OPEN ACCESS INTERNATIONAL JOURNAL OF SCIENCE & ENGINEERING

SYNADENIUM GRANTII MEDIATED GREEN SYNTHESIS OF Cdo NANO PARTICLES

M.S.Geetha[1*], H. Nagabhushana[2], H. N. Shivananjaiah[3]

Vijaya Composite College, Bangalore,560 011, India.[1]

CNR Rao centre for Advanced materials, Tumkur University, Tumkur 572 103, India.[2]

Government Science College, Nrupatunga road, Bangalore,560 001, India.[3]

geethashivu33@gmail.com[1]

Abstract: Multifunctional CdO nanoparticles were synthesised by combustion method using *Synadenium grantii* plant latex as reducing agent. A TEM image shows that the particles are spherical in shape. FTIR confirms purity of the sample. Energy gap of the semiconducting CdO nano particles was found to be 3.6 to 3.8 eV through UV-vis spectroscopic studies. The particle size is found to decrease with increase in fuel concentration, where as the micro strain is found to increase with fuel concentration. The report concludes an effective simple, eco friendly, fast, cost effective method for the synthesis of CdO nanoparticles.

Keywords: Multi functional CdO, Green synthesis, TEM, FTIR

I INTRODUCTION

Nanotechnology is a new and fast emerging technical field that mainly involves the manufacture, processing and suitable applications of structures, devices and systems with controlled morphology. Recently, the interest in studying nano structured metal oxide semiconductors has increased among researchers because of quantum size effect associated with the low dimensionality, which causes unique size and shape dependent physical and chemical properties. Transparent conduction oxides (TCO) namely ZnO, CdO, SnO_2, Ga_2O_3, In_2O_3 etc have extensive applications in electronic technology specifically in optoelectronic and other applications, including solar cells, photo transistors, photodiodes , transparent electrodes and gas sensors [1-4].The development of safe eco-friendly methods for biogenetic production is now of great interest due to simplicity of the procedures and versatility. In this scenario, our focus is on the development of new material and methods for biosynthesis of nano particles. CdO is one of the most important semiconductors which has attracted great attention from the scientists worldwide due to its interesting properties such as higher conductivity and transmission with prominent applications. It is an n-type wide band gap semiconductor with a direct band gap at 2.5 eV and an indirect bandgap 2.0 eV . Reduction in the dimensionality of such materials from the three dimensional bulk phases to the zero-dimensional nano particles can lead to enhanced non-linearity, determined by the quantum size effects and other mesoscopic effects [5]. Due to its interesting applications an attempt has been made to synthesise CdO nanoparticles. Liu et al. synthesized CdO nano needles by chemical vapour deposition. CdO nano wires have been synthesized by decomposing $CdCO_3$ in a KNO_3 salt flux [6]. Zou et al. have prepared CdO nanoparticles by the micro-emulsion method employing. There is also a report of stearate coated CdO nanoparticles of 5–10 nm size range, obtained by the micro-emulsion method starting from an aqueous solution of a cadmium salt and stearic acid in xylene .Wu et al. prepared a nano meter-sized CdO organ sol from an aqueous solution of Cd(NO3)2, in the presence of a surfactant and toluene as solvent. Some have modified the synthesis procedure for CdO with the aim of improving chemical and physical properties of the material.

II RESULTS AND DISCUSSION

Powder X-ray diffraction (PXRD)

Fig. 1 demonstrates the typical PXRD patterns of CdO nano particles (NPs) using 2ml,4ml and 6ml Synadenium grantii plant latex as fuel and the observed pattern was in good agreement with the standard JCPDS file (05-0640). No diffraction peaks corresponding to other impurities were observed. The average crystallite size calculated from the broadening of diffraction peaks and were found to be 35 nm, 33 nm and 25 nm as shown in the Table 1.The diffraction

peaks were observed at scattering angle (2θ) of 32.90, 38.280,55.240,65.870 and 69.160 corresponding to reflection (111), (200), (220), (311) and (222) crystal planes as shown in the Fig 1. Further the dislocation density (δ) of CdO NPs are calculated by William and Smallman's equation

