Powder Structure and Phase Analysis of HgSe and ZnTe Solid Phase

Nyo Nyo[1],Moe Moe Aye[1],Cho Cho Myat Aung[1],Than Than Win[2],
Yin Maung Maung[1] and Ko Ko Kyaw Soe[3]

Abstract

The great deal of information about the powder structure, phase assignment and crystallographic characterizations of fabricated powders (HgSe & ZnTe) was obtained by XRD measurement. The calculated lattice strains were found to be slightly changed as compared to reported value.

Keywords: crystallographic characterization, lattice strain, powder structure

Introduction

Transparent conducting oxide (TCO) films of tin, indium and zinc oxide (doped and undoped) have been extensively studied due to their high optical transmittance and electrical conductivity. A wide band gap II-VI compounds are promising materials of light emitters and for integrated optics. The realization of the potential of these materials are the sources of light emitting diode, diode array and phosphor display panel (flat panel), solid state indicators (e.g digital clocks, meter readouts), on the other hand , it has long been hindered by difficulty in forming the low resistivity p-n junction essential for efficient injection electroluminescent devices. The main problems with these materials has been that due to self-conpensation by native defects. In order to this difficulty in obtaining the p-n junctions, many alternative approaches making use of heterojection structure, p-n junction from solid solution, metal-insulator-semiconductor (MIS) structure and metal-semiconductor (MS) structure have been attempted with some degree of success. Among II-VI compound Zn Se , Zn S, Zn Te and Cd S are potential candidates for such application. They have a wide band gap between 2.26 eV and 3.66 eV for many years II-VI semiconductor includes compounds from elements of group II and group VI of the periodic table. They include oxides, sulphides, selenides and tellurides of beryllium, magnesium, zinc, cadmium and mercury. II-VI compound such as Hg S,HgSe and Hg Te are called chalcogenides. Among them, Hg Se and Hg Te are semimetals. Single crystal of II-VI compounds such as Zn Te (Zinc Telluride) can be grown by vapor of chemical transport techniques and from the melt.

---

1. Department of Physics, Yangon University, Myanmar
2. Department of Physics, Myingyan Degree College, Myanmar
3. Yangon University, Myanmar

Experimental Details

The properties of the solid solution are strongly influenced by their preparation procedures. Although the material compositional control is usually excellent, properties of the resulting solution are not necessarily good if improper processing are used.

Sample preparation includes the following steps: weighing of raw materials, grinding shaping by mould pressing or roll pressing and calcining. The first is to weight the starting material according to desirable composition. Zinc, Tellurim, Mercury and Selenium are used as starting materials. The raw materials are weighed to obtain the compound of ZnTe and Hg Se, according to the equal molar ratio of the desired composition. The mixture powder is heat treated at temperature 600°C for 1hr. After heat treatment the mixture is cooled down to room temperature.

Then, the mixture powder is ground by agate motor to obtain the homogenous and uniform grain size. After grinding the mixture is shaped by sample making machine and obtained a circular shaped pallet. Dimensions of the pallet are 2.5cm in diameter and thickness is 0.3 mm.

X ray diffraction was carried out to investigate for the crystallographic properties of these specimens.

Growth Mechanism

The powders were mixed mechanically according to the stoichiometric formula of the desired composition (equal molar ratio in this case). Mechanical mixing was usually done by either ball-milling for a short time. During the calcination step the solid phase reaction took place between the consistents giving the relative phase. As the calcination, the mixed powder was ground by agate motor with constant speed to be uniform and homogeneous grains and calcined at specific reaction temperature to obtain the hexagonal phase. The calcining temperature was important as it influences the density and hence the electromechanical properties of the final product. Following this, they were checked by XRD.

Table (2) The collected informations from Hg Se XRD profile.

2θ(deg) Observed	2θ(deg) Standard	d($\mathring{A}$)	h k l	FWHM(deg)
19.321	19.335	4.5903	(010)	0.279
28.339	28.082	3.1467	(200)	0.176
28.613	28.614	3.1172	(012)	0.281
29.280	29.336	3.0477	(200)	0.292
34.160	34.323	2.6226	(210)	0.215
49.061	49.137	1.8553	(-114)	0.321
58.162	58.056	1.5848	(400)	0.283
59.741	59.717	1.5466	(223)	0.288

Conclusion

ZnTe and HgSe solid-phase have been successfully investigated. To examine the crystalinity of laboratory- grown solid-phase, XRD measurement are performed. By the systematic analysis of XRD spectra, it was predicted that the laboratory-grown solid-phases were composed as Zn Te and Hg Se. Following this, the crystallographic properties were observed and found to be within the accepted range.

