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Determination Optical and Structure Properties for Semiconductor Marital Manufacture by Nickel oxide Doped by Magnesium

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Abstract

In this work, nickel oxide Nano-material samples were prepared with different concentrations (0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 and 1) m Molar by doping with magnesium oxide with respect to the formula ($Ni_xMg_{1-x}O_2$).
Optical properties of nickel doped by different concentration of magnesium was measured using the UV- Spectroscopy min 1240. The Nano crystal size of all samples were measured by XRD technique, and also studying the effect of different concentrations on the particle size and crystal properties of all samples.

The study the effaced of different concentration on the optical parameters before and after irradiation by gamma rays, for all samples the absorbance increases upon increasing the concentration, while the transmission decreases. The value of Energy band gap (E_g) was decreased from (3.757) eV to (3.503) eV. The density increasing by rat 0.009 mg. Cm^3/molar. Particle Size decreasing by rated
3.18 nm / molar, and d-spacing were decrease molar rated 1.9x 10^{-10}m / molar.

Introduction

The nickel is a chemical element, with symbol Ni and atomic number (Z) is
28, group ten in the periodic table after the cobalt and before the copper. It is a silvery-white lustrous metal with a gold tinge, nickel is hard and ductile transition metal. Pure nickel, powdered to maximize reactive surface area, shows as a significant chemical activity, put larger pieces are slow to react with air under standard conditions because an oxide layer forms on the surface and prevents corrosion. Nickel oxide is a chemical compound with formula (NiO), it is the principal oxide of nickel, it is classified as a basic metal oxide [1] even so pure native nickel is found in earth's crust only in tiny amounts, usually in ultramafic rocks [2, 3] and in the interiors of larger nickel-iron meteorites that were not exposed to oxygen when outside earth's atmosphere [4]. Nickel is slowly oxidized by air at room temperature and is considered corrosion-resistant. Historically, it has been used for plating iron and brass, coating chemistry equipment, and manufacturing certain alloys that retain a high silvery polish, such as German silver. About 9% of world nickel production is still used for corrosion- resistant nickel plating. Nickel- plated objects sometimes provoke nickel allergy. Nickel has been widely used in coins. Alnico permanent magnets based partly on nickel are of intermediate Strength between iron-based permanent magnets and rare-earth magnets. The metal is valuable in modern times chiefly in alloys, about 68% of world production is used stainless steel. further 10% is used for nickel-based alloys, and 7% for alloy steels , 3% in foundries, 9% in plating and 4% in other applications , including the fast-growing battery sector [5] including those in electric vehicles [6], as a compound , nickel has

a number of niche chemical manufacturing uses, such as a catalyst for hydrogenation, cathodes for rechargeable batteries, pigments and metal surface treatments[7] nickel is an essential nutrient for some microorganisms and plants that have enzymes with nickel as an active site [8].Solids are materials whose atoms are bonded strongly enough to form a rigid structure, the elements and their compounds which aggregate into the solid cuble, classified as amorphous, poly crystalline, single crystalline materials depend on arrangement of atoms in the materials. When the atoms in the materials are arranged in regular manner with a three – dimensional periodicity that extends throughout a given volume the solid, the material is considered to be as crystal. In poly crystalline materials the periodic arrange of atom is interrupted randomly along two-dimensional sections that can interest dividing a given volume of solid into a number of smaller single crystalline regions. If, however, there is no periodicity in the arrangement of atom the material is classified as amorphous. Although semi conducting properties are observed in all three classes of solids, we restrict our attention to semi conducting materials in single crystalline for doing this. The erotically, when we consider that the spacing between nearest neighbor atoms in a solid is typically several angstroms (10^{-8} cm) we find this enormous number of atoms were arranged randomly in the material it would be very difficult to construed a useful physically theory of semiconductor behavior [9].

