Laser Irradiation Effect on the Optical Band Gap of In_2O_3 Nanocrystalline onto Quartz Substrates

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optical properties of the on (nm 337) at irradiation N_2 laser nitrogen of influence we study the In this research ***-Abstract***
.with different power average (0.85, 1.70, 2.125 mW) for irradiation time (5min) Films In_2O_3 nanocrystalline
By using UV-VIS spectrophotometer technique ,can many of the optical properties account of study change spectral transmittance and absorbance of these membranes, and energy gap for direct transitions. It was found that the band gap increases when the thickness increases and the band gap values ranges between) 3.5 eV - 3.6 eV .(and calculate the extinction coefficient and refractive index. the exposure of the as deposited films to a selected dose of laser irradiation, the optical properties films varies with increase in the power average .

Key words: Quartz substrate, Nitrogen Laser Irradiations, Nanocrystalline In_2O_3, optical Properties, CSP.

1 INTRODUCTION

A wide band gap semiconductor is indium oxide with applications in optoelectronics , optical transparency or gas sensing . There is an increasing interest in the synthesis and characteristics of low-dimensional structures of In_2O_3 which have been fabricated by different techniques, crystallizes in a cubic structure. In_2O_3 is important semiconductors with band-gap values of about) 3.4–3.5 (eV] 1 .[In_2O_3 of the optical properties, which are studied using photoluminescence, absorption and photoconductivity, reflect the intrinsic direct band gap summary .

Then indium oxide nanobelts were reported in 2001 [2], various types of In_2O_3 nanostructures, such as quasi-monodisperse In_2O_3 nanoparticles, nanowires, nanotubes, nanocubes, In_2O_3 octahedrons and fundamental-case In_2O_3 nanoparticles have been prepared via various methods [3]. The fundamental-case In_2O_3 nanocomposites have been usually synthesized by solid-state reaction, physical vapor deposition, radio frequency sputtering technique [4]. In particular, during past decade the great attention was attracted to both the growth of perfect monocrystalline In_2O_3 films and to the study of electronic, structural and stability properties of the main small-index crystallographic surfaces of these epitaxial In_2O_3 films [5–8].

In the present work, Indium oxide (In_2O_3) thin films have been prepared using chemical spray pyrolysis method, the objective of this work is to investigate the tuning of structural properties of samples after irradiation by pulses N_2 laser at different power average.

2 EXPERIMENTATION

In the present function chemical spray pyrolysis way was active ,where in this technique ,the thin films were prepared by spraying the solution on a hot quartz substrate at a positive temperature, and the film could be then found by the chemical reaction on the hot substrate .But ,in some application these thin films could must good properties, for example. It might be used in solar and sensor applications .

The spraying solution which contains the materials required for fabrication of the $InCl_3$ film can be prepared by mixing Indium chloride $InCl_3$ and distilled water as starting materials [9]. The molar concentration of the solution should be equal to (0.1 mole/liter).

In order to prepare the solution of (0.1 molar) concentrations from these two materials, (0.5529 grams) weight of $InCl_3$ are needed from each of them, melted in (25 ml) of distilled water, according to the following equation:

the material of weight (g) =Volume (ml)×Molecular concentration (mol/l) × material weight (g/mol) ……….. (1)

The weight of $InCl_3$=(25/1000)× 0.1× 0.5529 = 0.00138 g.

where the $InCl_3$ of the material weight = 0.5529 g / mol

Finally, the material of weight melted in (25 ml) of distilled water to get the wanted solution (The spray solution). The solution then sprayed and deposited on a cleaned and heated quartz substrate to (573 K) to get the finally In_2O_3 thin films and thickness (200nm).

$$2InCl_3+6H_2O \qquad 6HCl+In_2O_3 \quad \text{……….. (2)}$$

It is required to leave the quartz substrate on the electrical heater for one hour at least after finishing the operation of spraying to complete its oxidation and crystalline growth process.

The nanocrystalline were irradiated with one shot of laser beam of (5ns) pulse and different power average (0.85, 1.70, 2.125 mW) from N_2 laser system at (337 nm) wavelength.

