5th National Conference on New Researches in Chemistry and Chemical Engineering
Tehran-2019

Preparation and Characterization of modified nanocellulose with CBIMMT ligand as a new nanosorbent

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ABSTRACT

In this study, nanocellulose with high surface areas have been obtained using α-cellulose (80% crystallinity) by acidic hydrolysis during the synthesis process. Our suggested modified nanocellulose was prepared by immobilization of CBIMMT ligand on nanocellulose. The properties of nanocellulose and modified nanocellulose were characterized by transmission electron microscope TEM, energy-dispersive X-ray spectroscopy EDS, thermogravimetric analysis TGA, elemental analysis CHNS, and Brunauer-Emmett-Teller BET techniques.

Keywords: Nanocellulose, CBIMMT ligand.

1. INTRODUCTION

Cellulose is an abundant [1] material and fore most component replenished continuously by photosynthesis [2] impart strength and stability to the plant cell wall [3]. Among the different methods for preparing nanocellulose acid hydrolysis is found to be the most prominent and extensively used method [4] which disintegrate the disordered and amorphous segments of the cellulose releasing single and well defined crystals with high degree of crystallinity [5].

This work describes the synthesis and characterization of nanocellulose modified with CBIMMT ligand. Also Various characterization techniques were applied to characterize the changes of nanocellulose physiochemical properties due to the loading of CBIMMT ligand.

2. Synthesis of nanocellulose

The cellulose nanocrystals employed in this study were formed by acidic hydrolysis as reported in the literature with only minor modification. Briefly, 2.0 g of cellulose pulp were obtained from Whatman filter paper (98% α-cellulose, 80% crystallinity) and blended in a 10 Speed Osterizer Blender. Hydrolysis of the resulting pulp was achieved after 3 h at 100 ˚C using 100 mL of 2.5 M HBr and intermittent ultrasonication (5 min per hour, 50% power, Omni Ruptor 250 w ultrasonic homogenizer. After dilution with deionized water, the mixture was subjected to five washing/centrifugation cycles (5000 rpm, 10 min, IEC Centra-CL_3 Series) to remove excess acid and water-soluble fragments. Once pH 4-5 was reached, the fine cellulose particles started to disperse into the aqueous supernatant. The polydisperse cellulose contained in the turbid supernatant was collected and subjected to centrifugation at 10000 rpm for 60 min in a Sorvall Superspeed centrifuge to remove ultrafine particles. The sediment containing the cellulose nanocrystals with an average length of 100-400 nm was dried using a lyophilizing system, yielding 0.9 g CNC (1; 47% yield).

3. Modification of the nanocellulose/CBIMMT

First, 1.8 g of nanocellulose, 3.8 g of tosyl chloride were added to 60 mL of pyridine and this solution were placed in ice bath at 10 °C to mix up and then it was stirred at 25 °C for 48 hours by a magnetic stirrer. After mixing, 100 mL of ethanol was added to the reaction mixture to precipitate, then stripped off with filter paper and washed several times with ethanol and distilled water and dried at 60 °C for one week. In the next step, for the preparation of modified nanocellulose, 0.6 g of tosylate nanocellulose, 0.6 g of CBIMMT ligand and 50 mL of ethanol were placed under reflux conditions using an oil bath at 80 °C for 24 hours. Then, the precipitate was removed with filter paper, and dried at 50 °C for two weeks.

3. RESULT AND DISCUSSION