Original Research

Effect Of In Situ Annealing On Structural And Optical Properties Of ZnTe Thin Films

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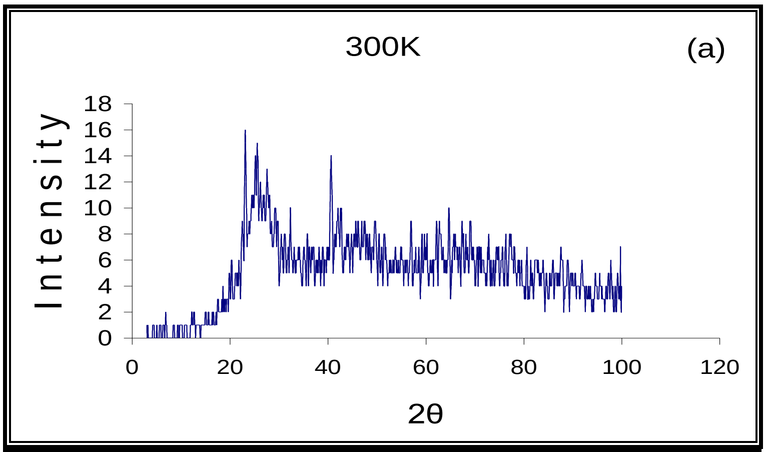
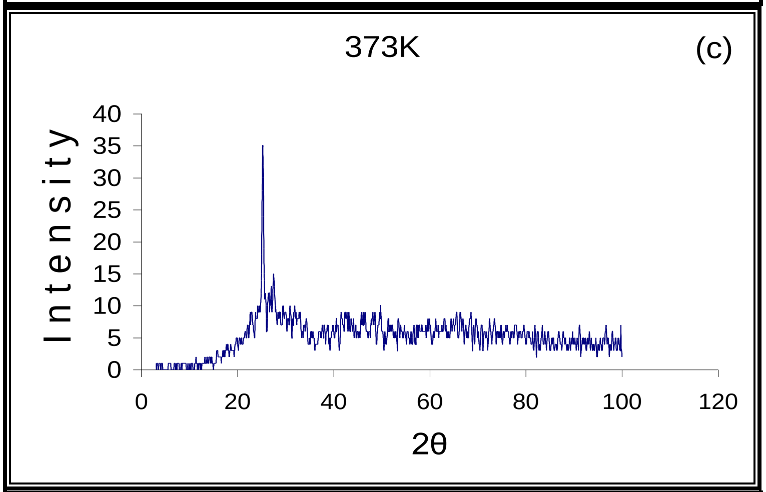
Abstract
ZnTe thin films with thickness around 2 kÅ have been deposited by thermal evaporation method on ultrasonically cleaned glass substrates at different substrate temperatures under the pressure of 5×10^{-6} Torr. The structural and optical characterizations of the films were carried out using XRD technique and UV-VIS-IR spectroscopy respectively. The grain size in films increase with increase in substrate temperature. The grain size (D), strain (ε), dislocation density (ρ) and lattice constant (a) were calculated and results are discussed in detail. The optical bandgap (E_g), as determined from the absorption spectra and also indicates direct band to band transitions.

