Novel Co-Precipitation Method for Synthesis of Nanostructured Nickel Oxide in Accordance to PH: Structural and Optical Properties as an Active Optical Filter

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Abstract

Low cost Co-Precipitation method was used for Preparation of novel nickel oxide (NiO) nano particle thin films with Simple, with two different PH values 6, 12 and its effect on structural and optical properties as an active optical filter. Experimental results of structural properties X-ray diffraction (XRD) showed that both Nickel oxide nanoparticles with (PH=6 and 12) have polycrystalline structure smaller average particle size about 8.5 nm for PH = 6 in comparison with PH = 12. Morphological studies using Scanning electron microscopy (SEM) and atomic force microscope (AFM) show uniform nano rod distribution for PH=6 with smaller average diameter, average roughness as compared with NiO with PH=12 that showed larger diameter, grain size, spherical shape with scope of excellent sensing applications due to high roughness. Optical properties results show blue shift for PH = 6 as compared with PH=12m leading to potential of optoelectronic applications and as active optical

Keywords: Nickel Oxide, Co-precipitation method, PH, particle size, nanostructure.

1. Introduction

Nickel oxide is considered a unique p-type semiconductor due to its structure of defects, and special properties [1]. NiO attracted Researchers interest for the potential use in several applications such as: magnetic materials, gas sensors, and fuel cells [2]. Many techniques have been used for fabrication of NiO nano particles such as: sol-gel method [3], spray pyrolysis [4], thermal decomposition [5] Ultrasonic radiation [6], hydrothermal synthesis [7]. The aim of this research is synthesized nickel oxide nano particles in two different PH then study its effect on nano particle size, structure and optical properties.

2. Experimental Methods

Two solutions of 0.01 M $Ni(NO_3)_2.6H_2O$ were solute in 100 ml Double deionized water with continuous stirring for 10 min then: first solution was added to (0.1 M) NaOH (PH = 12), second solution was added to (0.05 M) NaOH (PH = 6). the followed by drying in 120ºC for 6 hours. Calcination process occurred at 450ºC for 4 hours. Sampled were deposited on glass for further characterization of X-ray diffraction (XRD) with CuKα radiation (λ = 1.5405ºA) to investigate crystallite size.

3. Results and Discussion:

3.1 Structural Properties:

Figure 1. shows x-ray diffraction pattern with five peaks with preferential orientation 2θ=43.4º and cubic phase. XRD peaks are 2θ= 37.2º, 43.4º, 62.8º, 75.4º, 79.6º JCPDS card [file number: 4-0835] [8]. Particle sizes can be calculated due to Debye –Sheerer formula:

$$D = 0.9 \frac{\lambda}{COS\ \theta} \quad (1)$$

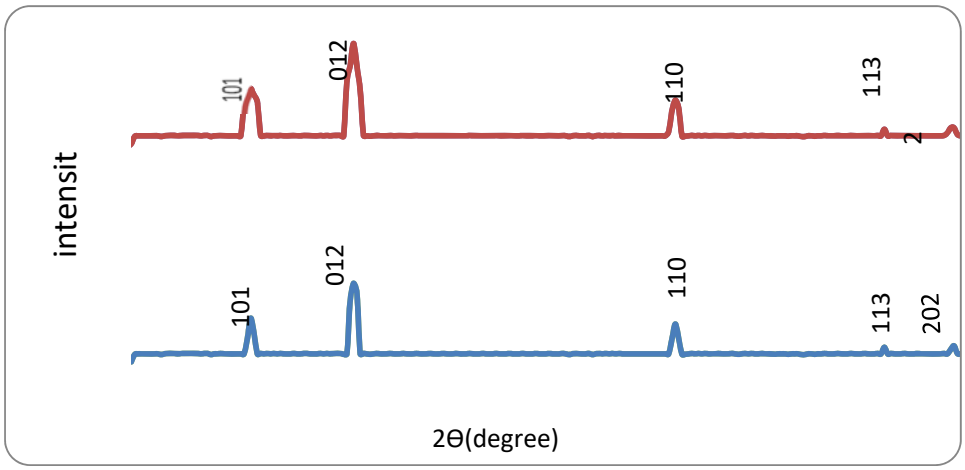

Figure 1. XRD pattern for the prepared sample.

Table 1. illustrate the comparison of Nickel oxide with PH=6 and PH=12. Nickel oxide with PH=6 has smaller particle size about 8.5 nm while Nickel oxide with PH=12 has greater particle size about 20nm. both have polycrystalline structure.