In single crystals however, the theoretical problems are reduced to manageable size and we find that many of the important properties of solids are actually determined by the periodicity of the atoms. Practically the use of single crystal is greatly simplifying a number of the processing steps the high device fields that are characteristic of modern integrated circuit technology. Also charge carriers in device operations, most useful semiconductor devices are fabricated with single crystalline material. Semiconductor materials at have basically the same structure as insulators filled valence band separated from any empty conduction band by a band gap containing no allowed energy states. Band gap is the distance between the valence bands essentially, the band gap represents the minimum energy that required to excite an electron up to a state in the conduction band where it can participate in condition [10]. The difference ties into size of band gap E_g , which is smaller in semiconductors than in insulators. The relatively small band gaps of semiconductors allow for excitations of electrons from the lower valence band to the upper conduction band by reasonable amount of thermal or optical energy at the room temperature semiconductors with E_g 1.0ev will have a significant number of electrons excited thermally a cross the energy gap into the conduction band, where as an insulator with E_g ~ 10.0 eV will have an eligible number of such excitations. Thus, an important difference between semiconductors and insulators is that the number of electrons available for conduction can be increased greatly in semiconductors by thermal or optical energy. The distinction between insulators and semiconductors is one of degree rather than kind insulator has larger band gaps perhaps 3 eV on more, while semiconductors have band gaps ranging from 2.5 eV down to 0.1 eV. In metals the bands either overlap or one only partially filled thus electrons or empty energy states are intermixed within the bands so that electrons can move freely under the influence of an electric field.

Materials and Methods

Sample preparation

10 samples of Nickel oxide doped by magnesium oxide with respect to the formula ($Ni_xMg_{1-x}O$) were synthesized by chemical precipitation method were dissolved in100 mL double distilled water (de-ionized water) separately under stirring at room temperature**,** drop wise addition of Magnesium with rated (0.1, 0.3, 0.5, 0.7 and 0.9) m Molar solution was stirred using magnetic stirrer at 3000 rpm for 2 hours at room temperature. Then the annealed sample was grinded to get the powdered nanoparticles, the crystal structure of all samples

characterized at 80^{o} temperature. The optical properties of all samples characterized at room temperature using min 1240 UV- Spectroscopy. From optical spectra of synthesized calculate all optical properties (Absorption, transition, Reflection, Absorption Coefficient, Extinction coefficient, Optical Energy Band Gap, Refractive Index, Real Dielectric Constant and Imaginary Dielectric Constant).

Method

The Materials Characterization Lab has a wide variety of characterization techniques in the areas of X-ray diffractometer, and min 1240 UV- Spectroscopy techniques which help to increase the different degrees of understanding why different materials show different properties and behaviors.

To investigate the optical properties of Nickel doped by magnesium with rated (0.1, 0.3, 0.5, 0.7 and 0.9) m Molar nanoparticles, some precise techniques have been used in our study. The following characterizations have been potentially performed for the analytical of the synthesized samples.

Ultraviolet -visible spectroscopy (UV-VIS)

Ultraviolet and Visible Spectroscopy is absorption spectroscopy uses electromagnetic radiations between 190 nm to 800 nm and is divided into the ultraviolet (UV, 190-400 nm) and visible (VIS, 400-800 nm) regions. Since the absorption of ultraviolet or visible radiation by a molecule leads transition among electronic energy levels of the molecule, it is also often called as electronic spectroscopy. When radiation interacts with matter, a number of processes can occur, including reflection, scattering, absorbance, Fluorescence phosphorescence (absorption and emission), and photochemical reaction (absorbance and bond breaking).In general, when measuring UV-visible spectra, we want only absorbance to occur. Because light is a form of energy, absorption of light by matter causes the energy content of the molecules (or atoms) to increase. The total potential energy of a molecule generally is represented as the sum of its electronic, vibrational, and rotational energies.

Figure (1): UV mini 1240 spectrometer shimadzu

X-ray diffractometers (XRD)

X-ray diffractometers consist of three basic elements: an X-ray tube, a sample holder, and an X-ray detector. X-rays are generated in a cathode ray tube by heating a filament to produce electrons, accelerating the electrons toward a target by applying a voltage, and bombarding the target material with electrons. When electrons have sufficient energy to dislodge inner shell electrons of the target material, characteristic X-ray spectra are produced. These spectra consist of several components, the most common being Kα and Kβ. Kα consists, in part, of Kα1 and Kα2. Kα1 has a slightly shorter wavelength and twice the intensity as Kα2.