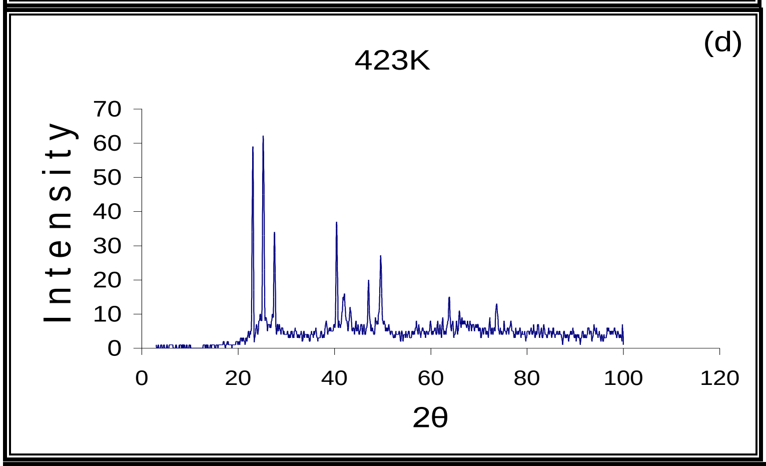
1 INTRODUCTION
Among the wide band gap II-VI semiconductors, ZnTe with its direct gap of 2.26eV at room temperature is promising material for a variety of optoelectronic devices in the visible region of electromagnetic spectra [1,23].
The other applications such as opto refractive materials for optical data processing [23], non-polarized memory switching [25] and γ-ray detectors are useful. Mo
A variety of thin film growth techniques have been used for the preparation of ZnTe thin films. Some of them are: thermal evaporation, vapour phase epitaxy, molecular beam epitaxy, hot wall epitaxy, metallorganic vapour phase epitaxy, r.f. sputtering, solution growth, spray pyrolysis, electrosynthesis etc.[34,36-39].

2 EXPERIMENTAL DETAILS
Pure Zinc Telluride powder (99.99% sigma Aldrich Chemicals Company) was evaporated from a tantalum boat under a vacuum of 5×10^{-6} Torr. The ZnTe films were deposited onto ultrasonically-cleaned glass substrates maintained at various temperatures (Ts = 300,323,373,423,473 K) during evaporation. The rate of evaporation, 2-5 Å/sec was maintained to grow films of good quality and uniform thickness. Thickness of the films was measured by quartz crystal monitor (“Hind Hivac” Digital Thickness Monitor Model–DTM–101). The structural parameters of the films were analyzed, using Philips X-ray diffractometer, Netherlands (model: X’PERT MPD) with filtered CuKα radiation (λ = 1.5405 Å). The optical absorption spectra of these films were recorded using a UV–VIS-NIR spectrophotometer (Perkin Elmer USA, Model: Lambda 19).

3 RESULTS AND DISCUSSION
Structural characterization:
Fig: 1(a, b, c, d and e) X-ray diffractograms of vacuum evaporated ZnTe thin film of thickness 2kÅ deposited at various substrate temperatures.


300K
(a)
Intensity
18
16
14
12
10
8
6
4
2
0
0
20
40
60
80
100
120
2θ


373K
(c)
Intensity
40
35
30
25
20
15
10
5
0
0
20
40
60
80
100
120
2θ


423K
(d)
Intensity
70
60
50
40
30
20
10
0
0
20
40
60
80
100
120
2θ

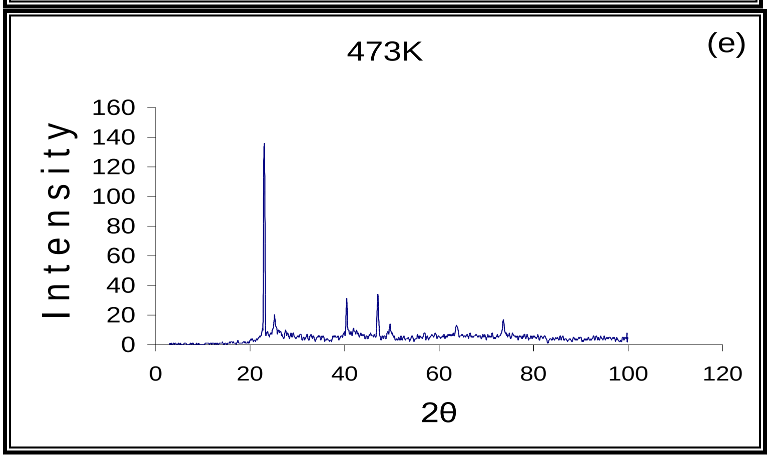

473K
(e)
Intensity
160
140
120
100
80
60
40
20
0
0
20
40
60
80
100
120
2θ

Table: 1 Structural parameter of ZnTe films.

