Preparation and Characterization of Vanadium Oxide Nanostructure

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Abstract: The different fundamental properties of nanostructure strongly depend on their shapes, sizes. By controlling such parameters one can achieve the desired properties of the nanoparticles. In the present study different shape of Vanadium oxide (V₂O₅) nanostructures were synthesized using solution cast method. Morphological and structural properties of the prepared samples were studied by using field effect scanning electron microscopy (FESEM), UV-visible spectroscopy (UV–VIS), Fourier transform infrared (FTIR) and X-ray diffraction (XRD) techniques. FESEM images reveal the flower and rod shape of nanoparticles. XRD peaks showed the orthorhombic structure of V₂O₅, while the FTIR spectrum confirmed the formation of complexes between the Vanadium oxide ions.

INTRODUCTION

Nanoscience is a wide and integrative area of research and development. In past few years it has been growing firmly across the world. Nanomaterials have the potential to improve the environment through the development of new solutions to environmental problems. Nanoparticle have conspicuous physical and chemical properties that sheltered the researchers attentions towards different technological applications. Transition metal oxides have been a subject of research in recent years in view of their fundamental and technological aspects. Among these, Vanadium creates many compounds with oxygen [1]. Vanadium oxide is a well-known prototype strongly interconnected material and present a fascinating and broad range of chemical and physical properties resulting from the various metal oxidation states (from +II to +V) and the different V-O coordination geometries [2]. Different forms of vanadium oxides can be obtained by changing the deposition process parameters, or by post-process treatment [3]. Though there are several structures of vanadium oxides exist. Different phases of vanadium oxides like; VO, VO₂, V₂O₃, V₂O₅ depend on their structure, which determines other properties [4]. From the application point of view, VO₂ and V₂O₅ are the most fascinating part of vanadium oxides [5].

EXPERIMENTAL

For the synthesis of Flower shape-V₂O₅, 0.1 M solution of Ammonia metavanadate (NH₄VO₃) was prepared at room temperature. After stirring this solution for 15-20 minutes, add Nitric acid (HNO₃) dropwise into the solution till the pH reach between 2-3. After color changing, kept this solution for one day for precipitate formation. Then, left the sample for drying for one day and collect the precipitate and dried it in microwave for 30-45 minutes. The color of the prepared sample will like brown. After drying, the product was heated in muffle furnace for 4 hours at 400°C.

For the synthesis of Rod shape-V₂O₅, Ammonium metavanadate (0.4 M), urea (0.2 M) and acetylacetone (0.4 M) were blended in 100 ml deionized water and mixed with an magnetic stirrer for 2 h until the solution got transparent and homogeneous. Oxalic acid and Ammonia solutions were adopted to change the pH of the solution to
6. The subsequent orange solution was aged at room temperature for 48 h and dried at 80 °C, and afterward the as-prepared sample was toughened at 500 °C for 2 hours.

**XRD STUDY**

The XRD patterns of Rod shape-V$_2$O$_5$ and Flower shape-V$_2$O$_5$ nanoparticle are shown in Figure 1(a) and (b). The most intense diffraction peaks having hkl values (200), (001), (101), (400), (010), (310) and (002) corresponds to V$_2$O$_5$. The obtained lattice parameters, $a = 3.5536$ Å, $b = 11.4698$ Å and $c = 4.378$ Å are consistent with orthorhombic structure of the V$_2$O$_5$ phase (JCPDS card no:41-1426).

The crystallite size of V$_2$O$_5$ nanoparticles was calculated by using Debye Scherer formula and found to be 50–60 nm.

\[ D = \frac{0.9 \lambda}{\beta \cos \theta} \]

where $\lambda$ is the wavelength of the X-ray, $\beta$ is the full-width at half-maximum of the diffraction peak and $\theta$ is the angle of diffraction.

![Figure 1(a) XRD patterns of Rod shape-V$_2$O$_5$ nanoparticle; (b) XRD patterns of Flower shape-V$_2$O$_5$ nanoparticle.](image)

**FESEM ANALYSIS**

FESEM images in Figure 2(a) showing the morphology of Flower like-V$_2$O$_5$ nanoparticle. The Flower like-V$_2$O$_5$ nanoparticle had rough and textured surfaces with porous structures [6]. The superior storage performance of the porous V$_2$O$_5$ nanoparticle could be mainly ascribed to the improved electrode interface [7]. The surface of the octahedrons was smooth, with a diameter range of 1 µm – 11 µm are found from the Figure 2(b). Whereas the morphology of Rod like-V$_2$O$_5$ shows rod like structure with a diameter range of 0 µm -2 µm in Figure 2(c,d).
CONCLUSION

Nanoparticles of V$_2$O$_5$ have been successfully prepared by simple chemical method. The XRD of these sample reveals that the required phase is present. The crystallite size which was done by XRD Scherer’s formula was found to be 50-60nm. The surface morphology of flower like-V$_2$O$_5$ nanoparticle revealed rough and textured surfaces with porous structure and having the diameter range 1µm – 11µm however for Rod like-V$_2$O$_5$ nanoparticle it appears rod structure and shows diameter range of 0 µm -2 µm.

REFERENCES