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SYNTHESIS OF $CU_2ZN_{1-X}CD_XSNS_4$ QUINTERNARY ALLOY NANOSTRUCTURES SOLAR CELLS THROUGH CHEMICAL APPROACH

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- **The $Cu_2Zn_{1-x}Cd_xSnS_4$ quinternary alloy nanostructures with different concentrations content were grown by sol-gel method. A quite good number of efforts have been made to synthesize quaternary alloy nanostructures with high surface area includes apply them in many fields, but an accurate exploring of quinternary alloy nanostructures is demonstrated here. Analytical study has proved multi-phase polycrystalline as well as the linear behavior of energetic transitions and optical elaborations to select the optimum for solar cells applications are exerted. Beside, we mention several related studies support our work.**

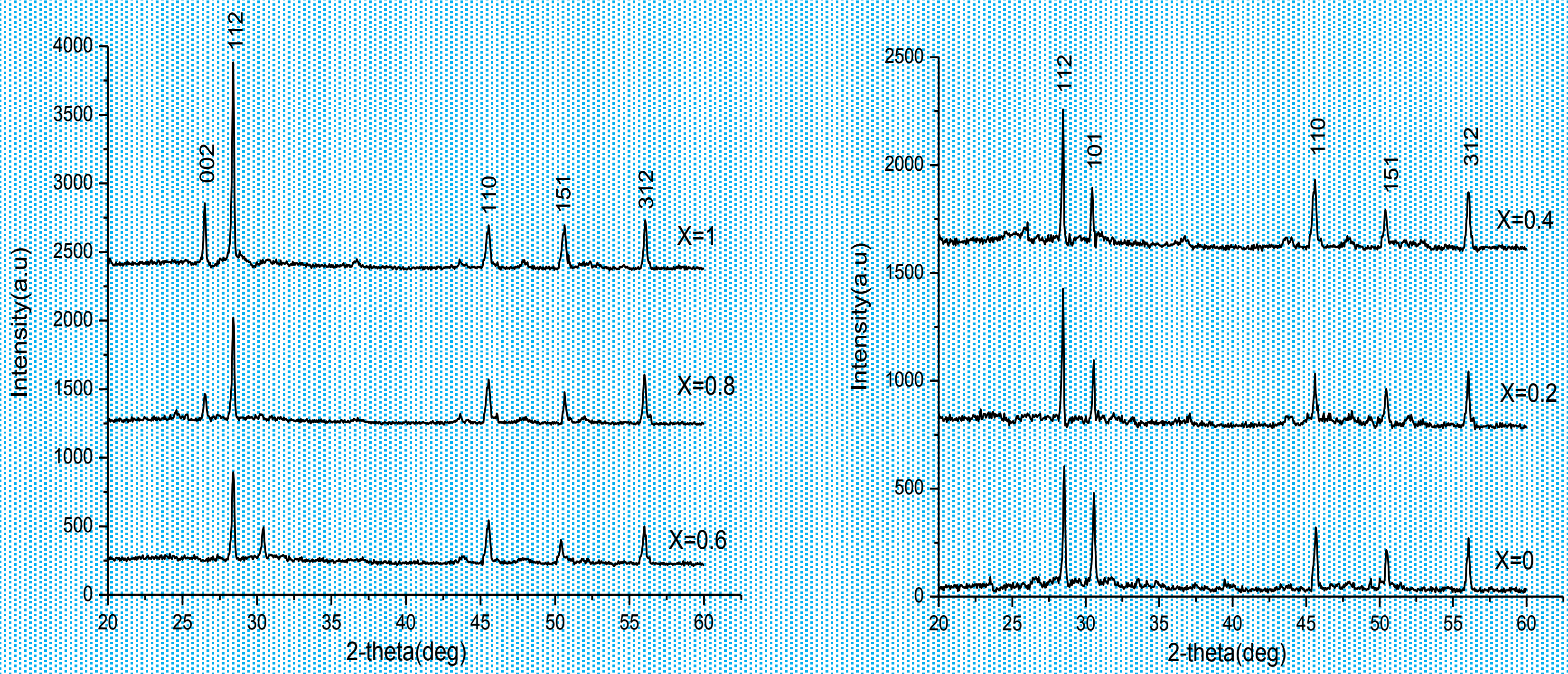
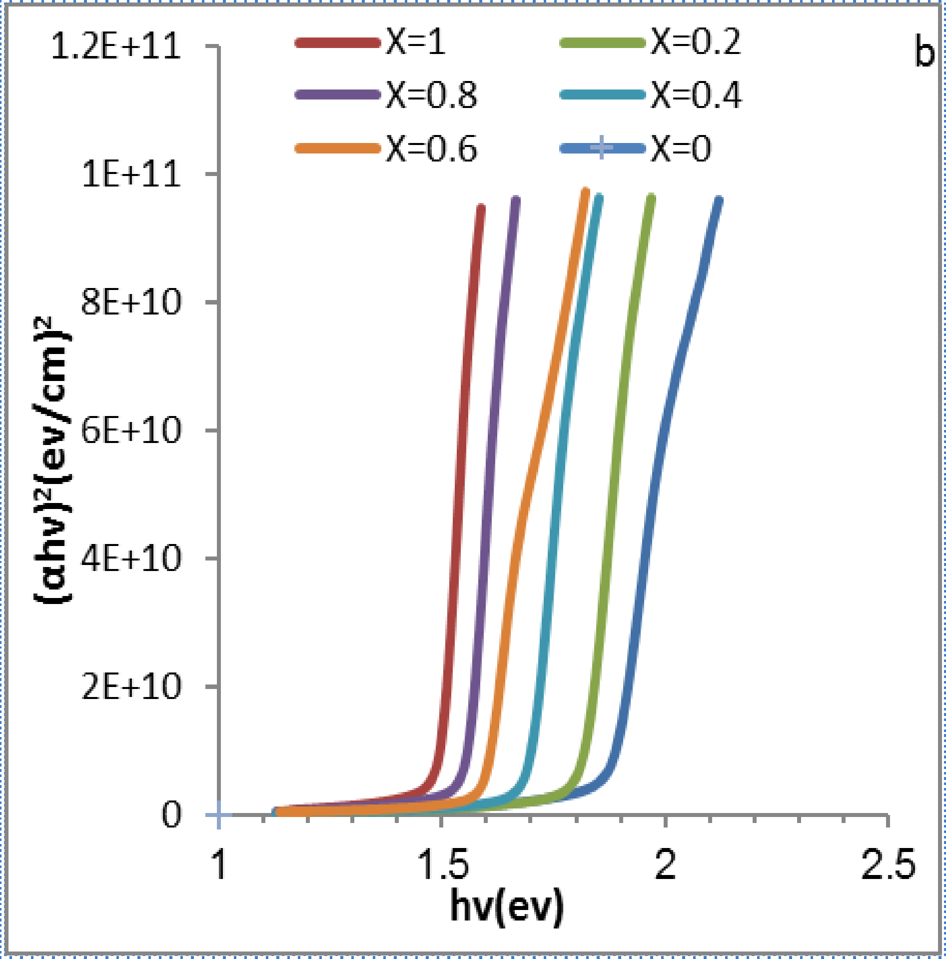


