International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.3, pp 689-692, 2017

A Study of Optical, Structural properties of V_2O_5 Thin Films for Light Transmission

S.Siddharthy*,S. Muruganand,

Department of Electronics and Instrumentation, Bharathiar University, Coimbatore – 46, Tamilnadu, India.

Abstract : Vanadium pent oxide nano composites are prepared using hydrothermal process. The morphological behaviour like crystalline structure, chemical composition are studied using XRD, SEM and Raman analysis. From the results of them, the orthorhombic structure is confirmed. The optical transmission were studied using spectrophotometer. The information is carried by photons in the form of light. The transmission rate of light by varying the temperature is studied.
Keywords : Vanadium pent oxide, hydrothermal process, Surface morphology, Optical transmission.

Introduction

Nowadays, VO, VO_2, V_2O_3 and V_2O_5 and vanadium composites that exhibits both optical and electrical properties are used for various applications. Optical modulation is controlled by the transfer of charge in direction and magnitude[10]. Due to their optical properties, the applications of V_2O_5 involves photocatalysis, gas sensors, electrochromic devices, color filters, reflectance mirrors and surfaces with tunable emittance for temperature control of space vehicles and in the synthesis of nanocomposites[1,2,3,4,5]. Between metal ions in different oxidation states electron hopping occurs in V^{5+} and V^{4+}) gives semiconducting properties and specific optical absorption[11,14].Vanadium pentoxide thin films can be prepared using various methods like sputtering[12], thermal evaporation, pulse laser deposition, sol–gel method and e-beam deposition. Vanadium pentoxide (V_2O_3) exibits metal transition at 250ºC and is stable with band gap 2.2 eV. The treatment of heat on V2O5 films results in different transmission of rates and the chemical composition and geometry of lattices depends on temperature and atmosphere[2]. It has various physical and chemical surface properties. Because of the presence of differently coordinated oxygen ions this is a rich structure[7]. V2O5 has reversibly of change in optical properties by charging or discharging, has proven to change colour[8].By applying voltage, the two oxides, VO2 and V2O5, can change their optical properties. VO2 has only anodic electrochromism while V2O5 exhibits both anodic and cathodic electrochromism[9]. Vanadium pentoxide is used for various scientific and technolological applications[10]. In which the oxides V02 and V205 acts as thermallyactivated optical switching devices

Experimental methods

The steps to be followed forthe formation of V2O5 nanorodsusing hydrothermal reaction. At first vanadium acetate is hydrated. Cetyltrimethyl ammonium bromide (Sigma Aldrich) with 0.5 g and 2 g of sodium hydroxide (NaOH) were dissolved in 50 ml of distilled water. Vanadium acetate of 3 g was dissolved with 50 ml of deionized water to form a solution. The solutions were transferred into a 100 ml Teflon lined stainless steel autoclave. The solution is allowed to heat at 300ºC for 20 hrs. The thin film is washed in deionised water and is allowed to anneal at 50ºC in air.

The SEM images are taken using FEI Quanta-250 FEG. Raman scattering is taken using JY-1058 Raman spectrometer.PANalytical (X'Pert-Pro) is used to take XRD.PerkinElmer Lambda 900 spectrophotometer with tungsten source is used to detect the transmission rate.

Result and discussion

Morphological analysis of V_2O_3

The XRD, Raman and SEM are taken for the study of morphological analysis of V_2O_3.

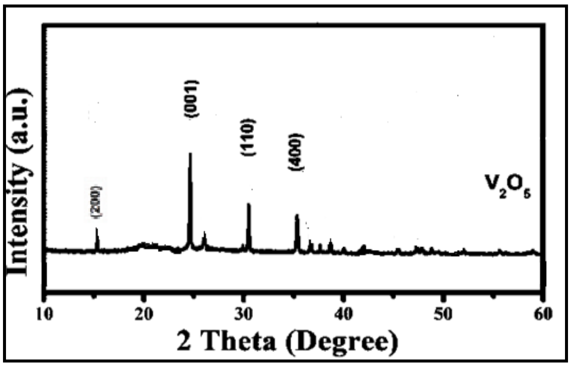

Fig 3.1 XRD results for the V2O5 nano rods at the annealed temp at 50ºC

This figure represents the X - Ray diffraction (XRD) spectrum of the obtained crystal of V_2O_5. The peaks of the XRD patterns 2θ = 15.04º, 24.01º, 31.02ºand 36.05 with (200), (001), (110), (400) diffraction reflective planes respectively represents the orthorhombic structure according to the JCPDS file (no. 77-2418) [1].

