International Conference on Recent Innovations in Science, Agriculture, Engineering and Management
University College of Computer Applications Guru Kashi University, Bathinda, Punjab (India)
20th November 2017, www.conferenceworld.in ISBN: 978-93-86171-80-1

Green Route for the Synthesis of Manganese Oxide Nanoparticles by Co-precipitation Method

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ABSTRACT

In this research paper, the synthesis of manganese oxide nanoparticles at low temperature about (80°C) by co-precipitation method using manganese sulphate and sodium hydroxide has been reported. The synthesized manganese oxide nanoparticles were characterized by X-ray diffraction (XRD), Scanning Electron Microscopy (SEM), Fourier Transform Infrared (FTIR) Spectroscopy and UV Visible Spectroscopy.

Keywords: *MnO_2 NPs, Co-precipitation method, FTIR.*

I. INTRODUCTION

Manganese oxide as a magnetic transition metal oxide has gained attraction due to its various applications in magnetic, electrochemical, lithium ion batteries and super capacitors. Nanosized manganese oxide particles with increased surface area and greatly reduced size are expected to perform better in all applications [1]. Manganese oxide nanoparticles have been synthesized by several methods like Physical vapor deposition, aerosol processing, Sol-Gel process, chemical vapor deposition, reverse micelle method, ball milling; these are some of the commonly used methods for the preparation of nanoparticles [2].

In the present study, MnO_2 nanoparticles were synthesized by co-precipitation method. Manganese oxide nanoparticles are one of the most attractive inorganic materials because of its physical and chemical properties and wide applications in catalysis, ion exchange, molecular adsorption. Present work reports the synthesis of MnO_2 nanoparticles by co-precipitation method and its characterization by XRD, FTIR, SEM and UV-Visible Spectroscopy.

II. EXPERIMENTAL

2.1 Materials And Methods

All chemicals used in the experiment were of AR grade. Manganese oxide nanoparticles were prepared by co-precipitation method. Manganese sulphate (0.2M) and sodium hydroxide (0.1M) are mixed with continuous stirring at a constant temperature of 70°C. While stirring, NaOH solution was added till the pH of solution become 12. The stirring was continued for 2 hours at a constant temperature of 70°C. Reddish brown

precipitates were formed, which were filtered and washed with acetone. Precipitates were dried overnight at 100°C. Precipitates were kept in muffle furnace at 500°C for 2 hours.

2.2 Characterization Techniques

MnO_2 nanoparticles were determined by the X-ray Diffraction (XRD), (Rikagu Mini-2 using CuKα1, λ=0.15406 nm radiations), Fourier Transform Infra-Red spectroscopy (FTIR) (Thermo-USA, FTIR-380) in the wavelength range 400-4000 cm^{-1}, and Scanning Electron Microscopy (SEM) for morphological study of material.

III. RESULTS AND DISCUSSION

3.1 X-Ray Diffraction

Fig. 1 shows X-ray diffraction study of manganese oxide metal nanoparticles synthesized by co-precipitation method. The X-ray Diffraction pattern reveals major peaks at 2θ values of 19.12 (200), 29.20 (220), 32.45 (222), 37.90 (400), 44.52 (332), 58.29 (600) respectively [3]. All the diffraction peaks of the sample correspond to manganese oxide nanoparticles. Size of MnO_2 nanoparticles corresponding to 100 percent intensity peak correspond to 32.04 nm as calculated by using Scherrer equation.

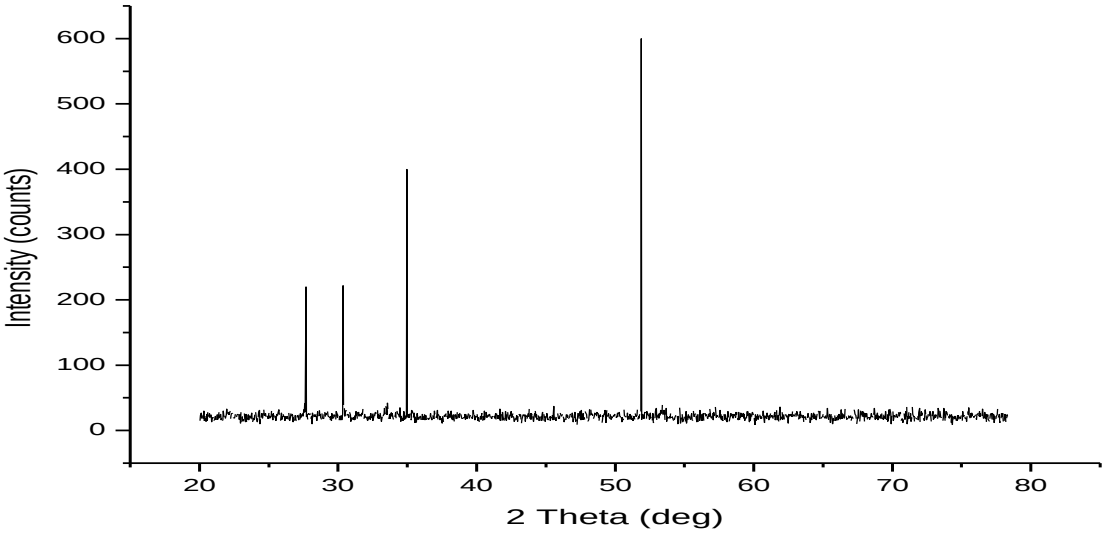
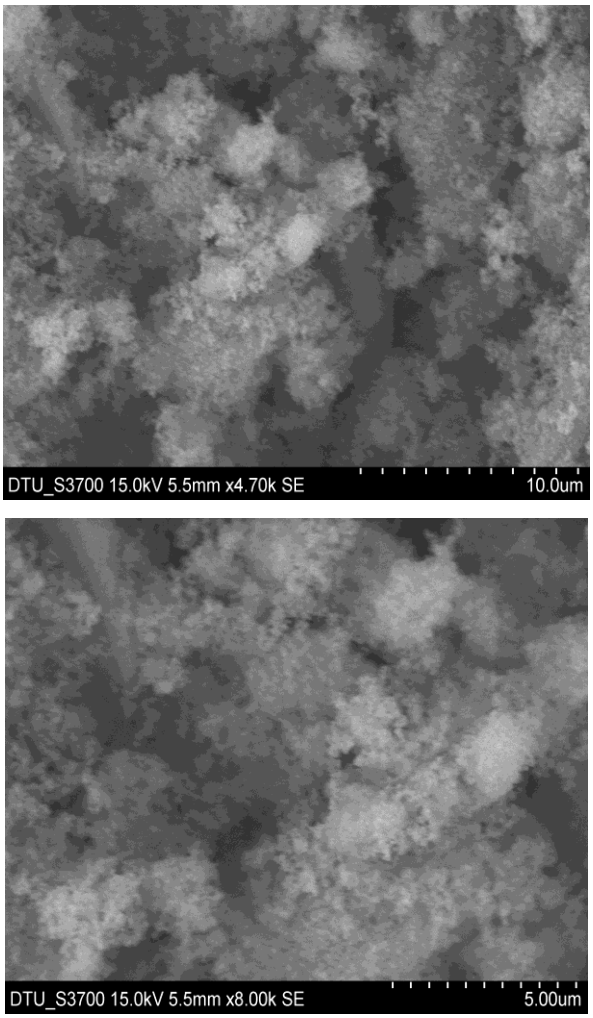


