AMERICAN SCIENTIFIC PUBLISHERS

Science of Advanced Materials
Vol. 5, pp. 1–12, 2013
(www.aspbs.com/sam)

ARTICLE

Efficient and Ecological Removal of Anionic Pollutants by Cationic Starch-Clay Bionanocomposites

Yamina Koriche[1,2,3,*], Margarita Darder[1], Pilar Aranda[1], Saida Semsari[2], and Eduardo Ruiz-Hitzky[1]

[1]*Instituto de Ciencia de Materiales de Madrid, CSIC, c/Sor Juana Inés de la Cruz 3, 28049 Madrid, Spain*
[2]*Laboratoire de Génie Chimique, Département de Chimie Industrielle, Université Saad Dahleb, 09000 Blida, Algérie*
[3]*Université de Khemis Miliana, Route de Theneit Alhad, 44225 Khemis Miliana, Algérie*

ABSTRACT

The present work introduces the role of bio-hybrid materials based on the combination of cationic starch and clays belonging to the smectites family, in the removal of pollutants such as organic dyes and pesticides of anionic character. Two types of smectite clay minerals have been used as inorganic counterpart of the bionanocomposites: a purified bentonite from deposits in Maghnia, in the west of Algeria, and the commercial Cloisite® (Na-montmorillonite). In the first stage, potato starch was modified with glycidyltrimethylammonium chloride, and then incorporated to the clay by ion-exchange reaction at diverse biopolymer/clay ratio. These bionanocomposites were characterized by using various techniques: IR spectroscopy, XRD, TG-DTG and FE-SEM. The excess of cationic charge in these bionanocomposites results of great interest for their application in the removal of anionic pollutants, such as the anionic dye Congo Red and the 2,4-dichlorophenoxy acetic herbicide, from water solution.

KEYWORDS: Bionanocomposite, Clays, Montmorillonite, Cationic Starch, Anionic Pollutants.

1. INTRODUCTION

Clay minerals belonging to the smectite family (Fig. 1(a)) and specially their derived organoclays are commonly used for environmental applications that include water treatment, removal of pollutants, as well as controlled release and stabilization of pesticides.[1,2] In this context, conventional organoclay materials based on alkylammonium cations have proved to be useful for the removal of organic pollutants from water reservoirs and effluents.[2,3] The organophilic properties of these organoclays enhance the capability to efficiently adsorb organic compounds, especially pollutant aromatic molecules such as many of the habitually used dyes. Biopolymers can be also assembled to clays in order to prepare organomodifiers or biohybrids with hydrophilic character, which can be used as fillers in biopolymer matrixes to prepare bionanocomposites.[4–6] These last materials are of interest in diverse applications, such as bioplastics and biomedicine, and more recently in environmental applications.[7] Starch, a polysaccharide derived from corn, wheat, rice or potato, is one of the main neutral polysaccharides specially used in the preparation of green nanocomposites.[6,7] Starch and its derivatives represent a cheap and environmentally safe source of materials for the preparation of low cost adsorbents that may be useful for the removal of pollutants from water. This biopolymer represents an interesting alternative for uses as adsorbent because of its particular characteristics (abundant, renewable and biodegradable raw resource) and its properties, such as chemically stability and high reactivity, resulting from the presence of chemically reactive hydroxyl groups in the polymer chains.[8]

Nevertheless, native starch has weak adsorbing functional groups in its backbone. Many approaches have been made to modify starch as a dye or metal absorbent by introducing various active groups, such as carboxylate, acrylonitrile, acrylamide, phosphate, etc.[9–12] However, the use of these chemically modified starches alone is disadvantageous for practical application. Thus, special attention has been paid to produce polymer/layered clay composites in order to improve the properties of the

*Author to whom correspondence should be addressed.
Email:
Received: XX Xxxxx XXXX
Accepted: XX Xxxxx XXXX