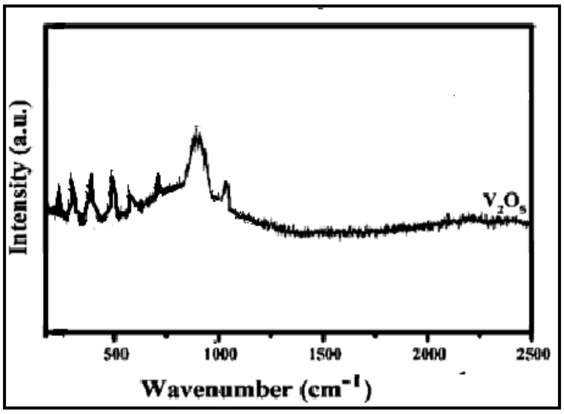

Fig 3.2 Raman spectra for morphological analysis.

The raman spectra is used for morphological analysis which supports the XRD pattern. Raman shift occurs from the change in the molecular polarizability gives different vibrational peaks. The peak183cm^{-1}represents lattice vibration. The peak 285 and 402 cm^{-1} represents the bending vibration of the V=O bonds. The peak 479 cm^{-1}represents the bending vibrations of the bridging V–O–V. The peak 530 cm^{-1}represents the edged-shared oxygen and the other peak at 698 cm^{-1} results from corner-shared oxygen. The presence of these vibrations indicates the layer like structure of V_2O_5 films. The peak located at 938cm^{-1}represents the Raman active mode of VO_2. The peaks located at 989 and 992 cm^{-1}correspond to the terminal oxygen stretching mode which results from the unshared oxygen [1].

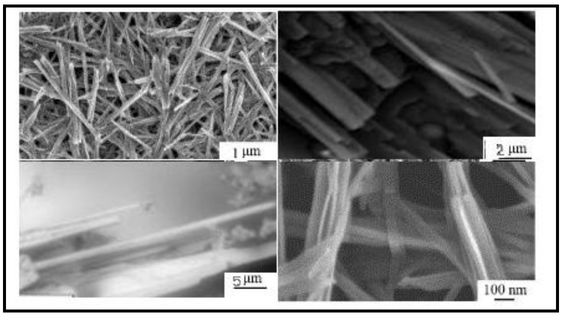

Fig 3.3 SEM images of V_2O_5 for various measurements after annealing at 50°C

The SEM images confirms the formation of nano rods of V_2O_5. SEM images are used for identification of bonds between vanadium and oxygen. It clearly shows the edge shared oxygen and corner shared oxygen bondings likeV=O andV–O–V. The SEM image denotes the formation of crystalline in the form of rods in different magnifications like 1µm, 2 µm, 5 µm and 100nm ranges.

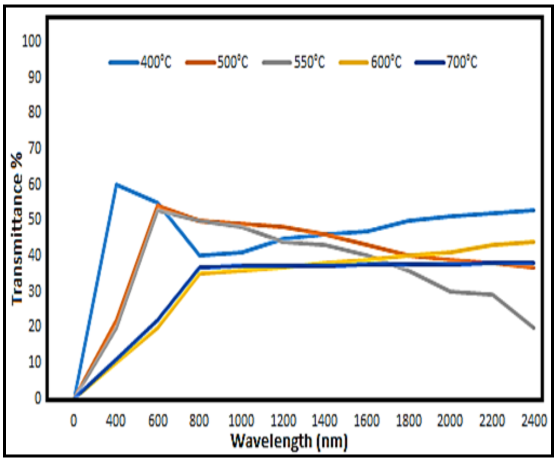

Fig 3.4 Optical transmittance curves of vanadium oxide thin films as a function of growth temperature

Since the source used is tungsten filament the transmission for the visible light is calculated in various temperatures. The spectral transmittance of the filmsdecreases with the increase in temperature[6].