Table 1. XRD parameters for the prepared samples

Sample	β (rad)	D(nm)	ε (* 10^{-3} lines $^{-2}$ m^{-4})	Δ	hkl
NiO (PH=6)	0.98	8.5	3.97	0.013	101 012 110 113 202
NiO (PH=12)	0.52	20	2.1	0.0025	101 012 110 113 202

The SEM images for NiO nano particles is shown in **Figure 2.** to investigate surface morphology of the synthesized samples NiO nano particles with (PH=6) showed uniformly distributed nano rod shapes While NiO nano particles with (PH=12) have spherical shapes with some agglomeration due to tendency to have high surface energy. It is concluded that NiO nano particles with (PH = 6) had smaller particle size in comparison with NiO nano particles with (PH = 12) with uniform distribution of nano rods which encourage catalytic activity of nano particles. AFM analysis showed high average roughness (1.94 nm) for NiO nano particles with (PH = 12) in comparison with NiO nano particles with (PH = 6) which were (0.995 nm) as shown in **Figure 3**.

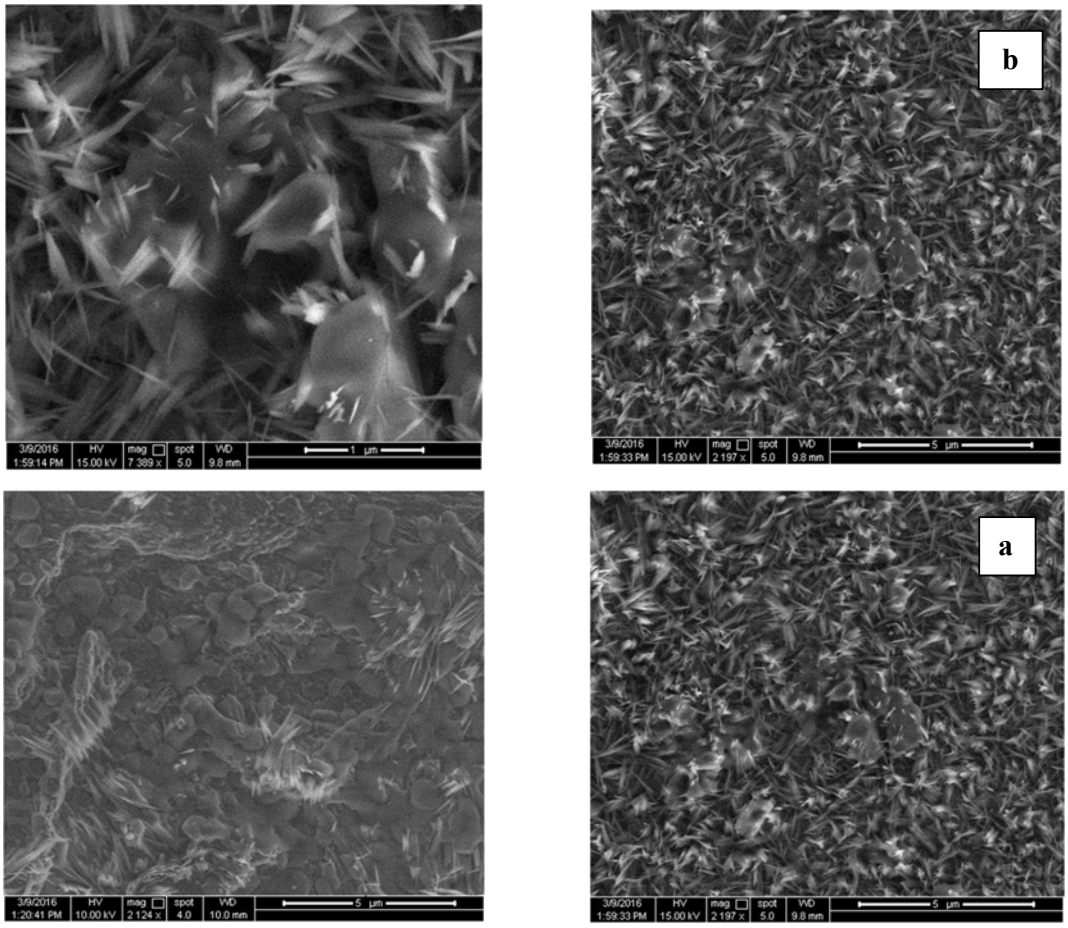

Figure 2. SEM images for a- NiO nanoparticles (PH=6) and b- NiO nanoparticles with (PH=12).