2.1 Measurements of Thickness

In this work the experimental technique of thickness measurement was used:

Digital Scales Method:

The thin films of thickness is decided through a micro gravimet-rical technique. The films deposited on clean quartz slides whose mass had formerly been decided. After the deposition, each substrate itself is weighted again to determine the quantity of deposited In_2O_3.

Measuring the surface area of the deposited film, taking account of In_2O_3 specific weight of the film, the thickness is (200nm), concluded by the relation [8]:

$$=$$

where *A* is the actual area of the film in cm^2, In_2O_3 is the quantity of deposited indium oxide, and is the specific weight of In_2O_3.

2.3 Laser Irradiation nitrogen (N_2) Technique

The laser of nitrogen count for the reason that they could yield high –power short- period pulses of ultraviolet emission (λ=337 nm).These radiation are conventional in pumping dye radiation, spectroscopy and fluorescence studies, fast speed photography, etc.

In the present work, Indium oxide (In_2O_3) thin films have been prepared using chemical spray pyrolysis method, and irradiated pulses laser N_2 with different power average (0.85, 1.70, 2.125 mW) for irradiation time (5min) and Pulse width (2.5ns) and peak power (100kw) made in Germany that was used for the first time in the Ministry of Science and Technology in Iraq.

3.THE MEASUREMENTS OF OPTICAL

The optical parameters of the In_2O_3 thin films were determined of the passing and absorbance gamut at reasonable frequency more the range(200 – 1100) nm, through the use of UV-VIS spectrophotometer, type (SHIMADZU) (UV-1650/1700 series).

Results and Discussion

Measurements of Optical Properties The

Optical properties of high-quality significance in the have a look at of the conduct of the optical semiconductor materials, that could display the sensible use of appropriate, visible conduct is closely associated with the crystal structure of the cloth, and the installation of energy aircraft.the optical traits of the nano crystalline In_2O_3 films deposited via chemical spray pyrolysis method on quartz substrate at) 573 k (temperature with out different average power (0.85, 1.70, 2.125 mW).

Many of the optical parameters can account for studying change spectral transmittance and absorbance of these membranes, such as the expense of absorption coefficient and energy gap for direct transitions and calculate. The reflectivity, extinction coefficient , refractive index , dielectric constant real and imaginary and optical conductivity.

(3.1) Transmission (T)

Transmission of movies depends as a rule on the thickness of the film, and the idea of the surface and the sort of material, and its precious stone structure, and the level of warmth substrate , and the mathematical aggregate of the sponginess and the reflectivity of these movies.

The transmittance spectra of the In_2O_3 films covered with changed power normal are displayed in figure(2-1).This figure demonstrates that movies with normal power (Pa=pure, 1.70 and 2.125 mW) have a most extreme transmittance of (85%) in the unmistakable region[8]. The porosity, crystalline, auxiliary and surface homogeneity impact the film transmission.

