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First electrospun immobilized molybdenum complex on bio iron oxide nanofiber for green oxidation of alcohols

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Bio iron oxide was synthesized from natural Sesbania sesban plant and modified by a molybdenum complex (Fe_2O_3/MoSB). Fe_2O_3/MoSB was deposited on polyvinyl alcohol (PVA) using a conventional single nozzle electrospinning technique (PVA/Fe_2O_3/MoSB). TEM, SEM, AFM, FT-IR, TGA, EDAX, and elemental analysis were used to determine fiber compositional information. The catalytic efficiency of electrospun PVA/Fe_2O_3/MoSB nanofiber in the oxidation of alcohols was exploited. The green reactions were conducted at solvent free conditions as a green media in the presence of H_2O_2 to have the desired aldehydes and tert-butyl hydrogen peroxide to obtain acid products in high yields and excellent selectivity. The survival of this nanocomposite was investigated and it could be reused and recycled in consecutive runs.

1. Introduction

Todays, development of electrospun nanocomposites reinforced polymer fiber materials with intention to stimulate interests in both academia and industry makes them highly attractive [1]. Electrospun nanofiber have great potential for synthesis of next-generation polymer nanofibers [2,3]. Continuity, diverse material choice, controlled diameter/structure, possible alignment/assembly, and mass production capability are comprehensive advantages of electrospun nanopolymers [3–5]. Inorganic nanofibers, with smaller pores and higher surface area than regular fibers, have enormous catalytic applications [6,7]. Despite enormous efforts devoted to explore industrial applications of electrospun nanofibers, there are limited attempts to employ these nanofibers for reinforcement in polymer nanohybrids [8,9]. Among all polymers, polyvinyl alcohol (PVA) due to its low cost, high hydrophilicity, and excellent chemical resistance has used in broad application areas. PVA is a synthetic water-soluble hydrophilic polymer and the degree of polymerization or the degree of hydrolysis can effect on its properties such as adhesives, emulsificantes, and paper industry applications [1,10]. Modified PVA with metal oxides, with different mechanical, thermal and chemical stability, has already been proven as an effective way to produce new materials with specific properties and high performances [11–13]. In many recent studies, iron nanoparticles (NPs) for environmental remediation have indicated excellent potentials [14,15]. Microwave assisted synthesis, ultrasonication assisted synthesis, coprecipitation, chemical reduction methods, and hydrothermal methods are the methods for iron oxide synthesis. While, the most commonly used conventional strategy for the synthesis of the nanoparticles are chemical physical and biological methods [16–18]. However, they need expensive instruments, high energy, usage of toxic reducing agents maintaining the cell culture, and recovery steps [19]. The undesirable features of traditional reagents and methods have forced chemists to use phyto-mediated synthesis to reduce the costs of chemical production [20,21]. Hence, the synthesis of nanoparticles using the plant extract has several advantages [22–24].

On continuing our work on the green catalytic system [25–29], bio α-Fe_2O_3 was synthesized using Sesbania sesban plant and molybdenum complex was supported on it and nanofiber of immobilized molybdenum complex on α-Fe_2O_3 in the presence of PVA was synthesized through electrospinning

