

Chemical Synthesis of Manganese Dioxide Nanoparticle by Using Co-Precipitation Method

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ABSTRACT: The advancement in nanotechnology research has helped in the development of eco-friendly methods for the synthesis of nanoparticles. In this work manganese dioxide nanoparticles with controlled particle size & composition were synthesized by co-precipitation method with the help of salt such as a sulphates under a fine control of pH by using NaOH solution. To analyse the structure of MnO₂ nanoparticles through powder X-ray Diffraction (PXRD) and ultra/violet spectroscopy (UV). To Investigate the particle size, morphology of MnO₂ nanoparticle through various instruments like Scanning Electron Microscopy (SEM). To study the synthesis of MnO₂ nanoparticles by Co-precipitation method. In this Co-precipitation method offers advantages like simple & rapid preparative method & easy control of particle size & composition made in this method commercially widely used because of the cost-effective. The MnO₂ is one of the catalysis attracting the most attention due to this unique properties such as high activity, low cost and less toxicity & environmental compatibility.

KEYWORDS:- MnO₂ nanoparticle, Co-precipitation method, UV-Spectroscopy, Scanning Electron Microscopy[SEM], Powder X-ray Diffraction [PXRD].

I. INTRODUCTION

Nanotechnology, which is one of the new technologies, refers to the development of devices, structures and systems whose size varies from 1 to 100 nanometres (nm)[1] The last decade has seen advancement in every side of nanotechnology such as nanoparticles and powders, nanolayers and coats electrical, optical, mechanical nanodevices and nanostructured biological materials. Presently, nanotechnology is estimated to be influential in the next 20-30 years in all fields of science and technology [2]. Nanotechnology produces materials that range between 1 and 100 nm [3]. They are further classified into metallic, dielectric and semiconductor Nanoparticles, quantum dots, semi-solid and soft nanoparticles. Nanomaterials are not simply another step in the miniaturization of materials or particles. They often require very different production approaches[4]. There are several processes to create various sizes of nanomaterials, classified as 'top-down' and 'bottom-up'. Although large numbers of nanomaterials are currently at the laboratory stage of manufacture, many of them already are being commercialized[6-7]. MnO₂ can exist in different structural forms α , β , γ , δ , ϵ , and λ types and so forth, when the basic structural unit ((MnO₆) octahedron) is linked in different ways. Based on the different (MnO₆) links, MnO₂ can be divided into three categories: the chain like *structure*, the sheet or layered structure and the 3D structure[8-9]. Manganese dioxide (MnO₂) as an electrode material for super capacitors is of great potential, the merits of the MnO₂ electrode material as follows ; high theoretical specific capacitance wide potential window, rich reserves, environmental friendliness.etc..[10]. One dimensional manganese dioxide structures such as nanorods, nanowires, and nanofibers have produced to intense science research over the decade due to their superior optical, electrical, catalytic, magnetic and electrochemical properties [11]. The Co-precipitation method is commonly employed because it is cost effective and has no money advantages. Nanostructure manganese dioxide has been considered as an ideal electrode materials for energy storage, such as super capacitors. Manganese dioxide is considered as one of the best catalysts due to its low cost and less toxicity, environmental compatibility[12]. Taking into account that many properties of MnO₂ depend heavily on its morphology and texture, our procedure enables us to manipulate its properties effortlessly. Some compared with others are its facile operation condition, simple apparatus

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and short reaction time, which are of great value from the view point of commercialization [13]]. Hence, MnO₂ nanoparticles were synthesized by Co-precipitation method. By studying powder XRD and SEM Techniques to MnO₂ nanoparticles. MnO₂ characterization by UV-visible spectroscopy, XRD and SEM techniques. The MnO₂ properties of the immobilized cellulose, including thermal, pH, and operational stability were also Investigated.[14-15].

II. EXPERIMENTAL & METHODS

2.1 Synthesis of MnO₂ nanoparticles:-

All chemicals used were analytical grade. MnO₂ Nanoparticles were synthesized by Co-precipitation Method. In this co-precipitation method was performed by using manganese salt like Manganese II sulphate of 0.2 M dissolved in double distilled water with continuous stirring at constant temperature of 80°. While stirring, sodium hydroxide solution was added till the pH of the solution become 12. The stirring was continued for 1 hour at a constant temperature of 80°C. Brown precipitate formed was then filtered and washed with ethanol. And dried with Brown precipitate of MnO₂ nanoparticles.

2.2 CHARACTERISATION OF NANOPARTICLES:-

In nanotechnology, nanoparticles synthesize either biologically or chemically must be characterized in order to understand their intrinsic properties such as size, monodispersity, aqueous stability, the net charge, adsorption to bio molecules, aggregation and flocculation in various media. This provides vital information in terms of application of these nanoparticles. For instance, it provides answers to know whether a particular nanoparticle can be used in a biological application, or else to improve their synthetic processes, or chemical fictionalization.