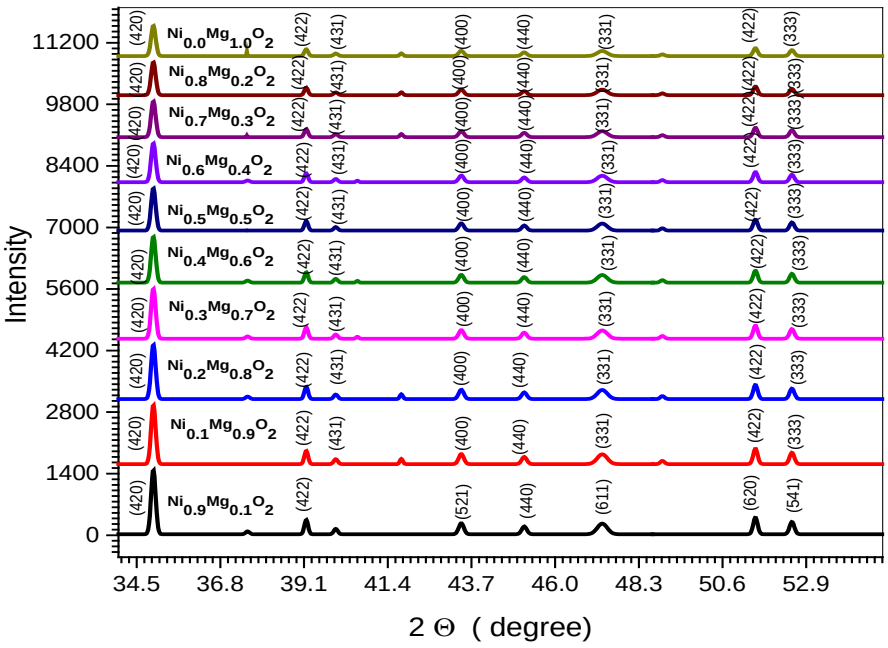
The specific wavelengths are characteristic of the target material, Filtering by foils or crystal monochromators, is required to produce monochromatic X-rays needed. For diffraction Kα1and Kα2 are sufficiently close in wavelength such that a weighted average of the two is used. Copper is the most common target material for single-crystal diffraction, with CuKα radiation = 1.5418Å. These X-rays are collimated and directed onto the sample. As the sample and detector are rotated, the intensity of the reflected X-rays is recorded. When the geometry of the incident X-rays impinging the sample satisfies the Bragg Equation, constructive interference occurs and a peak in intensity occurs. A detector records and processes this X-ray signal and converts the signal to a count rate which is then output to a device such as a printer or computer monitor. The geometry of an X-ray diffractometer is such that the sample rotates in the path of the collimated X-ray beam at an angle θ while the X-ray detector is mounted on an arm to collect the diffracted X-rays and rotates at an angle of 2θ. The instrument used to maintain the angle and rotate the sample is termed a goniometer.

For typical powder patterns, data is collected at 2θ from ~5° to 70°, angles that are preset in the X-ray scan.

Figure (2) X-Ray diffractometer: XRD (wavelength 1.54 A°)

Results and Discussion

This study used of XRD for analysis and characterization of $Ni_xMg_{1-x}O_2$ samples.



Fig(3): XRD spectrum of Nickel doped by Magnesium $Ni_x Mg_{1-x} O_2$ before exposure by Gamma ray (35gray)

XRD Data		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Space Group		I a -3 d (230)	I a -3 d (230)	I a -3 d (230)	I a -3 d (230)	I a -3 d (230)	I a -3 d (230)	I a -3 d (230)	I a -3 d (230)	I a -3 d (230)	I a -3 d (230)
Crystal System		cubic	cubic	cubic	cubic	cubic	cubic	cubic	cubic	cubic	cubic
Cell Parameters 10^{-10} m	a	11.47	11.47	11.47	11.47	11.47	11.47	11.47	11.47	11.47	11.47
	b	11.47	11.47	11.47	11.47	11.47	11.47	11.47	11.47	11.47	11.47
	c	11.47	11.47	11.47	11.47	11.47	11.47	11.47	11.47	11.47	11.47
Density ($g.cm^{-3}$)		3.683	3.681	3.679	3.675	3.673	3.671	3.669	3.667	3.664	3.662
Volume $(10^{-10})^3$		594.0	594.1	594.3	594.6	594.9	595.1	595.3	595.5	595.7	595.9
d (10^{-10} m)		1.762	1.765	1.767	1.769	1.771	1.772	1.773	1.775	1.778	1.781
Cell Angular	alpha	90	90	90	90	90	90	90	90	90	90
	beta	90	90	90	90	90	90	90	90	90	90
	gamma	90	90	90	90	90	90	90	90	90	90