The UV-V is characterization spectrum was investigated to calculate optical Energy gap. It was found that absorption peak from UV absorption spectrum was about 348nm with blue shift in comparison with bulk NiO. The calculated band gaps for NiO with (PH = 6) was (4eV) while NiO with (PH=12) was (3.83eV) as shown in **Figure 4.** It can be due to larger particle size for NiO with (PH=12) compared with NiO with (PH = 6). Equation (2). was used to calculate energy gap using [1, 9, 10]:

$$\alpha h\nu = A(h\nu - Eg)^n \quad (2)$$

Where A is constant related with inter band probability, Eg is referred to optical energy gap and n is characteristic for the nature of transition process where n = 2 (direct transition) [12].

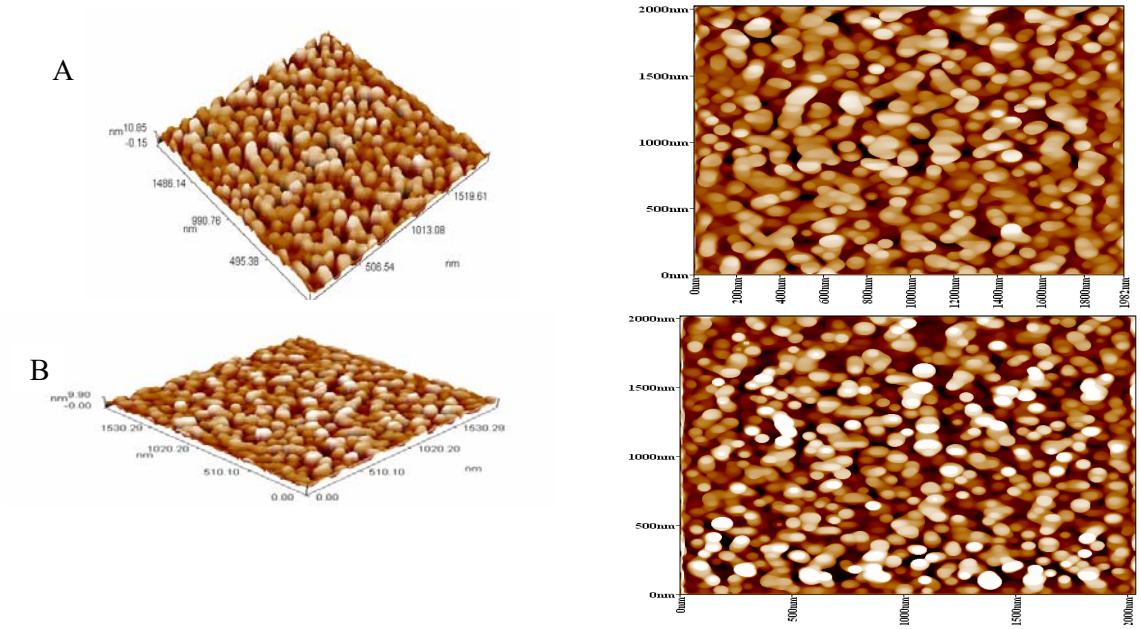

Figure 3. AFM images a- NiO nanoparticles with (PH=6) and b- NiO nanoparticles with (PH=12).

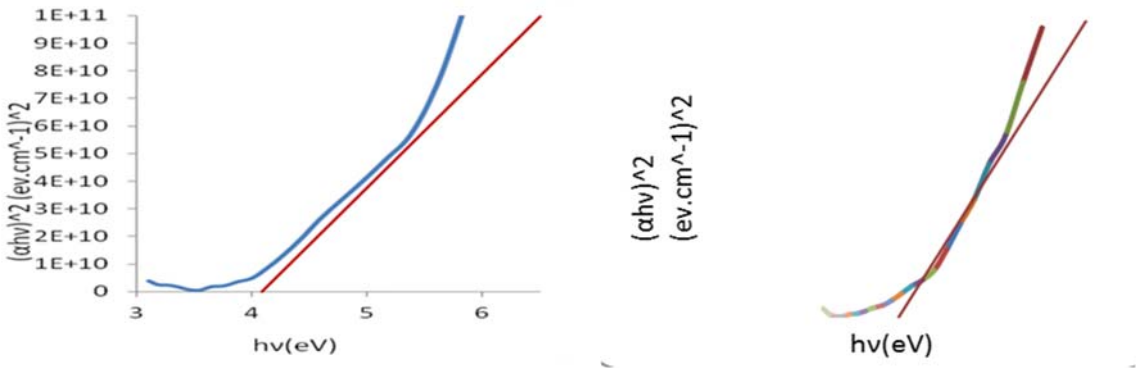

Figure 4. (αhv) ^2 as function of (hv) for a- NiO with PH=6 and b-NiO with PH=12.