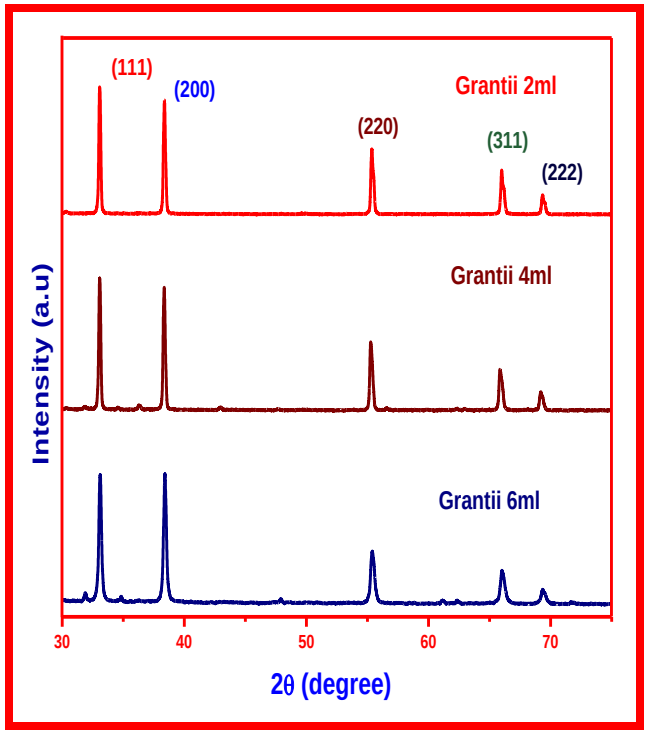

Figure 1 PXRD patterns of CdO prepared using latex of *Synadenium grantii* as fuel (2ml, 4ml and 6ml)

$$\delta = 1/D2 \quad \text{..... (1)}$$

Where D is the particle size in nm. The average dislocation density for 2ml,4ml and 6ml Synadenium grantii was found to be 0.7830×10 15 to 1.4940×1015 as shown in Table 1.The small δ for CdO NPs indicates higher crystallisation of the sample. Thus 2ml shows high level of surface defects and deteriorates crystal quality. But 4ml and 6ml CdO NPs shows the low level of surface defects. The average crystallite size of CdO NPs was determined from Scherer equation

$$D = \frac{k\lambda}{\beta cos\theta} \quad \text{..... (2)}$$

stress is calculated using the equation

$$\sigma = \varepsilon Y \quad \text{..... (3)}$$

By combining Scherer equation and Williamson-Hall an analysis was done. The following results give the equations for Williamson-Hall analysis. Therefore

$$\beta_{hkl} = \left(\frac{k\lambda}{D\ cos\theta}\right) + 4\varepsilon\ tan\theta \quad \text{..... (4)}$$

Rearranging Equation (4) we get the equation

$$\beta\ cos\theta = \frac{K\lambda}{D} + 4\varepsilon\ sin\theta \quad \text{..... (5)}$$

Equation (5) stands for Uniform Deformation Model (UDM) where it is assumed that strain is uniform in all crystallographic directions. From the lattice parameters calculations it was observed that this strain might be due to the lattice shrinkage. Fig 2 (a) shows W-H plot (UDM) of CdO nanoparticles using *Synadenium grantii* latex as fuel.

Table 1: Crystallite size, strain, Dislocation density and stress of CdO nano particles prepared by various concentration of Synadenium grantii plant milky latex

Sample (ml)	Scherrer Equation D (nm)	Strain ε x 10^{-3}	Dislocation density δ= $1/D^2$ x10^{15}	Stress σ=εY x 10^6 Nm^{-2}
2	35	1.00	0.783	150
4	33	1.06	0.884	160
6	25	1.38	1.494	208

Using the intercept and slope particle size and micro strain were calculated.UDM analysis is shown in Table 2. Observing the linear proportionality between stress and strain σ = Yε, USDM was a plot of β cosθ versus 4 sinθ /Y (whereY= 130x10^9 Nm^{-2}). The USDM plot is shown in Fig 2(b).The graph of β cosθ versus 4 sinθ /$(Y/2)^{1/2}$ (where Y= 130x10^9 Nm^{-2}) was plotted. The plot obtained is shown in Fig 2(c). Using the intercept and slope particle size and energy density were calculated. Micro strain ε = $(2u / Y)^{1/2}$ and stress σ = εY were also calculated. UDEDM analysis results are shown in Table 2. From the graph we can conclude that as the particle size decrease increases strain decreases and energy density increases.