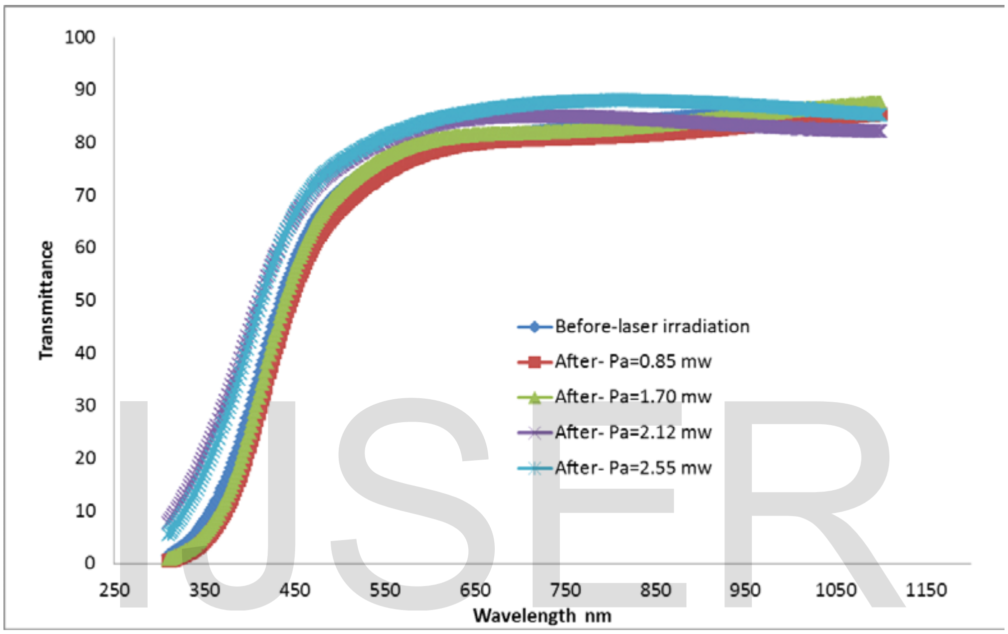


Figure (2-1) The optical transmittance of In_2O_3 thin films with different average power.

(3.2) Absorbance (A)

The thin movies of absorbance spectra of In_2O_3 ,having diverse midpoints control, are appeared in figure (2-2). These spectra absorbance uncover that movies increments with increment control normal. Most possibly, which means that big debris might be presented because of longer increase time and to the excessive chance of deposited debris muster . In different phrases, atoms and nanoscale particles deposited underneath laser radiation have a tendency to muster all through and after the laser pulse .

This fact ends in generate large particles that grow to be more outstanding while the density of the In_2O_3 debris will increase similarly with increasing the average energy.