Fig. 1 XRD patterns of $Cu_2Zn_{1-x}Cd_xSnS_4$ quinternary alloy nanostructures with different Cd contents.

TABLE 1 Structural characteristics of $Cu_2Zn_{1-x}Cd_xSnS_4$ quinternary alloy nanostructures for different values of x, derived from XRD results.

x	Peak (θ)	Particle size (nm)	Dislocation density (δ) (10^{14}) (lines/m^2)	Strain (10^{-3})	d_{hkl} (112) (Å)	Lattice constants a and c (Å)
0.0	28.43	32.25	9.614	0.1384	3.123	a=5.36 a=5.42* c=10. 78 c=10.84*
0.2	28.42	35.54	7.917	0.1038	3.127	a=5.44 c=10.86
0.4	28.40	38.29	6.820	0.0957	3.128	a=5.46 c=10.89
0.6	28.39	42.19	5.618	0.0864	3.131	c=5.49 a=10.95
0.8	28.36	50.68	3.893	0.0690	3.133	a=5.50 c=11.60
1.0	28.34	60.24	2.755	0.0668	3.138	a=5.55 a=5.53# c=11.14 c=11.13#


X=1
X=0.2
X=0.8
X=0.4
X=0.6
X=0
b
1.2E+11
1E+11
8E+10
6E+10
4E+10
2E+10
0
(αhν)²(ev/cm)²
1
1.5
2
2.5
hv(ev)

