Preparation of nanofibers consisting of MnO/Mn$_3$O$_4$ by using the electrospinning technique: the nanofibers have two band-gap energies

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Abstract In the present study, nanofibers consisting of manganese monoxide (MnO), which is hard to prepare because of the chemical activity of the manganese metal, and the popular Mn$_3$O$_4$ have been synthesized via the electrospinning technique. The nanofibers were obtained by electrospinning of an aqueous sol-gel consisting of manganese acetate tetra-hydrate and poly(vinyl alcohol). The obtained nanofiber mats were dried in vacuum at 80°C for 24 h and then calcined in argon atmosphere at 900°C for 5 h. According to X-ray diffraction results, the obtained nanofibers contain 65% MnO. Transmission electron microscope analysis reveals good crystallinity of the produced nanofibers. UV-visible spectroscopic analysis has indicated that the produced nanofibers have two band-gap energies, 2 and 3.7 eV, which enhances utilizing of the nanofibers in different applications.

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1 Introduction

Manganese oxides have considerable importance in many technological applications. Mn$_3$O$_4$ is known to be an active catalyst for removing carbon monoxide and nitrogen oxide from waste gases [1]. Also, MnO$_2$ and Mn$_3$O$_4$ can be used as effective catalysts for the oxidation of methane and carbon monoxide or selective reduction of nitrobenzene [2, 3]. MnO$_2$ has been intensively investigated as promising electrode material in primary/secondary batteries and electrochemical capacitors due to its excellent electrochemical performance, low cost, nonpoisonous nature, environmental friendliness, and convenient preparation [4–6]. However, among the various forms of manganese oxides, information about the nanoshapes and structures of manganese monoxide (MnO) in the literature is scarce mainly because of its production complexity since manganese as an active metal tends to stay in a high-oxidation state.

One-dimensional (1-D) nanostructures including nanofibers, nanorods, and nanotubes have received increasing interest for their superior optical, electrical, catalytic, and magnetic properties, based on their low dimensionality and quantum confinement effect, which can be widely exploited as fundamental building blocks for nanoscience and nanodevices [7]. Consequently, much attention has been paid to the fabrication of popular manganese oxides in 1-D nanostructures [8–16]. It is noteworthy mentioning that the