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Crystal Growth and Powder X-Ray Diffraction Data of Cadmium Zinc Tellurium ($Cd_{0.29}Zn_{0.71}Te$)

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ABSTRACT

X-ray powder diffraction data for a new Cadmium Zinc Tellurium compound synthesized by Bridgman technique is reported. The unit cell dimensions were determined from diffractometer methods using CuKα radiation, and the indexing programs. The cubic phase was the sole crystalline phase which detected by X-ray diffraction analysis in the $Cd_{0.29}Zn_{0.71}Te$ sample with lattice constants of a= 6.26218(34) Å, The results are in agreement with those obtained from cadmium Zinc tellurium ($Cd_{0.4}Zn_{0.6}Te$) PDF carte number (50-1438).

Key words: Crystal Growth, CZT, Cadmium Zinc Tellurium, XRD

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INTRODUCTION

CdZnTe is a ternary semiconductor compound. Semiconductors compound are generally derived from elements of groups V and VI of the periodic table. In addition to binary compounds, the ternary compounds, such as CdZnTe could be also produced. One of the advantages of this kind of semiconductors is the possibility to make materials with a wide range of physical properties, such as band gap, atomic number and density. These materials are suitable for application to radiation detectors operating at room temperature. In comparison to Si and Ge semiconductor CZT has a wide band gaps. Moreover, for X-or gamma ray detection, semiconductor compounds with high atomic numbers are more suitable in order to emphasize the photoelectric interaction. Cadmium Zinc Telluride (CZT) gamma detectors are produced by high pressure Bridgman (HPB) crystal growth technique (Raiskin et al, 1988; Doty et al, 1988; Parnham et al, 1996; Fougeres *et al*, 1988). In this approach crystals are grown from a melt of nearly equal amount of cadmium and tellurium, with small cadmium excess. The cadmium excess generates high vapor pressure and the crystal grows at high temperature, above 1150^0 C, at a high growth rate of few millimeters per hour. Zinc addition increases the crystal's band gap and electrical resistivity. This high resistivity is caused by intrinsic defects and residual impurities that are present in the forbidden band. This paper report a new Cadmium Zinc Tellurium compound ($Cd_{0.29}Zn_{0.71}Te$) synthesized by Bridgman technique (HPB). The powder diffraction pattern data of this new compound shows a cubic symmetry.

EXPERIMENTAL

The Cadmium Zinc Telluride ($Cd_{0.29}Zn_{0.71}Te$) alloy prepared from its own elements. Appropriate weights of pure Cd, Zn and Te (99.999%) were mixed together and charged in 15mm ID (17 mm OD) quartz tube ampoules. The vessel was sealed under a vacuum of 10^{-5} Torr with a very small free volume to accommodate for the vaporization of Cd during subsequent heating. The sealed quartz ampoule was placed in a Vertical Bridgman furnace. The temperature of the furnace was raised gradually to 1150 ^oC and maintained at this temperature for about 10 hours, then the ampoule was slowly cooled to room temperature at a rate of 30°C/h (B. Samantha et al.,1995). The $Cd_{0.29}Zn_{0.71}Te$ ingot was then grown from the melt using a commercial 17-zone VB growth furnace.

POWDER DIFFRACTION PATTERN ANALYSIS

Phase analyses were carried out by the X-ray diffraction (XRD) method using CuKα radiation (□=1.54184) with Ni filter with 2θ =5-100°2θ. APD Philips PW3710, version 3.6g (Philips Electronics N. V., Amsterdam) was used to identify the phases present in the sample. The precise determination of the positions of the peaks was carried out using the measurement and data processing package APD-3.6g. The intensities of the diffraction lines were measured as peak heights above the background and expressed as a percentage of the strongest line. The indexing of the X-ray powder diffraction patterns were performed by means of the computer program DICVOL91 (Boutif and Louer, 1991) and TREOR90P (Werner et al., 1985). The absolute zero error was found to be less than 0.02 degree in 2θ, and the alignment of the diffractometer was checked using SRM 640b.