- **Empirical models of n_o**

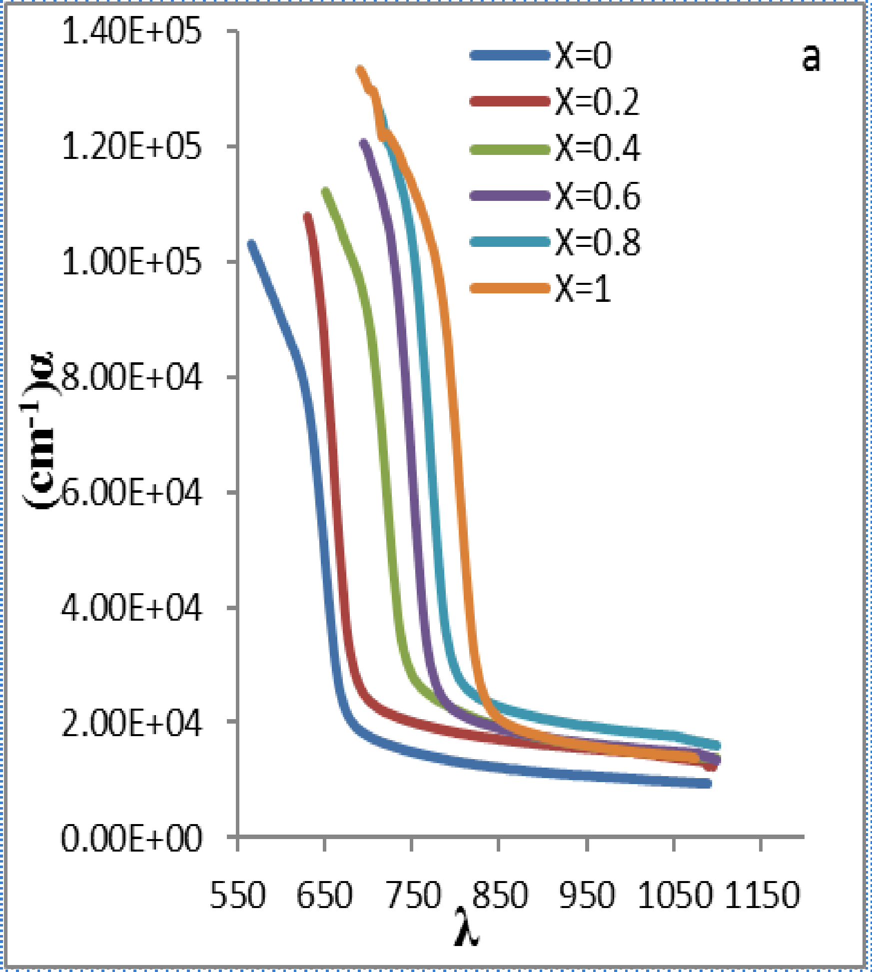
$n = \alpha + \beta E_g$ **Ravindra et al.**

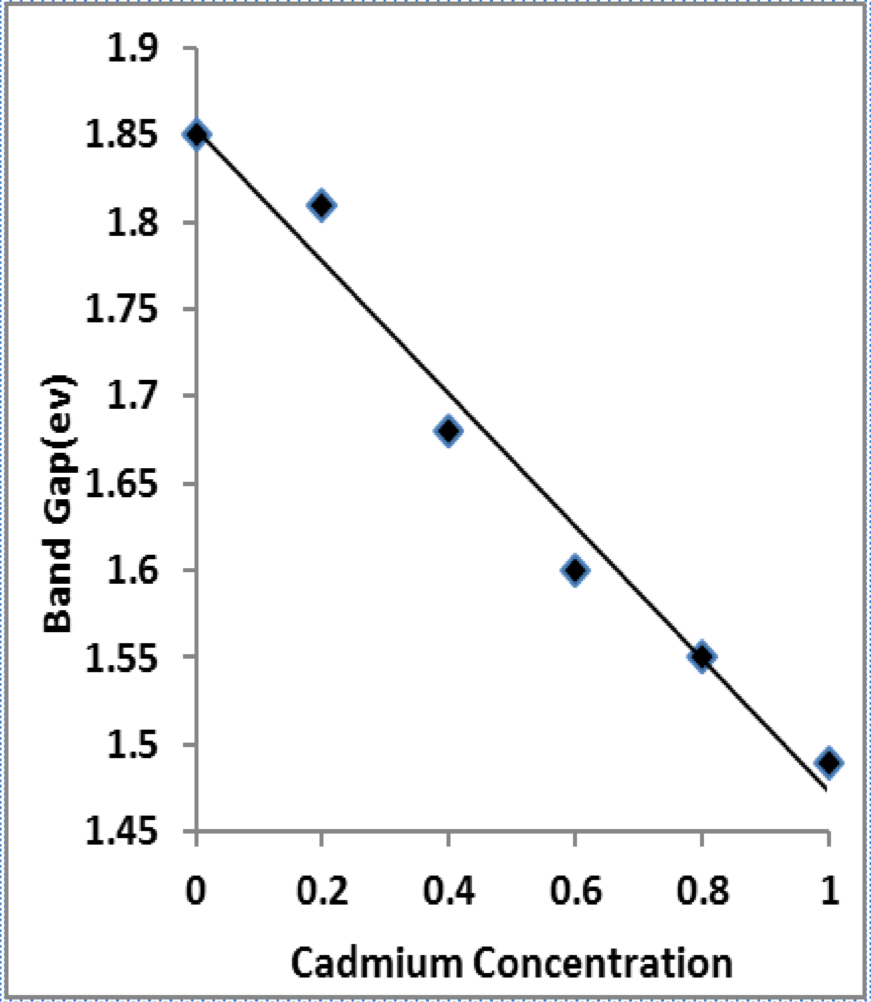
$$n = \sqrt{1 + \left(\frac{A}{E_g + B}\right)^2}$$ **Herve & Vandamme**