Table 2 Crystallite size, strain, stress and energy density of CdO nano particles prepared by various concentration of Synadenium grantii plant milky latex

Sample	UDM		USDM			UDEDM			
	D (nm)	ε x10^{-3}	D (nm)	ε x10^{-3}	σ MPa	D (nm)	ε x10^{-3}	σ MPa	U kJm^{-3}
2ml	48	1.52	48	1.52	228	48	1.52	228	2310
4ml	46	1.73	46	1.732	259	46	1.73	259	2992
6ml	35	2.21	35	2.211	331	35	2.21	331	4884

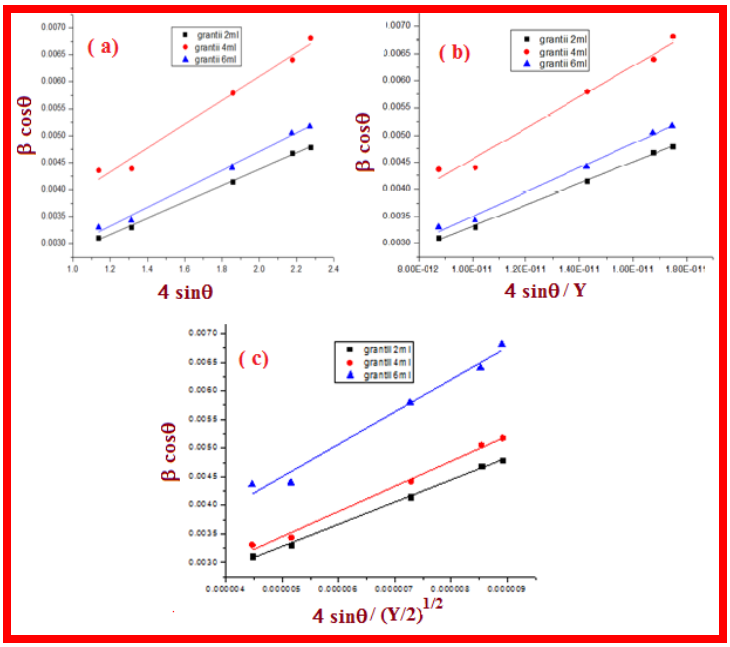

Figure 2 The W-H (a) UDM plot (b) USDM and (c) UDEDM of CdO

Fourier Transform Infrared spectroscopy (FTIR)

Fig 3 shows the FT- IR spectra for CdO sample, which was prepared using 2 ml, 4ml and 6 ml of *S.grantii* latex. The characteristic peak of CdO was recorded at 1384 cm^{-1}. A broad band in the range of 3600-3250 cm^{-1} is due to the -OH stretching of water molecules which is associated chemically with CdO. The transmittance peaks at 1623 cm^{-1} can be assigned as symmetric stretching mode of C=O [7].

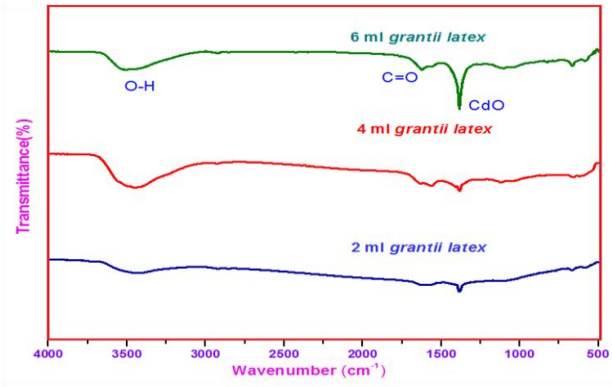

Figure 3 FTIR of CdO prepared by latex of Synadenium grantii (2ml,4ml,6ml)

UV- Visible spectroscopy

The UV–visible absorption spectra of CdO nanoparticles are shown in Fig 4. Even though the light source was restricted within its wavelength in the spectrometer, the corresponding maximum wavelength in the absorption spectra was found to have a blue shift. This blue shift was due to the quantum confinement of the excitons present in the sample [8]. Thus this optical phenomenon shows the nanoparticles experience a quantum size effect. By taking the extension of the linear part and using the formula $E_g = hC/\lambda$, the energy gap was calculated and is found to be nearly 3.6 eV, 3.72 eV, 3.8 eV respectively for 2 ml, 4 ml and 6 ml latex respectively.