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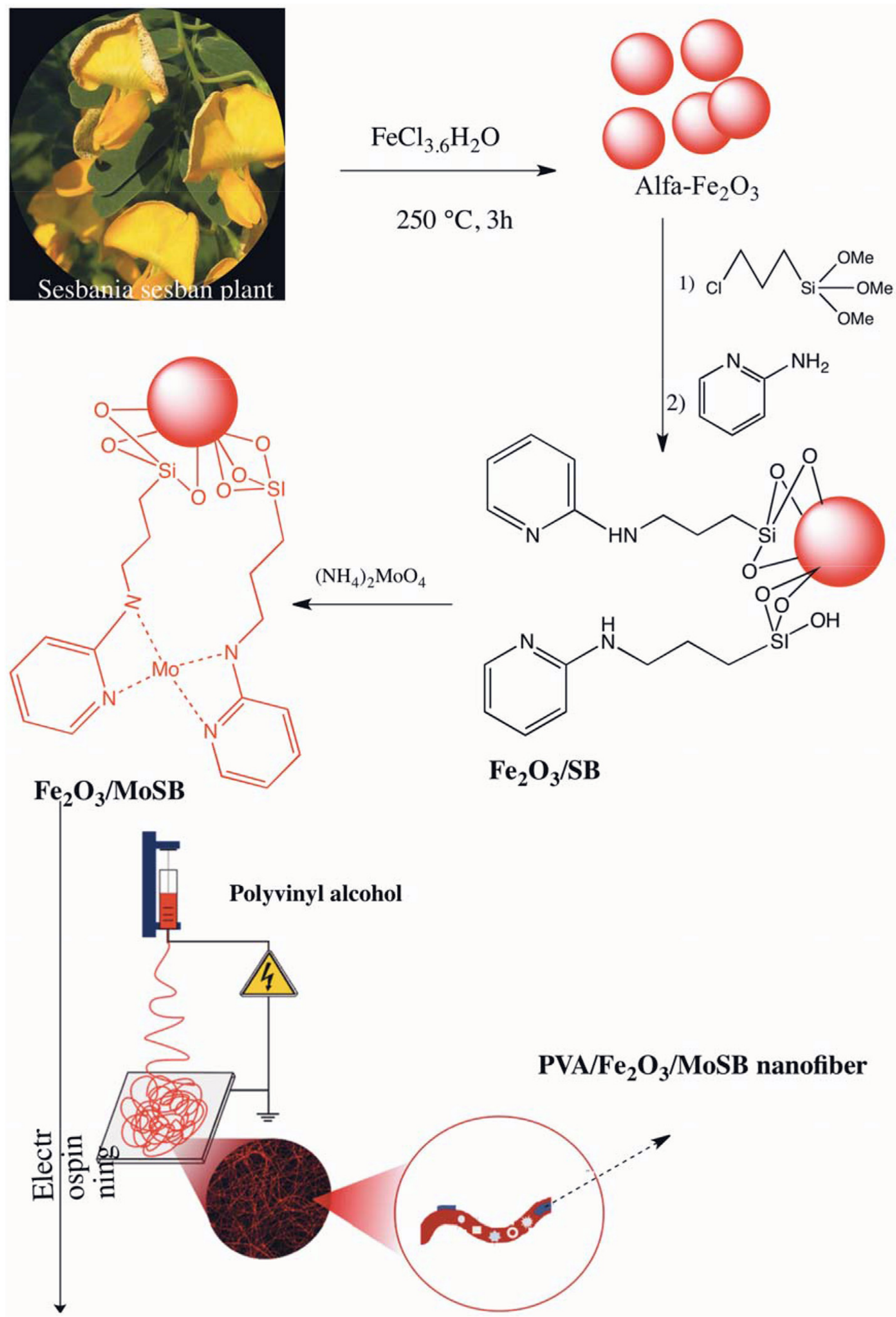

Scheme 1. The synthesis of electrospun PVA/Fe_2O_3/MoSB nanofiber.

(PVA/Fe_2O_3/MoSB). As our acknowledgment, this work is the first report of catalytic potential of an electrospun nanofiber base on one transition metal complex in oxidation reactions. Here, we describe catalytic properties of PVA/Fe_2O_3/MoSB in the presence H_2O_2 as an ideal oxidant to aldehyde products and t-BuOOH as a common oxidant to produce the acid products.

2. Material and methods

Sesbania sesban was provided from University of Jiroft. 2-amino pyridine was purchased from Across Company. 3-chloropropyltrimethoxysilane and Polyvinyl alcohol were procured from Alderich and Merk Company, respectively. FT-IR spectra were recorded by FT-IR spectrophotometer (NICOLET iS10). Thermo stability of PVA/Fe_2O_3/MoSB was investigated by Simultaneous Thermal Analyzer. Synthesis of iron oxide nanoparticles was performed by furnace (FANAZMA GOSTAR). Shape and morphology of PVA/Fe_2O_3/MoSB was considered by TEM microscope (Philips CM30). X-ray energy-dispersive spectroscopy (EDS) detector (IE 300X,Oxford, UK) attached to the SEM was analyzed the elemental composition of materials. For AFM images of PVA/Fe_2O_3/MoSB, an atomic force microscopy (DME Model Igloo) was performed. Electrospinning instrument was used for synthesis of PVA/Fe_2O_3/MoSB (Nanoazma company, Iran).