$n^2 - 1 = A / (E_g + B)^2$ **Ghosh et al.**

TABLE 2 Estimated band gap energy, Urbach tail width, and steepness parameter (β) of the different $Cu_2Zn_{1-x}Cd_xSnS_4$ quinternary alloy nanostructures, calculated using Ravindra et al. [26], Herve and Vandamme [27], and Ghosh et al. [28] models.

x	E_g (eV)	n	ε_∞
0.0	1.85 1.90*	2.90[a] 2.77[b] 2.67[c]	8.41[a] 7.67[b] 7.12[c]
0.2	1.81	2.92[a] 2.79[b] 2.68[c]	8.52[a] 7.78[b] 7.18[c]
0.4	1.68	3.00[a] 2.85[b] 2.72[c]	9.00[a] 8.12[b] 7.39[c]
0.6	1.60	3.05[a] 2.89[b] 2.75[c]	9.30[a] 8.35[b] 7.56[c]
0.8	1.55	3.08[a] 2.92[b] 2.77[c]	9.48[a] 8.52[b] 7.67[c]
1.0	1.49 1.35#	3.12[a] 2.95[b] 2.79[c]	9.73[a] 8.70[b] 7.78[c]


a
X=0
X=0.2
X=0.4
X=0.6
X=0.8
X=1
α(cm⁻¹)
1.40E+05
1.20E+05
1.00E+05
8.00E+04
6.00E+04
4.00E+04
2.00E+04
0.00E+00
550
650
750
850
950
1050
1150
λ


1.9
1.85
1.8
1.75
1.7
1.65
1.6
1.55
1.5
1.45
Band Gap(ev)
0
0.2
0.4
0.6
0.8
1
Cadmium Concentration