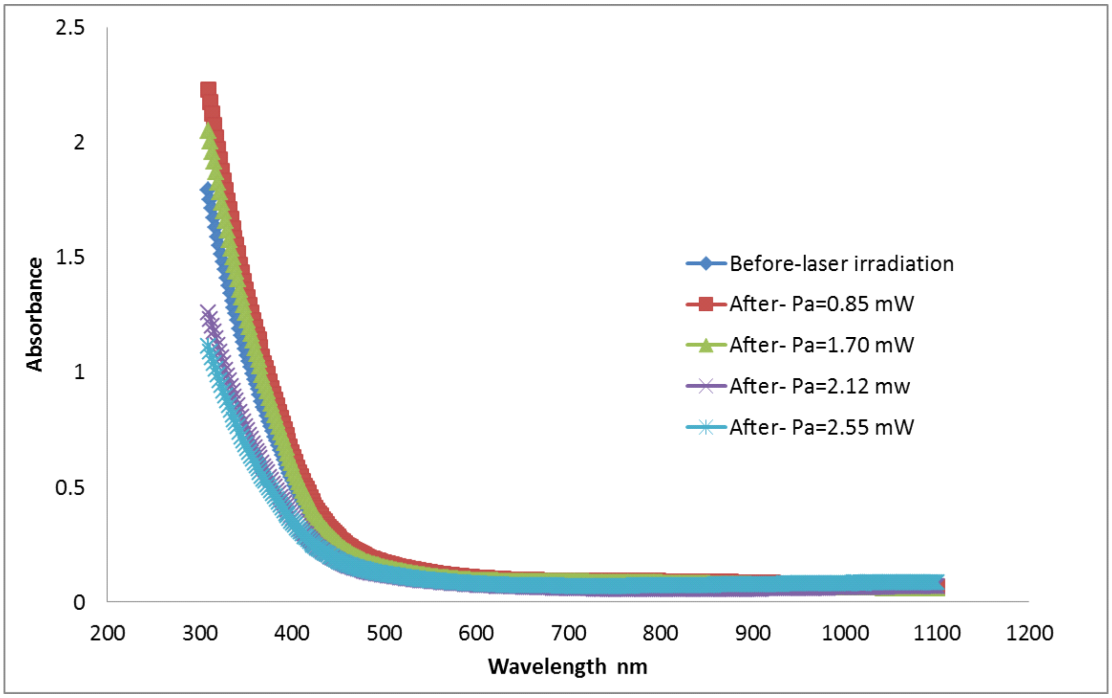
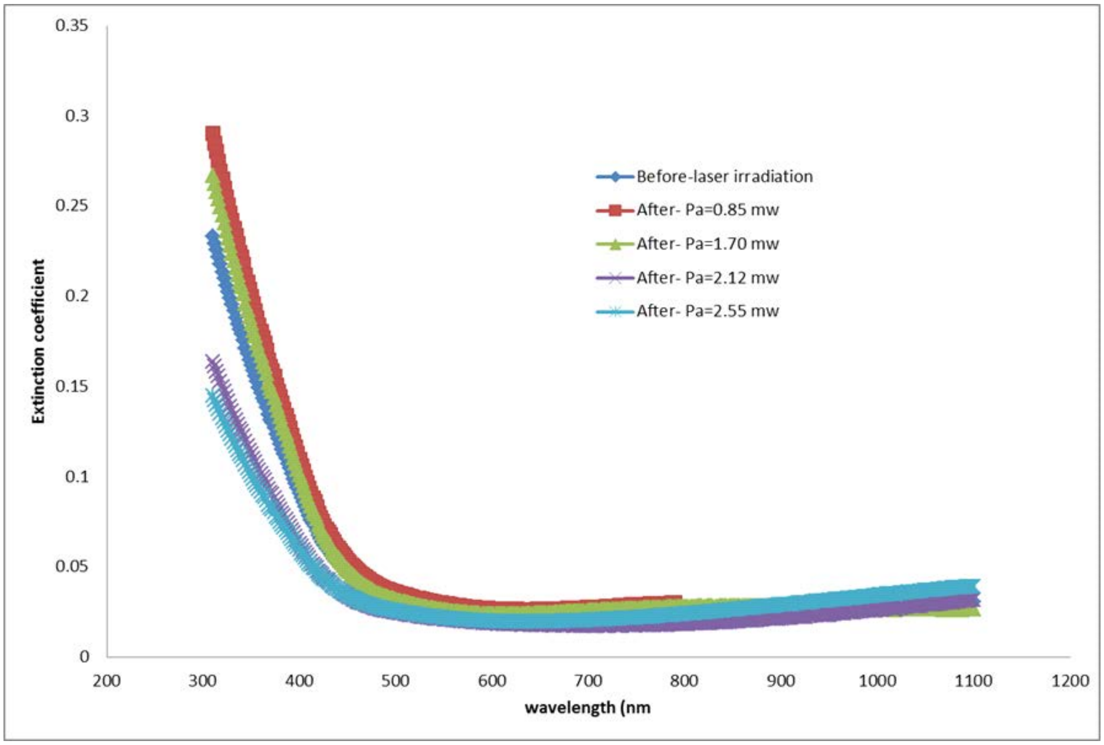


Figure (2-2) The optical absorpance of In_2O_3 thin films with different average power.

)3.3(Extinction Coefficient) K_{ex}(

Figure (2-3) shows the extinction coefficient (K_{ex}) as a feature of wavelength for In_2O_3 thin films with unique common strength.The extinction coefficient decreases as the wavelength increases, and its increases as the average electricity will increase[8]. The boom of surface roughness with reducing energy average for crystalline film will lower surface

optical scattering and optical loss.



Figure(2-3 (Extinction coefficient as a function of wavelength In_2O_3 thin films with different average power.

)3.4(Refractive Index (n(

The relation amongst refractive index and wavelength for spectrum variety (200-1100 nm) of In_2O_3 skinny films is shown in discern (2-4). It can be seen that there may be apeak for the refractive index. Its price increases closer to the long wavelengths .The conduct of those figures reflects the standard dispersion relation in better wavelength .Results display that the refractive index values of prepared films have values inside the variety of (3.5 - 4.5).The growth in the common electricity effects within the over all one of a kind values in the refractive index.