Table 2. AFM surface analysis**.**

PH	Average Roughness (nm)	Root mean square (r.m.s) (nm)
PH=6	0.995	1.17
PH=12	1.94	2.38

4.Conclusions

Nickel Oxide nano particles were synthesized using Co-Precipitation method with two different (PH = 6 and 12) to investigate PH effect on size and shape of nano particles. XRD results indicate that Nickel oxide with (PH = 6 and 12) have polycrystalline structure smaller average particle size about 8.5 nm for (PH = 6) win comparison with PH=12.UV-VIS spectrum Showed blue shift for (PH = 6) as compared with (PH = 12). SEM and AFM Morphological studies showed uniform nano rod distribution for (PH = 6) with smaller average diameter and average roughness as compared with NiO with (PH = 12). This study enhances the idea of use NiO nano particles for different and wide range applications according to PH values in various industries.

Literature Contribute

This study attract attention on nickel oxide nano particles synthesized in simple, low cost, friendly method with two PH values= 6,12. Uniform nano rod with blue shift spectra obtained from NiO nano particles with PH=6 e emitters, catalyst, NiO nano particles with PH=6 possessed rough surface which enhance gas sensing applications.

Conflict of Interest

Dr-zehraa najim declare that there is no conflict of interest.

References

1. Devi, B.S.R.; Raveendran,R.; Vaidyan, A.V., J. Pramana. Synthesis and characterization of Mn2+-doped ZnS nanoparticles. *Pramana – Journal of Physics*. **2007**, *68, 4*, 679-687.
2. Din, M. I.; Rani, A**.** Recent Advances in the Synthesis and Stabilization of Nickel and Nickel Oxide Nanoparticles: A green Adeptness*, International Journal of Analytical Chemistry*. **2016**, *4*, 1-14**,** doi.org/10.1155/2016/3512145.
3. El-Kemary,M.; Nagy,N.; El-Mehasseb, I. Nickel Oxide nanoparticles: Synthesis and spectral studies of interactions with glucose.Materials Science in Semiconductor Processing. **2013**, *16, 6*, 1747–1752.
4. Han, D.Y.; Yang, H.Y.; Shen, X.; Zhou,C.B. ; Wang F.H., Synthesis and size control of Nio Nanoparticles by water- Powder-In-Oil Microemulsion. *Powder Technology Powder* Teach. Elsevier. **2004**. *147, 1-3,*113-116.
5. Ravindhranath,K; Ramamoorty,M. Nickel Based Nano Parles as Adsorbents in Water Purification Methods - A Review. *Orient J. Chem*. **2017**, *33, 4,* 1603-1613.
6. Palombari, R. Influence of surface acceptor–donor couples on conductivity and other electrochemical properties of nonstoichiometric NiO at 200 °C. *J. Electroanal. Chem*. **2003**. 546, 23-28.
7. Pulimi, V. R. R.; Jeevanandam,P. Effects of calcinations temperature and precursor concentration on crystallinity of Nio nanocrystalline powder synthesized via Ethylene Glycol rote;*Alp conference proceeding*. **2009,** *321,* 2556-2562.

8. Sang-Jin, L.; Young-Min, H.; Choong-Hwan, J.; Ji-Yeon, K.Nano-Sized Nickel Oxide Powder Synthesized by Organic- Inorganic Solution Route. *Journal of Nanoscience and Nanotechnology.**2013**.13, 2,* 1520-1524.
9. Tao, D.; Wei, F. New Procedure towards Size-Homogeneous and Well-Dispersed Nickel Oxide Nanoparticles of 30 nm. *Mater. Letts.* **2004**, *58, 25*, 3226-3228 .
10. Teoh, L.G.; Li, *K.*Synthesis and Characterization of NiO Nanoparticles by Sol Gel Method. *Materials Transactions.***2012**.*53, 12,* 2135-2140.
11. Visuvasam, A.S.; Dineshbabu, N.R. Study the Structural and Optical Properties of Nickel Oxide Nanoparticles, Inter. *J. Adv.Res.* **2016**.*3, 13.*
12. Xiang, L.; Deng, X.Y.; Jin,Y. Experimental study on synthesis of NiO nano-particles. Scripta Mater. Elsevier. **2002**.*47, 4*, 219-224.