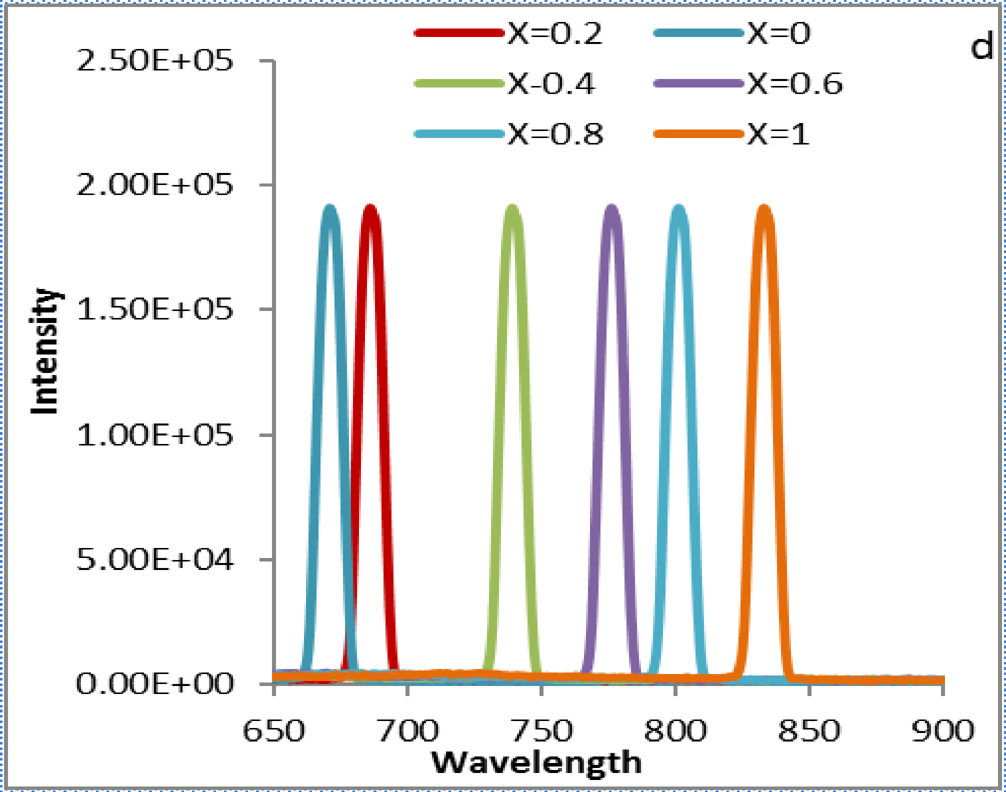


Fig. 2 Optical properties of $Cu_2Zn_{1-x}Cd_xSnS_4$ quinternary alloy nanostructures: (a) Absorption coefficient, (b) absorbance versus photon energy for band gap determination, (c) variation of band gap with Cd content, and (d) PL spectra.

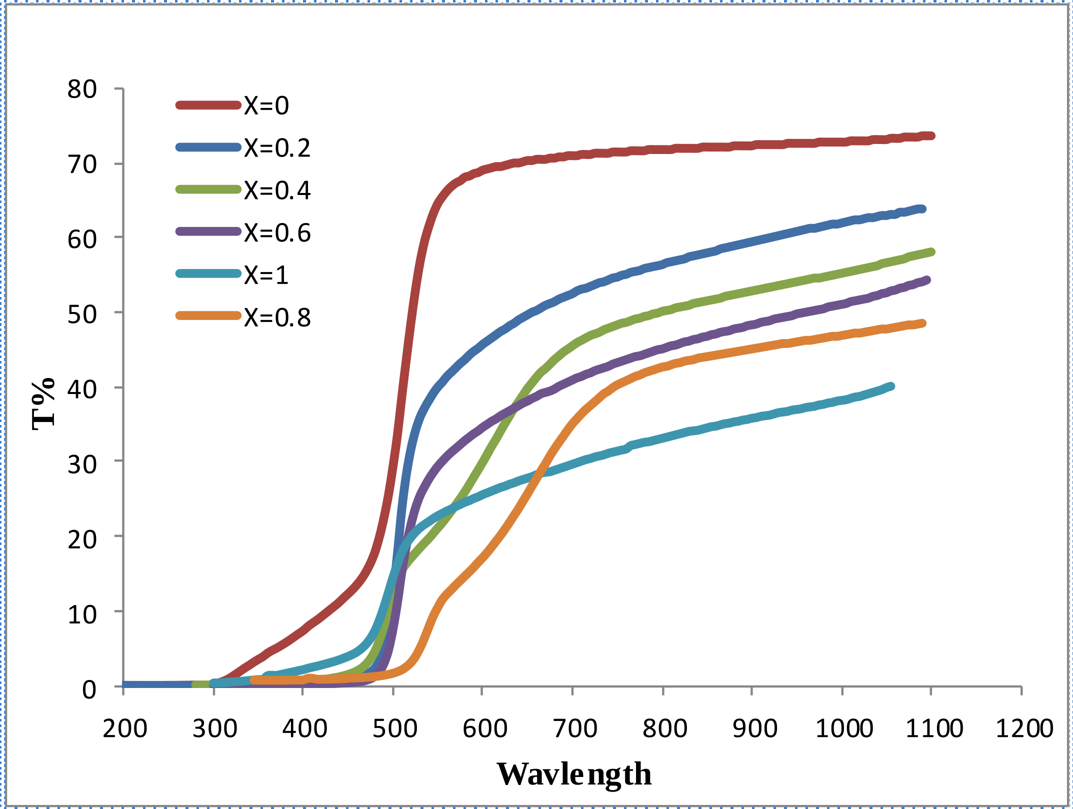


Fig. 3 Transmittance Spectra of $Cu_2Zn_{1-x}Cd_xSnS_4$ quinternary alloy nanostructures.

- **CONCLUSIONS**

This work represents an advancement in the development of active $Cu_2Zn_{1-x}Cd_xSnS_4$ quinternary alloy nanostructure materials for PV applications fabrication of via a sol-gel method. The structural characteristics and optical properties were elaborated to determine which Cd concentration yielded the best crystallization to reduce crystal defects. High crystallinity, mixed crystal phase, specific crystal facets are in high demand to meet the high performance requirements of PV applications.

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Cadmium effect on optical properties of $Cu_2Zn_{1-x}Cd_xSnS_4$ quinternary alloys nanostructures

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Thank You