its application in bovine serum albumin (BSA) separation. The morphology and structure of as-prepared samples are characterized by scanning electron microscopy (SEM), transmission electron microscopy (TEM) and X-ray diffraction (XRD) analysis. It is found that the fibrous morphologies are retained in inorganic replicas, and the surface of composites is composed of many small nanosheets. Batch adsorption results indicated that the prepared samples were very effective in adsorbing BSA. Effects of solution pH, adsorbent dose, adsorption time, and adsorption temperature were investigated in detail. The equilibrium data were found to be well described by Dubinin–Radushkevich model, while the kinetic data were well-fitted to the intraparticle diffusion model. Based on the mechanism of adsorption, the adsorption sites of composites can be easily occupied by adsorbed high negative charge anions through electrostatic interactions. The BSA desorption can be controlled via the addition of salt solution.

1. Introduction

With the increasing stress on world resource shortages and eco-environment degradation, much attention has been focused on the development of renewable resource and environmentally friendly material. Biomass, as a renewable resource, is ubiquitous and abundant on earth [1]. In particular, biomolecules with an inherent nanodimension have aroused considerable interest for their potential applications in functional materials. Most biomolecules were easily assembled on inorganic nanomaterials to fabricate composite materials by utilizing their biochemical functionalities. However, it is difficult or impossible to strictly control the binding of the biomolecules and nanomaterials, mainly due to the different size between host and guest materials. In order to enhance the combination of the biomolecules and nanomaterials, several hierarchical structure materials, namely colloidal-nanoparticle [2], porous nanowires [3] and nanoporous silica [4], were used to bind the biomolecules. On the other hand, some macroscopic scale biological tissues, such as butterfly wing scales [5], leaves [6] and bamboo fibers [7], were used as biological templates to fabricate environmentally friendly materials. The fabricated biomorphic materials usually present hierarchical structure or macroporous structures, which can be utilized to bind the biomolecules for fabricating functional composite materials. The biomolecules and macroscopic scale biological templates were derived from bioresources. Hence, there is considerable interest in developing biomorphic materials to bind biomolecules.

Layered double hydroxides (LDHs), as an important class of inorganic functional materials, have received great attention due to their versatile applications in catalysis [8], separation [9], electrochemistry [10], and the biomedical field [11,12]. One of the

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