In our studies, the MnO₂ nanoparticles were synthesized and characterized by UV-Vis spectroscopy, XRD and SEM analysis have been obtained to confirm the nanosize of the materials. The optical properties of the nanoparticle were analysed using UV-Vis spectroscopy. Powder XRD analysis has been carried out on the sample to examine the crystalline and check the purity. Particle size and Morphology of the synthesized Manganese dioxide nanoparticles were analysed using Scanning Electron Microscope (SEM).

III. RESULT AND DISCUSSION

The chemical synthesized MnO₂ nanoparticles were characterized by UV-Visible spectroscopy, XRD and SEM analysis. The important parameters viz., RWHM (Full, Width, Half, Maximum), particle size and Morphology of the synthesized Manganese dioxide nanoparticles were discussed. The present work was focused on the development of a chemical synthesis method for the production of manganese dioxide (MnO₂) nanoparticles by using Co-Precipitation method.

3.1 CHARACTERISATION OF MnO₂ Nanoparticles:-

3.1.1 UV-Vis Spectroscopy:-

UV-Visible spectrum has been widely used to characterize the nanoparticle. As the particle size decreases absorption wave length will be shifted to shorter wave length and the band gap increases for the nanosized particles. This is the quantum confinement effect of nanoparticles.

UV-Vis Spectrum of Manganese dioxide Nanoparticles:-

Ultraviolet spectrometer consists of a light source, reference and sample beams a mono chromator and a detector. The ultraviolet spectrum for a compound is obtained by exposing a sample of the compound to Ultraviolet light from a light source. Optical absorption measurement was carried out on nanoparticles. Figure 1 shows the variation of the optical absorbance with the wavelength of the nanoparticles. The optical absorption Co-efficient has been calculated in the wavelength large of 200-600nm. The absorption edge has been obtained at a shorter wavelength. The absorption edges are seen to be shifted slightly towards lower wave number (blue shift). This shift indicates an

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increases in the band gap, which can be attributed to a decrease in particle size. The value of the absorption edge of nanoparticles is 340nm. Blue shift was observed due to the quantum confinement effects.

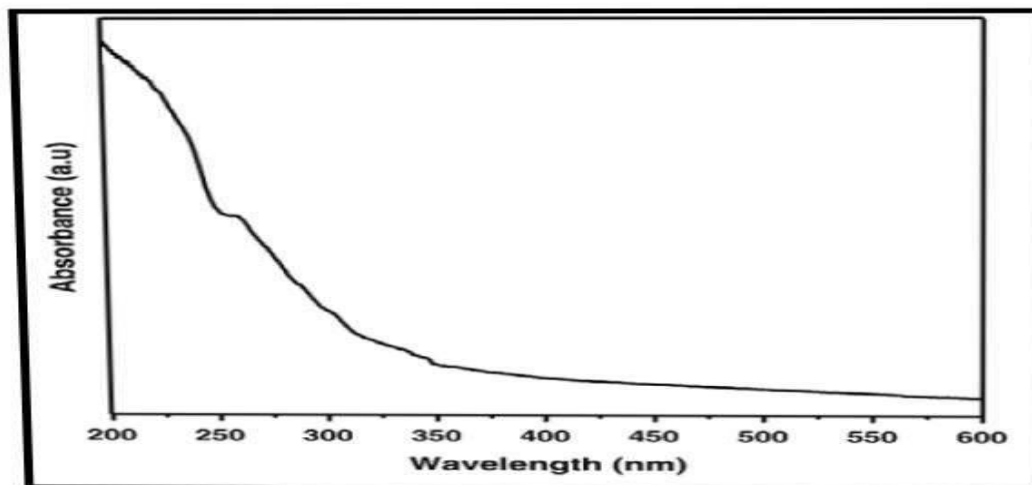


Figure 1 :- UV-Vis spectrum of MnO₂ nanoparticles

3.1.2 : Powder X -Ray diffraction of Manganese dioxide Nanoparticles:-

The result shows the PXRD pattern of the MnO₂ powder prepared by co-precipitation method. X-Ray Diffraction (XRD) analysis was carried out on powder form and typical diffraction patterns are shown below. From the XRD pattern it is clear that Manganese oxide metal nanoparticles synthesized were purely crystalline in nature. The peak at $2\theta = 21.9^\circ, 29.1^\circ, 32.6^\circ, 36.2^\circ, 44.5^\circ, 51.1^\circ, 58.5^\circ, 60.2^\circ,$ and 64.7° indicates the formation of tetragonal MnO₂. These peak was indexed to (020), (310), (102), (110), (101), (411), (411), (521), and (002) planes which is in good agreement with the JCPDS (044-0141) values. Average particle size of Manganese oxide Nanoparticles was found to be 9 to 30.0 nm. Size of MnO₂ Nanoparticles corresponding to 21.22nm as calculated using Scherer equation.