Acknowledgements

The authors would also like to express our gratitude to Prof Dr Sein Htoon, CSci CPhys FInstP *Lond*, Head of Department of Physics (Rtd), University of Yangon for his interest and encouragement to carry out this work. We are delighted to thank Prof Dr Win Win Thar, PhD Y*gn*, Head of Department of Physics and Associate Professor Dr Khin Yi, PhD (UKM), Department of Physics, University of Yangon for their kind permission and help. We would also like to express our gratitude to several of our immediate colleagues and friends for making useful suggestion.

References

A .V Singh et al, 2004, Journal of Applied Physics, 95, 7.

Fridin V ,1980, Ferroelectric Semiconductor (Plenum : New York)

Onoda G Y Jr and hench LR (eds) ,1978" Ceramics Processing before Firing" (Wiley : New York)

Sze SM, 1981, "Physics of Semiconductor Devices",(Wiley, New York)

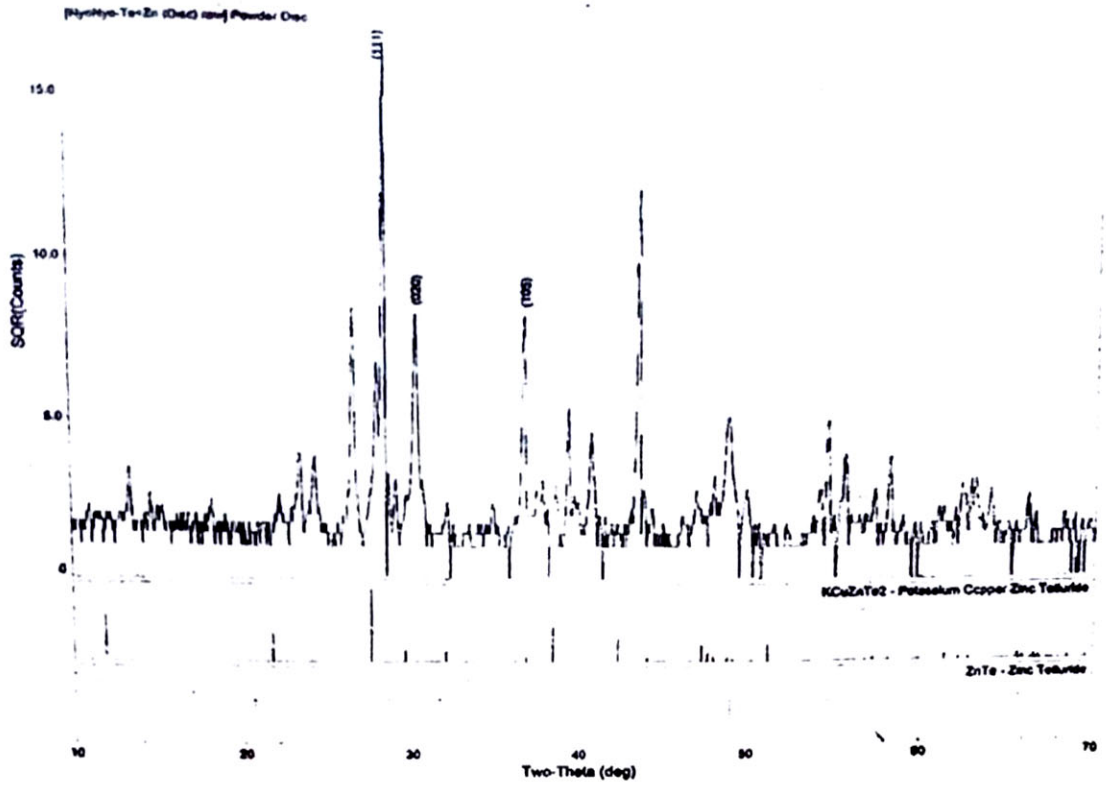


Figure 1(a) XRD profile of ZnTe Solid-phase

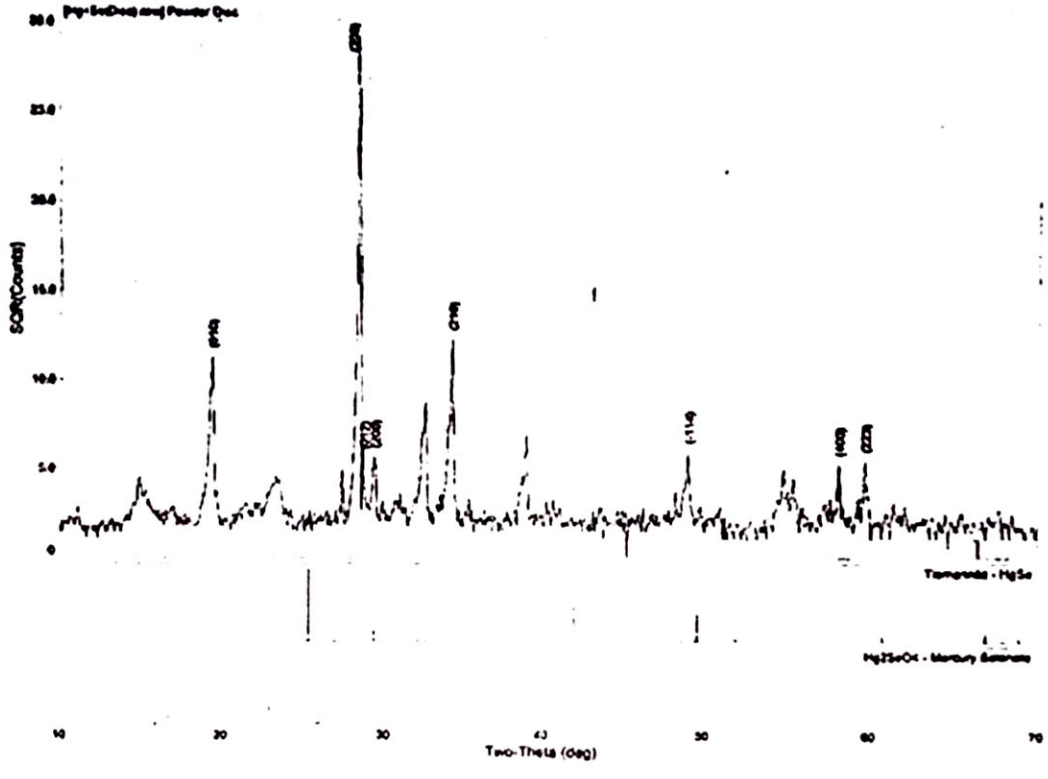


Figure 1(b) XRD profile of HgSe Solid-phase

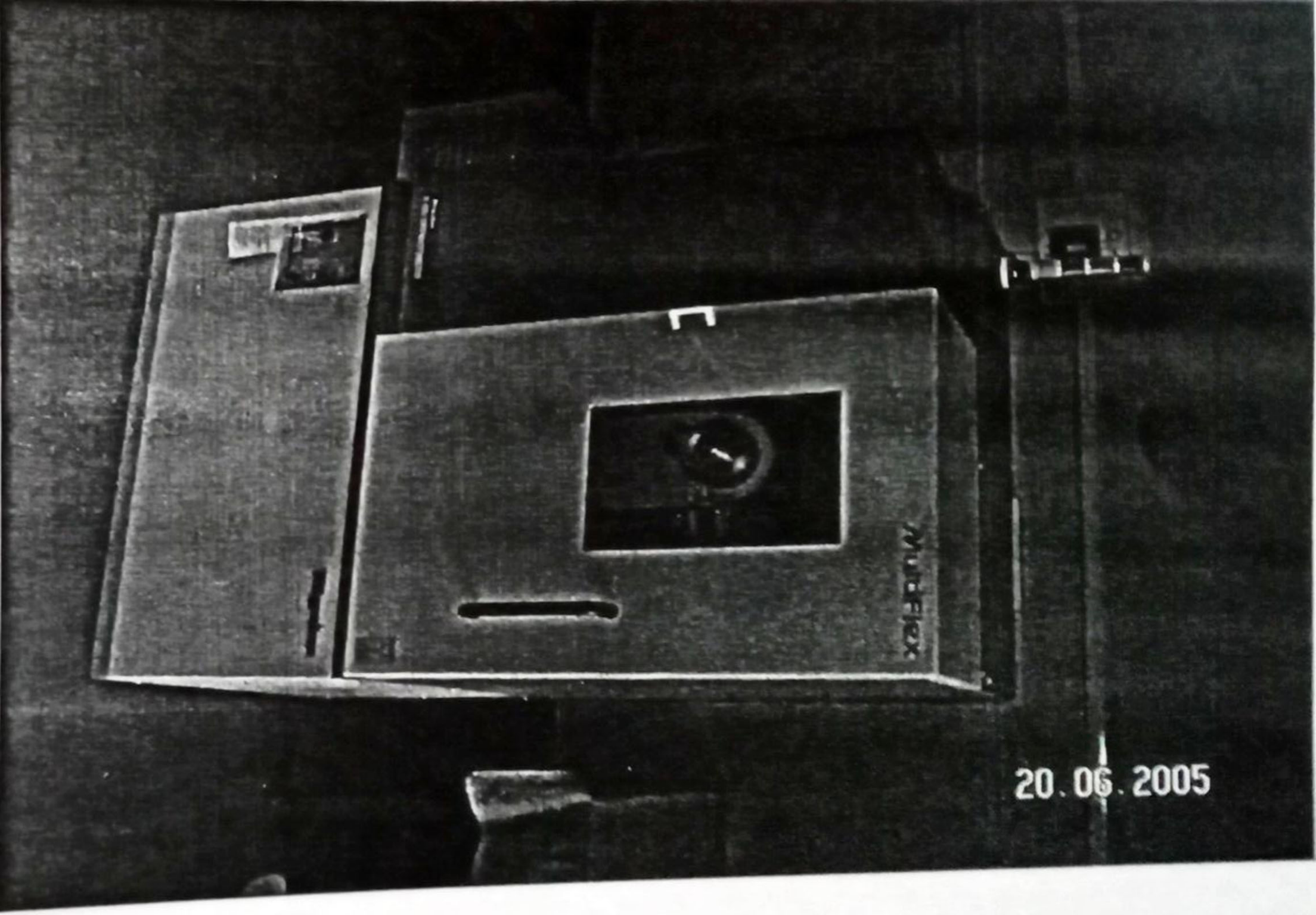
Result and Discussion