Table (1) XRD crystal structures parameters of Nickel doped by Magnesium $Ni_x Mg_{1-x} O_2$ before exposure by Gamma ray (35gray)

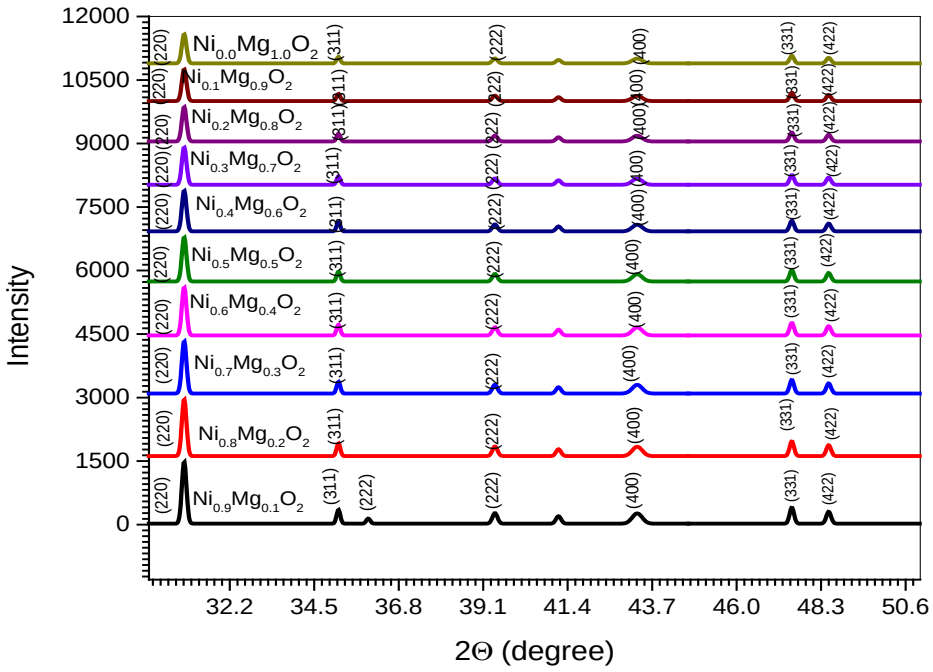


Fig (4) XRD spectrum of Nickel doped by Magnesium $Ni_x Mg_{1-x} O_2$ after exposure by Gamma ray (35gray)

XRD Data		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Space Group		F d -3 m (227)	F d -3 m (227)	F d -3 m (227)	F d -3 m (227)	F d -3 m (227)	F d -3 m (227)	F d -3 m (227)	F d -3 m (227)	F d -3 m (227)	F d -3 m (227)
Crystal System		cubic	cubic	cubic	cubic	cubic	cubic	cubic	cubic	cubic	cubic
Cell Parameters 10^{-10} m	a	8.299	8.299	8.299	8.299	8.299	8.299	8.299	8.299	8.299	8.299
	b	8.299	8.299	8.299	8.299	8.299	8.299	8.299	8.299	8.299	8.299
	c	8.299	8.299	8.299	8.299	8.299	8.299	8.299	8.299	8.299	8.299
Density ($g.cm^{-3}$)		4.683	4.681	4.679	4.675	4.673	4.671	4.669	4.667	4.664	4.653
Volume $(10^{-10})^3$		570.0	570.1	570.3	570.6	570.9	571.1	571.3	571.5	571.6	571.7
d (10^{-10} m)		2.258	2.260	2.261	2.263	2.265	2.267	2.269	2.270	2.271	2.272
Cell Angular	alpha	90	90	90	90	90	90	90	90	90	90
	beta	90	90	90	90	90	90	90	90	90	90
	gamma	90	90	90	90	90	90	90	90	90	90

Table (2) XRD crystal structures parameters of Nickel doped by Magnesium $Ni_x Mg_{1-x} O_2$ after exposure by Gamma ray (35gray)

