

Preparation and Characterization of Nickel Oxide Thin Film

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ABSTRACT: NiO thin film was successfully prepared by using Spray pyrolysis method from the aqueous solution of Nickel Chloride (NiCl₂). Characterization of nickel oxide thin film studied

I. INTRODUCTION

1.1. Analysis

When high-frequency electromagnetic waves are selected to have a wavelength in the order of interplanar spacing of crystals, they are diffracted according to Bragg's law. The typical inter-atomic spacing in crystal is in the order of 2-10 Å. So, the wavelength of the radiation used for crystal diffraction should be in the same range. X-rays have wavelengths in this range and thus diffracted by crystals. Hence, an excellent experimental verification for the crystal structures can be availed by X-ray diffraction. This method is an important technique for the characterization of thin films, since it gives a very broad range of information about the material such as crystal structure.

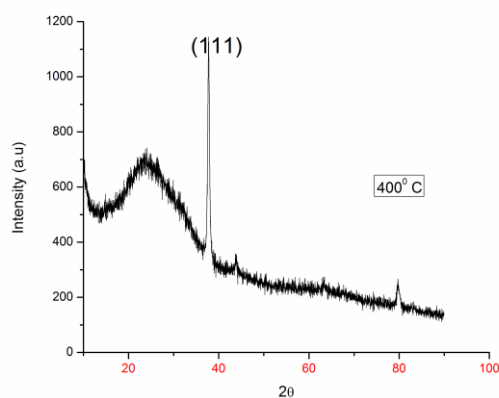


Figure 1 XRD spectra of the NiO film deposited at 400°C

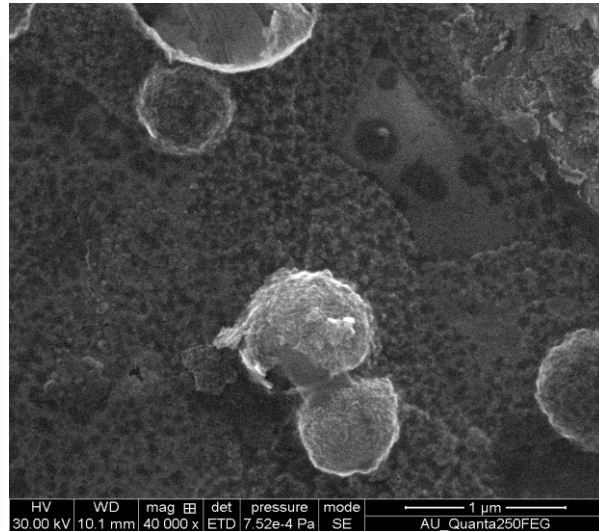
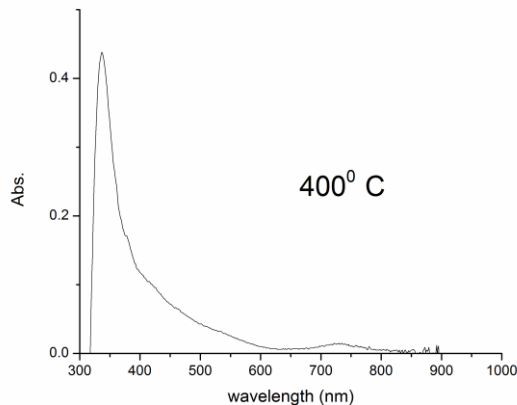


Figure 2 shows the absorption spectrum of the NiO film deposited 400°.

Figure 3 SEM image of the NiO film deposited at 400°C

Figure 5.1 shows the XRD pattern of NiO thin film prepared at substrate temperature 400°C. From the XRD spectra, it is clearly observed that the prepared NiO film shows poly crystalline nature with a dominant peak along the plane (111). This corresponds to cubic NiO. The grain size was calculated for this plane (111) as 96nm using to Scherer's formula

$$D = \frac{0.94 \lambda}{\beta \cos\theta}$$

II. SEM ANALYSIS

Scanning electron microscopy is used for inspecting topographies of specimens at very high magnifications using a piece of equipment called the scanning electron microscope. A beam of electrons is focused on a spot volume of the specimen, resulting in the transfer of energy to the spot. These bombarding electrons, also referred to as primary electrons, dislodge electrons from the specimen itself. The dislodged electrons, also known as secondary electrons, are attracted and collected by a positively biased grid or detector and then translated into a signal.

To produce the SEM image, the electron beam is swept across the area being inspected, producing many such signals. These signals are then amplified, analyzed and translated into images of the topography being inspected

Fig 3 shows the SEM image of prepared NiO thin film at substrate temperature 400°C. It reveals that the prepared

The absorption spectrum of NiO thin film has an absorption edge around 336nm.

The optical absorption co-efficient is related to energy band gap and it is given by the following equation

$$\alpha h\nu = B (h\nu - E_g)^n$$

where,

h is the Planck's constant,

B is a constant

and E_g is the optical band gap.

Apparently, the plot of $(\alpha h\nu)^2$ or $(\alpha h\nu)^{1/2}$ against $(h\nu)$ provides the nature and 'Eg' value of the film.

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2.1 Band gap energy calculation

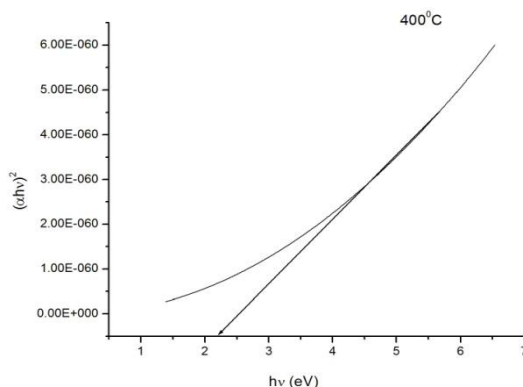


Figure 4 shows the NiO film deposited 400°.

By extra plotting this curve the band gap energy value was calculated as 2.2eV

Hence, through UV-Vis spectrophotometer, bandgap energy of the material determined as 2.2 eV. The band gap energy of bulk NiO is 3.84eV reported by M.NowsathRifaya on chemical capping synthesis of nickel oxide nanoparticles and their characterizations studies. The value of band gap energy carried out that the decrease in band gap shows the red shift of nanostructure from the bulk material.

III. CONCLUSION

- NiO thin film was successfully prepared by using Spray pyrolysis method from the aqueous solution of Nickel Chloride (NiCl₂).
- XRD pattern confirms the poly crystalline nature of the film with preferential orientation along the plane (111) which corresponds to cubic NiO.
- SEM image reveals the formation of spherical shaped NiO with grain size 96nm oriented randomly over the substrate.
- From the UV-Vis absorption spectrum, the band gap energy was calculated as 2.2eV.

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