Figure1 shows the powder diffraction pattern of $Cd_{0.29}Zn_{0.71}Te$ (CZT) and the corresponding crystallographic data are listed in Table 1.

H	K	L	DOBS	DCAL	I	2TH.OBS	2TH.CAL	DIF.2TH.
1	1	1	3.62245	3.62324	100	24.575	24.570	0.005
2	0	0	3.13467	3.13687	3	28.474	28.454	0.020
2	2	0	2.21712	2.21681	60	40.695	40.701	-0.006
3	1	1	1.89086	1.89009	50	48.122	48.143	-0.021
2	2	2	1.80937	1.80953	1	50.437	50.432	0.005
4	0	0	1.56713	1.56684	33	58.935	58.947	-0.012
3	3	1	1.43792	1.43770	9	64.842	64.853	-0.011
4	2	0	1.40128	1.40126	2	66.755	66.756	-0.001
4	2	2	1.27882	1.27905	12	74.147	74.131	0.016
3	3	3/	1.20568	1.20583	6	79.495	79.483	0.012
5	1	1						
4	4	0	1.10763	1.10754	3	88.215	88.224	-0.009
5	3	1	1.05885	1.05897	12	93.450	93.437	0.013
4	4	2/	1.04395	1.04414	3	95.202	95.178	0.024
6	0	0						

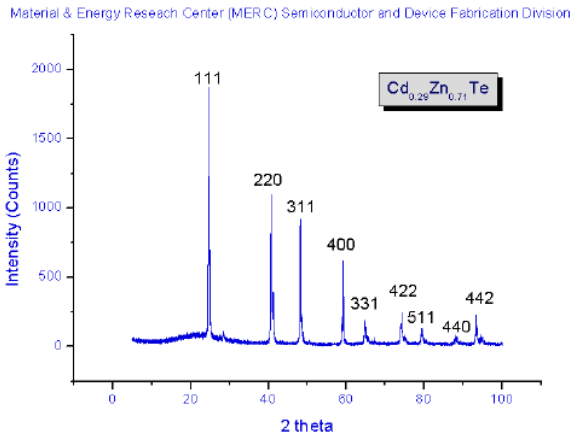

Figure 1.Power diffraction pattern for $Cd_{0.29}Zn_{0.71}Te$

A solution with cubic symmetry was proposed for this new CZT: The corresponding parameters are: a= 6.26218(34) Å, with FOM's M (13) = 80.2 (de Wolff, 1968) and F (13) = 27.8(0.0120, 39) (Smith et al., 1979). All differences between observed and calculated 2θ angles are less than 0.024 degree.

CONCLUSION

In this work, a new Cadmium Zinc Tellurium $Cd_{0.29}Zn_{0.71}Te$ compound have been successfully synthesized and Grown by the Bridgman technique. X-ray analysis showed that the sample has a cubic phase and lattice constant was calculated for this sample.

REFRENCES

E. Raiskin and J.F. Butler, IEEE Trans. Nucl. Sci. **NS-35** 82 (1988).

F.P. Doty, J.F. Butler, J.F. Schetzina and K.A. Bowers, J. Vac. Sci. Technol. B **10**(4) 1418 (1992).

K. Parnham, Nucl. Instr. and Methods **A 377** 487 (1996).

P. Fougeres *et al* , J. Crystal Growth **184** 1313 (1998).

Evain, M. (1992). "U-FIT: A cell parameter refinement program," I.M.N. de nants, France.

Werner P.E., Erikson, L., Weslatahl, M.J. (1985) "A semi-exhausive trial-and-error power indexing program for all symmetries", J. Appl. Crystallogr. 18, 367-370.

Wolff, P. M. de (1968). "A simplified Criterion for the Reliability of a Powder Pattern Indexing," J. Appl. Crystallogr. 1, 108-113.

Smith, G. S. and Snyder, R. L. (1979). "F(N): A Criterion for Rating Powder Diffraction Patterns and evaluating the reliability of Powder Pattern Indexing." J. Appl. Crystallogr. 12, 60-65.

B. Samantha, S. L. Sharma, A. K. Chaudhuri, Vacuum 46(1), 739 (1995)