T_S(K)	h k l	Lattice Constant a (Å)	2θ		Grain size D (Å)	Micro strain e 10^{-3} (lines-m^2)	Dislocation density ρ 10^{15} (lines/m^2)	Lattice spacing d (Å)
			XRD	JCPDS				
323 k	(1 1 1)	6.115	25.307	25.279	211.06	1.824	2.244	3.530
373 k	(1 1 1)	6.090	25.223	25.279	299.45	1.286	1.12	3.516
423 k	(1 1 1)	6.111	25.242	25.279	256.79	1.499	1.52	3.528

The crystalline nature of the films deposited at higher substrate temperature is better and more number of X-ray peaks are observed. From figure1 (a), the absence of peaks in the diffractogram clearly shows that the films deposited at substrate temperature 300K possesses amorphous structure whereas the presence of sharp peaks of the film deposited at higher substrate temperatures (323,373,423,473 K) reveals that the film is crystalline in nature. A strong peak is observed around at 2θ=25.25 which corresponds to the preferred orientation along (111) plane of cubic phase. It is in good agreement with the standard JCPDS (15-0746) data of cubic ZnTe. While in case of substrate temperature 473 K, [fig (e)], the slight shifting of prominent peak for the value of 2θ= 23.04 has been seen. From the table 1 it can be seen that the strain, dislocation density and lattice constant decrease with increase in substrate temperature while the grain size of the film increase.

optical characterization: The values of bandgap width, Eg, can be determined by extrapolating the linear portion of the respective curve to $(\alpha h\nu)^2=0$. The values of energy gap, calculated from absorption spectra, ranged between 2.01 to 2.20 eV. Figure 2 depicts the variation of square of $(\alpha h\nu)$ versus photon energy $(h\nu)$ for ZnTe film of the thickness 2kÅ for different substrate temperatures Ts = 300, 323, 373, 423, 473K. Optical band gap energy has been evaluated by extrapolating the linear portion of the curve to the energy axis.

Fig: 2 The dependence of $(\alpha h\nu)^2$ on hν for ZnTe films of thickness 2kÅ deposited at different substrate temperatures

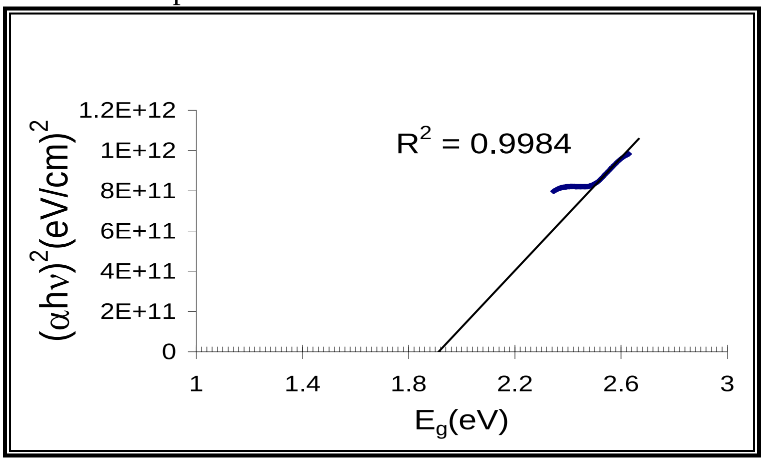


Table: 2 The direct band gap decreases with increase of substrate temperature.

Ts(K)	Bandgap energy(eV)
300	2.22
323	1.92
373	2.14
423	2.02
473	1.7

4 CONCLUSION

ZnTe thin films were deposited onto well-cleaned glass substrates by vacuum evaporation at various substrate temperatures. The X-ray diffraction analysis indicates that the crystalline nature of the film increases with increase in the substrate temperature. The optical transition in ZnTe films is direct and allowed type. The optical band gap energy determined from absorption spectra shows an inverse dependence on substrate temperature.

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