XRD patterns of Zn Te and Hg Se crystals were displaced at Fig (a & b). From Zn Te pattern, twelve reflections were approved on XRD plot scanned from 10° to 70° . The intensity of (111) reflection was scanned to be remarkably stronger than others. The diffraction angle of dominant (111) peak was 28.279° . Thus a little increase in diffraction angle was observed compared to that of standard. All the peaks corresponded to standard ZnO diffraction with Zinc belende structure. It seemed that the addition of Te was not affect the structure of ZnO. The a-axis of Zn Te ceramic was calculated to be 6.1A°. Some informations obtained from Zn Te (Zinc Telluride) XRD profile was collected and listed in Table 1.

Table (1) The collected informations from Zn Te XRD profile.

2θ(deg) Observed	2θ(deg) Standard	d($\dot{A}$)	h k l	FWHM(deg)
28.279	28.547	3.1533	(111)	0.172
30.141	29.904	2.9625	(020)	0.285
36.558	36.729	2.4559	(105)	0.167

From the XRD spectrum of Hg Se, it was obvious that only eight reflections were appeared with that of Hg Se standard scanned from10° to 70° . It was found that some reflections were not well-matched with that of Hg Se standard. The intensity of (200) reflection, the diffraction angle of domainant peak was 28.339° . All the peaks corresponded to standard Hg Se diffraction pattern with (010),(200),(012),(-414),(400) and (223) reflections.


MUDFLEX
20.06.2005

Acknowledgements

The authors would also like to express our gratitude to Prof Dr Sein Htoon, CSci CPhys FInstP FAAS, Head of Department of Physics (Rtd), University of Yangon for his interest and encouragement to carry out this work. We are delighted to thank Prof Dr Win Win Thar, PhD Ygn, Head of Department of Physics and Associate Professor Dr Khin Yi, PhD (UKM), Department of Physics, University of Yangon for their kind permission and help. We would also like to express our gratitude to several of our immediate colleagues and friends for making useful suggestion.

References

Fridin V .(1980), Ferroelectric Semiconductor (Plenum : New York)

Onoda,G Y Jr and hench LR (eds) ,(1978) " Ceramics Processing before Firing" (Wiley : New York)

A V Singh et al, (2004), Journal of Applied Physics, 95, 7.

Sze SM, (1981), "Physics of Semiconductor Devices", Wiley, New York,