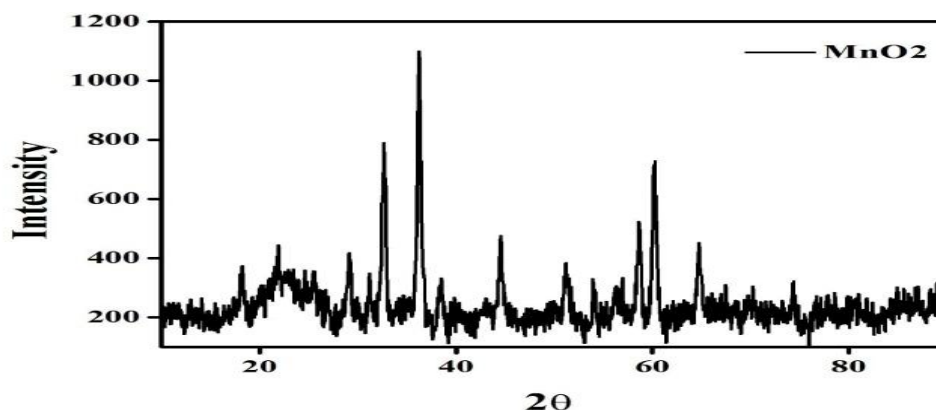


Figure 2 : Powder X- ray diffraction of MnO₂ nanoparticles

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3.1.4 SEM studies of Manganese dioxide Nanoparticle:-

SEM analysis is carried out to study the surface morphology of the nanoparticles. In the present work MnO_2 Nanoparticles was synthesized by the co-precipitation technique SEM image of Manganese oxide nanoparticles in shown in the figure 3. Manganese oxide Nanoparticles with the mean diameter of 50 nm were synthesized using manganese sulphate as the metal source and NaOH as the precipitating agent. It was well documented that the surface morphology has significant impact on the performance of nanostructure materials. The SEM image reveal that the nanoparticle synthesized were spherical in nature. The particles are nearly spherical in shape has uniform size and found to have an average size of about 50 nm.

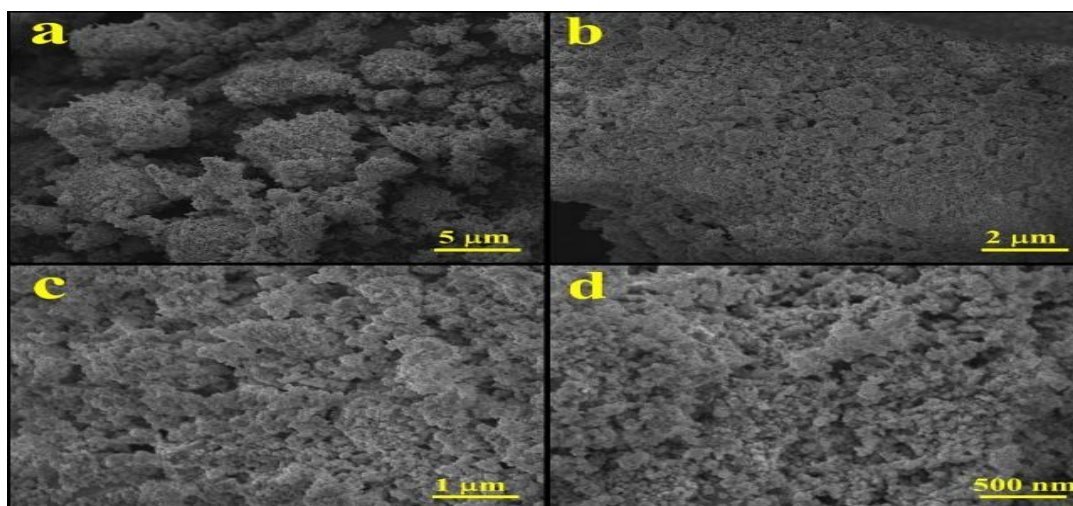


Figure 3 :- SEM images of as prepared MnO_2 nanoparticles

IV . CONCLUSION

MnO_2 nanoparticles have been successfully synthesized by co-precipitation method. The nanoparticles are characterized by UV –Vis spectroscopy , XRD and SEM techniques. The results showed that the parameters like the effect of pH and contact time will play a very important role on the adsorption. These as prepared MnO_2 nanoparticle showed a good ability to remove organic pollutants and heavy metal ions and is expected to be useful in many other applications. The UV- Visible adsorption show shapes adsorption at 340 nm due to metal nanoparticles. The PXRD pattern shows the crystallite size estimated found to be in the range 9 to 30 nm. Spherical shape with a diameter range from 50 nm was found out using SEM analysis. The MnO_2 nanoparticle can be analyzed for various temperatures. Further optical, electric and Magnetic properties can be studied for the as prepared and annealed structure in the future. Along with gas sensors, the compositions of manganese and other low cost elements can be utilized for the purpose of food detectors and disease diagnosis monitors, easily at a very low cost. Also, as we know that, nanospheres, nanorods, nanowires, nanoflowers, nanotubes, pillow-shape, urchin-like shape, hollow nanospheres, hollow nanocubes and hollow cone have been synthesized by using MnO_2 , it finds the applications in every field of science, nanoscience, nanobioscience, engineering and technology, energy production, food safety, security, etc.

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