The crystal structure of all samples characterized at room temperature using X-ray diffractometer (operated at 40 kV and current of 30 mA) and samples were scanned between 10^{O} and 80^{O}. The representative XRD charts of all ten samples different concentration Nix $Mg_{1-x}O_2$ as show in fig (3) before exposure. Miller indices provided in the figure for all peaks determine transformation of ten samples different concentration Nix $Mg_{1-x}O_2$ Molar crystallites with cubic crystal structure. Fig (3) describes the relation between the concentration and density of samples, and table (1) shows the XRD parameters value of ten samples different concentrations at various crystalline orientations.
It is show that before exposure the space group is [I a -3 d (230)] and crystal shape are cubic for all samples and the cell parameters values (a, b, c) is equal to11.47, the density between (3.683-3.662) ($g.cm^{-3}$), the density of sample increase by concentration increase the of nickel in the samples increasing. The values of volume range is (594.0-595.9) $(10^{-10}\ m)^3$ and the values of d- space are in range (1.762-1.781) (10^{-10}m), the cell angular is 90 degree for all samples after exposure fig (4) shows that the behavior of the different samples as peaks diagram and table (2) give some parameters of all samples after exposure by Gamma ray (35gray) , the space group values are F d -3 m (227) and also the shape of crystals are cubic , the cell parameters values (a ,b ,c) are 8.299 and density range (4.683-4.653) ($g.cm^{-3}$), the volume of all samples after to exposure by Gamma ray (35gray) in range (570.0-571.9) $(10^{-10}\ m)^3$, the cell angular is equal 90 degree for all samples. On the other hand, it's noticed that the rated of concentration increases concentration decreasing the crystals size, the relation between the rated of and d- spacing of concentration samples ten in different nanoparticles samples, and noticed that the rated of decreasing the d- spacing of samples different concentration.

Conclusion & Discussion

For ten samples of nickel doping by magnesium Oxide, before and after exposure there slight increase of maximum value of absorption from 1.005 (a.u) at wavelengths 318 nm to 1.008(a.u) at wavelength 295nm , also show that absorbance value increase when the molar of nickel increase, which is mean there is an increase in energy.

For absorption coefficient the maximum value was increased for the samples of nickel doping by magnesium Oxide from $4.61X10^2$ (cm^{-1}) at wave length 318 nm to $4.64\ X10^2$(cm^{-1}) at wavelength 308nm.

There is a decrease in the maximum value of transmission from 0.630 (a.u) to 0.627 (a.u) after exposure and increases of nickel concentration in the sample.
The reflection maximum value was decreased after exposure and sample behavior as a mirror. There is a decreasing in the maximum value of extinction coefficient from $1.17X10^{-3}$ at wavelength 318 nm to $1.09X10^{-3}$ at wavelength 296 nm, but there is an increasing in the maximum value of refractive index after exposure from 2.803at wavelength range (305-360)nm to 2.808 at wavelength range (288-326)nm , but the maximum value of dielectric constant was decreased from7.83 at wavelength (305-360) nm to 7.81 at wavelength range (283-336)nm, and the imaginary constant maximum value was decreased also after exposure from $3.22X10^{-3}$ at wavelength 330 nm to $2.98x10^{-3}$ at wavelength 308 nm.
The energy band gap after exposure was decreased and there is there is an energy band gap shift. The increased of optical conductivity at high
Photon energies is due to the high absorbance of the samples and may be due to electron excitation by photon energy. the maximum value of the electrical conductivity for all samples before exposure is between ($41X10^5$ and $46.6X10^5$) $(W.cm)^{-1}$ at wavelength range (310 -350)

nm, but after exposure to gamma rays the value be com between (38 $X10^5$ and 44 $X10^5$) $(W.cm)^{-1}$ at wavelength range (288 -325) nm.

In crystals analysis before and after exposure by gamma rays there is a change in space-group and cell parameters a,b,c are decrease from 11.47 to 8.299 for all samples, and there is increasing in the density range from(3.683-3.662) $(g.cm^{-3})$ to (4.683-4.653) $(g.cm^{-3})$ with decrease in the volume range from (594.0-595.9) $(10^{-10}\ m)^3$ to (570.0-571.9) $(10^{-10}\ m)^3$ for all samples, the shape of the crystals is cubic before and after exposure and the cell angular also was constant 90^0 before and after exposure.

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