Fig. 1: X-ray diffraction pattern of manganese oxide metal nanoparticles

3.2 Sem Image

Fig. 2 shows the SEM image of manganese oxide nanoparticles. SEM image shows the particles are dispersed with size lying between 25 and 45 nm. The observed size also agrees with the XRD result. Figure 2 (a) and (b) shows higher to lower magnification i.e. from 10 µm to 5 µm.



(a) **(b)**

Fig. 2: SEM image of manganese oxide metal nanoparticles

3.3 Ftir Spectra

Fig. 3 shows the FTIR spectra of manganese oxide nanoparticles. The bands around 3398.36 and 1734.12 cm^{-1} corresponds to O-H vibrating mode and is due to physically adsorbed water on MnO_2 crystal from the environment. The band between 610.54 and 510.65 cm^{-1} is the characteristic peak of MnO_2 and the peak at 1103 cm^{-1} is due to –C-H stretching vibrations [4].

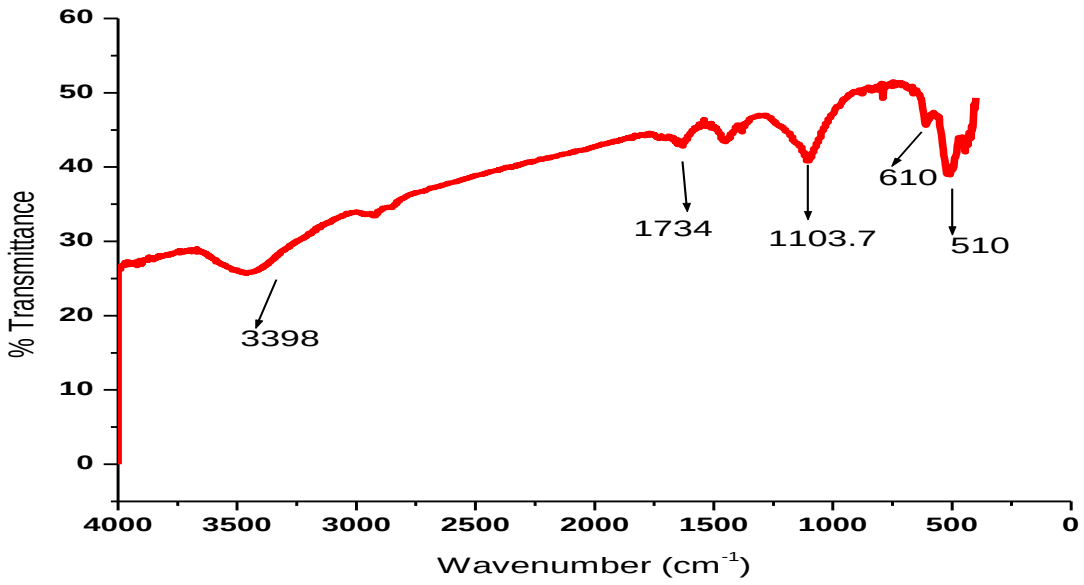


Fig. 3: FT-IR spectra of manganese oxide metal nanoparticles

IV. CONCLUSION

MnO_2 nanoparticles were synthesized by co-precipitation method using green chemistry. The FTIR spectral analysis reveals the characteristics peaks of Mn-O stretching at 510 $cm^{-1}$and 610 cm^{-1}.

XRD spectra predict the average size of manganese nanoparticles is 32.04 nm. There are large numbers of applications of MnO_2 metal nanoparticles such as in the field of electrode materials in different rechargeable batteries, coatings, biosensors, nanofibres, nanowires and in bioscience applications.

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