Conclusion

In this paper optical and structural structural studies are carried out. The XRD and raman studies confirms the growth and the orthorhombic structure of vanadium pentoxide. The SEM images conforms the formation of V_2O_5nano rods. The V_2O_5thin films were slightly transparent in visible light range and the transmission decreases with increase in temperature.

References

1. Sengodan Rajaa, Gopal subramania, Dinesh Bheeman, Ranjith kumar Rajamanic and ChandarShekar Belland, "Structural and optical properties of vacuum evaporated V2O5 thin films" Optik 127 (2016) 461–464 Elsevier.
2. V.V. Atuchin, B.M. Ayupov, V.A. Kochubey, L.D. Pokrovsky, C.V. Ramana, and Yu.M. Rumiantsev "Optical properties of textured V2O5/Si thin films deposited by reactive magnetron sputtering" Optical Materials 30 (2008) Elsevier 1145–1148.
3. Katsunori Takahashi, Ying Wang and Guozhong Caob"Growth and electrochromic properties of single-crystal V2O5 nanorod arrays "Appl. Phys. Lett. **86**, 053102 (2005).
4. Yuri Diaz-Fernandez, Lorenzo Malavasi and Eliana Quartarone "Flexible deposition of nanocrystalline vanadium oxide thin films" J. Mater. Chem., (2008), 18, 5190–5192.

5. S. B. Zhang, D. W. Zuoand W. Z. Lu "Influence of film thickness on structural andoptical-switching properties of vanadiumpentoxide films" © 2016 Institute of Materials, Minerals and Mining DOI 10.1080/02670844.2016.1252897, Taylor and Francis, (2016).
6. C. V. Ramana, R. J. Smith,O. M. Hussain,C. C. Chusuei,and C. M. Julien "Correlation between Growth Conditions, Microstructure, and Optical Properties in Pulsed-Laser-Deposited V2O5 Thin Films" Chem. Mater. (2005) American Chemical Society, 1213-1219.
7. S. Beke, S. Giorgio, L. Kőrösi, L. Nánai and W. Marine "Structural and optical properties of pulsed laser deposited V2O5 thin films"Thin Solid Films 516 (2008) Elsevier, 4659–4664.
8. Youxiu Wei, Mei Li, Jianming Zheng and Chunye Xu "Structural characterization and electrical and optical properties of V2O5 filmsprepared via ultrasonic spraying"Thin Solid Films 534 (2013) Elsevier, 446–451.
9. Chiranjivi Lamsal ands N. M. Ravindra "Optical properties of vanadium oxides-an analysis" J Mater Sci (2013) 48: DOI 10.1007/s10853-013-7433-3, 6341–6351.
10. K. V. Madhuri, K. Srinivasa rao, S. Uthanna, B. S. Naidu and O. M. Hussain "Optical and electrical properties of (V2O5)1-x-(MoO3)x thin films"J. Indian Inst. Sci., Nov - Dec. 2001, 81, 653 –658.
11. Jacques Livage "Optical and electrical properties of vanadiumoxides synthesized from alkoxides" Coordination Chemistry Reviews (1999) Elsevier, 391–403.
12. C W Zou1, X D Yan, J Han, R Q Chen and W Gao1 "Microstructures and optical properties of β-V2O5 nanorods prepared by magnetron sputtering" Journal of Physics D: Applied Physics © (2009) IOP Publishing Ltd.
13. Elizabeth E. Chain "Optical properties of vanadium dioxide and vanadiumpentoxide thin films" Applied Optics, Vol. 30, No. 19, 1 July (1991).
14. S. Sindhu, S. Sanghi, A. Agarwal, V.P. Seth and N. Kishore "Structural, optical, physical and electrical propertiesof V2O5·SrO·B2O3 glasses" Spectrochimica Acta Part A 64 (2006) 196–204

*****