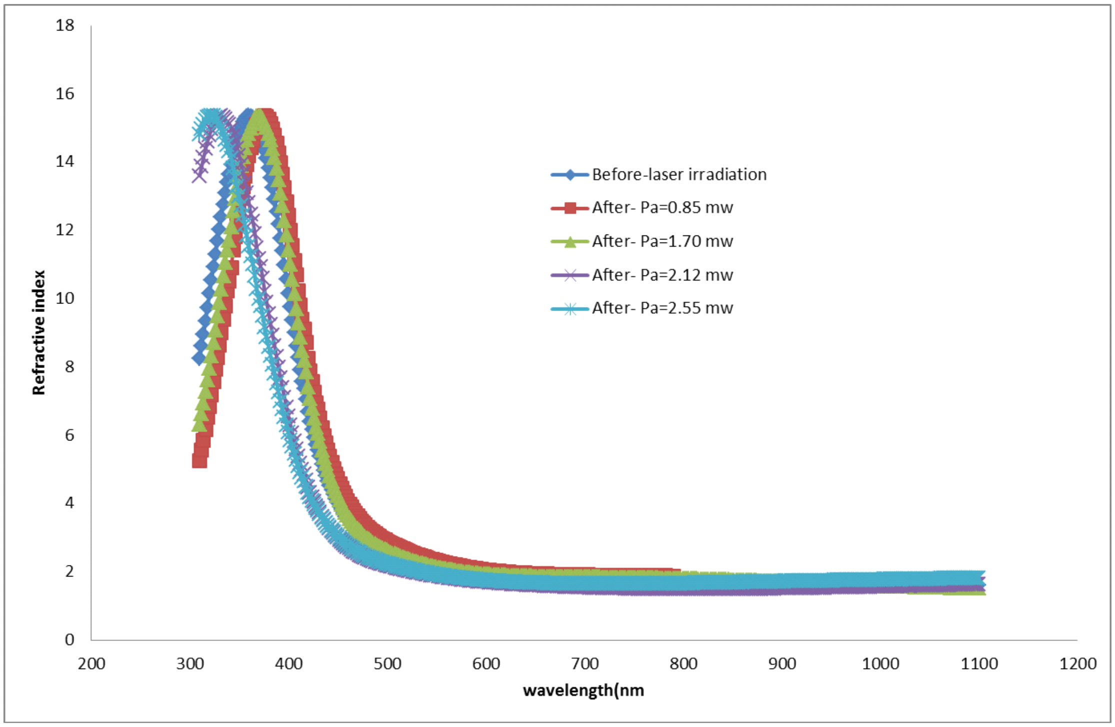


Figure) 2-4 (Refractive index as a function of wavelength for In_2O_3 thin films with different average power.

(2.5)Optical energy gap (E_g)

The optical band hole (E_g) of nanocrystalline In_2O_3 films became calculated from the transmission (or absorption) spectra Figure (2-5) shows the version of band gap with the exclusive averages energy of the movies. In_2O_3 skinny films grown here have band gap in the range (3.5 eV - 3.6 eV) which affords in Table (4) .These values of prepared films are decreasing with the increasing averages power.

There is the opportunity of structural defects in the movies because of their basis this will provide rise to the allowed states near the conduction band within the forbidden place. In case of increasing electricity average movies those allowed states should well merge with the conduction band resultant in the reducion of the band hole.

Figure (2-5) Shows the variation of band gap with In_2O_3 thin films with different average power.

Table)4 (The values of optical energy gap for In_2O_3thin film with averages power.

Power Average (mW)	Energy gap (eV)
Before Irradiations	3.6
P_a=0.85 After-	3.55
P_a=1.70 After-	3.5
P_a=2.125 After-	3.6

Conclusions

In_2O_3 Films Prepared by Chemical Spray Pyrolysis technique are irradiated with N_2 laser at 337 nm at substrate temperature of (573 K (on quartz substrate and different power average (0.85, 1.70, 2.125 mW .(

Results show that the refractive index values of prepared films have values in the range of (3.5 - 4.5).The increase in the average power results in the over all different values in the refractive index.

The transmittance for all thin films increases rapidly equally the wavelength increases in the range (320-400 nm).The average a maximum transmission 85% for (pure,1.70,2.125 mW) the films in the visible and IR wavelength region (400-1100). The band gap decreases when the average power increases and the band gap values range between 3.6 eV and 3.5 eV.

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