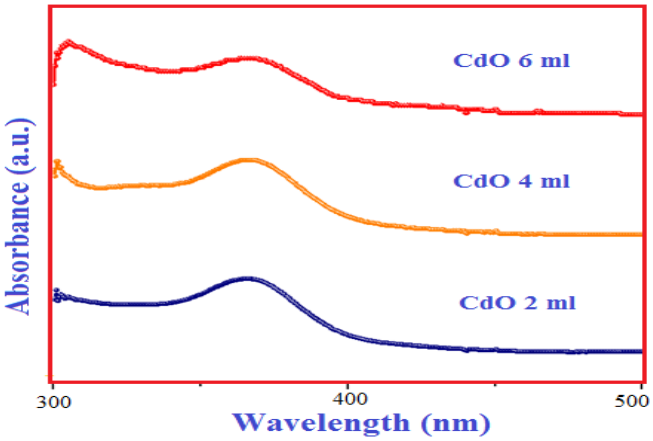

Figure 4 UV-vis spectra of CdO synthesised using 2 ml, 4 ml, 6 ml of *Synadenium grantii* latex as fuel

Transmission electron microscopy

Fig 5 shows the TEM image of CdO synthesized using 2 ml, 4 ml and 6 ml *Synadenium grantii* latex as the reducing agent. The average particle size was found to be around 500 nm. Most of the particles were found to be in elliptical or spherical in shape. Some particles show well defined crystalline structure also. Fig 5 (d) gives SAED pattern which clearly shows the planes corresponding to the (hkl) values (110), (200),(220) and (311) respectively. The inter planar spacing from HRTEM Fig 5(e) was found to be 4.128 Å.

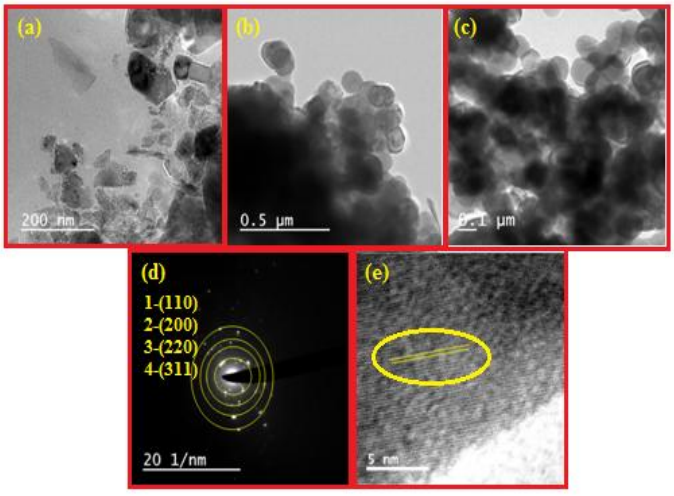

Figure 5 TEM images of (a) 2 ml (b) 4 ml and (c) 6 ml CdO and its (c) SAED pattern (d) HRTEM

III CONCLUSIONS

We have synthesised CdO nano particles using Synadium grantii latex as fuel followed by the calcination at 750℃ for 2 h. From XRD and TEM data obtained the particle size were ~ 50 nm.The advantage of this method that is eco friendly, fast, convenient for synthesis of CdO nanoparticles. The TEM images shows the spherical nature of CdO particles. FTIR confirmed the CdO particles in the sample. The UV–visible analysis showed the band gap of CdO semi conductor which is around 2.45.eV. The particle size is found to decrease with increase in fuel concentration, where as the micro strain is found to increase with fuel concentration.

REFERENCES

[1] A.A.Dakhel , H.Hamad, *Journal of Solid StateChemistry*, 208(2013)14–19

[2] S. Sivakumar, A. Venkatesan, P. Soundhirarajan, Chandra Prasad, *Molecular and Biomolecular Spectroscopy* , 151(2015)760–772

[3] M. Thambidurai, N. Muthukumarasamy, A. Ranjitha, Dhayalan Velauthapillai, *Journal Superlattices and Microstructures* ,86 (2015) 559–563

[4] SumeetKumara, SamarLayek, MadhuYashpal, AnimeshK.Ojha, *Journal of Magnetism and Magnetic Materials*, 393(2015)555–561

[5] Y. Liu, C. Yin, W. Wang, Y. Zhan, and G. Wang, *Journal of Material Science Letter*, 21(2001)137

[6] X. Wu, R. Wang, B. Zou, L. Wang, S. Liu, J. Xu, *Journal of Material Research,*13(1998)604

[7] B.S. Zou, V.V. Volkov, Z.L. Wang, *Chemistry of materials*, 11(1999)3037

[8] K. Kavyarasu, E. Manikandan, P. Paulaj, S. B. Mohammed, J. Kennedy, *Journal of Alloys and compounds*, 593(2014)67-70