# Preparation Cadmium Telluride Compound and Study Structural Properties of thermal evaporation thin films

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**Abstract**

Polycrystalline ingots of cadmium telluride have been synthesized using the direct reaction technique, by fusing initial component consisting from pure elements in stoichiometric ratio inside quartz ampoule is evacuated $10^{-6}$ torr cadmium telluride has been grown under temperature at (1070) $^{o}$C for (16) hr. was used in this study, the phases observed in growing **CdTe** compound depend on the temperature used during the growth process. Crystallography studies to **CdTe** compound was determined by X-ray diffraction technique, which it has zinc blend structure and cubic unit cell, which lattice constants is a=6.478 $\overset{o}{A}$ .

## تحضيرأفلام مركبات الكادميوم تولرايد بطريقة التبخير الحراري ودراسة مواصفاتها التركيبية

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***الخلاصة***

حضرت سبائك **CdTe** متعددة البلورات بأستخدام تقنية التفاعل المباشر بصهر المركبات الأولية والتي تحتوي على العناصر النقية بنسب متجانسة داخل انبوبة من الكوارتز مفرغة $10^{-6}$ تور.

في هذه الدراسة نُمَّتْ كادميم التلورايد تحت درجة حرارة 1070 °C لمدة 16 ساعة وقد لوحظ ان اطوار المركب CdTe تعتمد على درجة الحرارة خلال عملية التنمية.

تم استخدام تقنية الأشعة السينيه لمعرفة التركيب البلوري لمركب CdTe

## Introduction

The cadmium telluride is being studied as part of program of research in to advanced $\mathbf{Cd_xHg_{1-x}Te}$ technology. It is important not only as a substrate for epitaxy, but also as an active part of potential hetrojunction device structures [1] . Since the band gap, of **CdTe** is very close to that of **GaAs**. Also **CdTe** prepared using a Bridgman method with ($N_D$= $5*10^{14}$ $cm^{-3}$). Hoschl et.al. Successfully synthesized **CdTe** with $N_D$ =$10^{16}$ $cm^{-3}$ and $\mu$ = 78 $cm^2$/v.s at 272 K by a Bridgman technique. The successful growth of **CdTe** on **GaAs** usually relies on a tow – step growth process where by initial layers are grown at lower temperatures. **GaAs** substrates are used commonly for growth of $\mathbf{Cd_xHg_{1-x}Te}$ because, compared with bulk grown **CdTe**, they are cheap and of good quality.

**Experimental:**

Polycrystalline **CdTe** was synthesized form fusing initial components consisting of the elements via the horizontal Bridgman technique. In stoichiometric from pure elements (99.9999% purity from Balzer comp.). After being evacuated ($10^{-6}$) torr and then sealed v, the ampoule was set in a single – zone horizontal Lindbergh furnace reaches to (1200) $^{o}$C the maximum temperature. The heating was began in the element has low melting temperature run to the element has high melting temperature and it was kept for several time. Then was heated above the melting point to the compound is (1070) $^{o}$C at range (1.5) $^{o}$C/min., the ampoule was kept for (16) hr. in the zone horizontal furnace, where the temperature was higher than the crystallization temperature. The melt was shaken during heating several times. Then the temperature zone furnace was cooled at range (1.5-2) $^{o}$C/min. on gradient heat inside zone furnace as show Figure (1). The solidification process was achieved, below the crystallization temperature we obtain bulk polycrystalline **CdTe** inside ampoule as show is Figure (2). Also evaporating **CdTe** compound as thin films in vacuum $10^{-5}$ torr deposited on clean glass microscopy substrates at room temperature by thermal evaporation method using the system (Edward Vac. Speed, England), the thickness of the deposited films were (0.789) $\mu m$ that we measured by weight method.

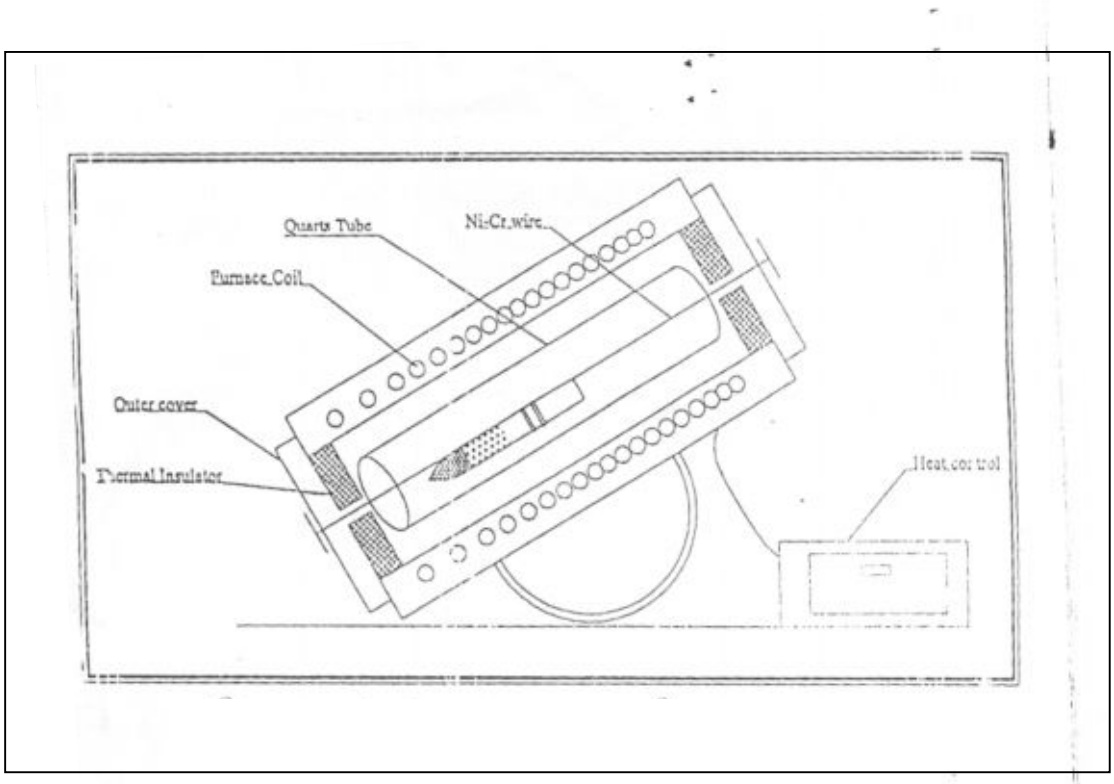


***Fig.(1):Ampoule inside furnace***

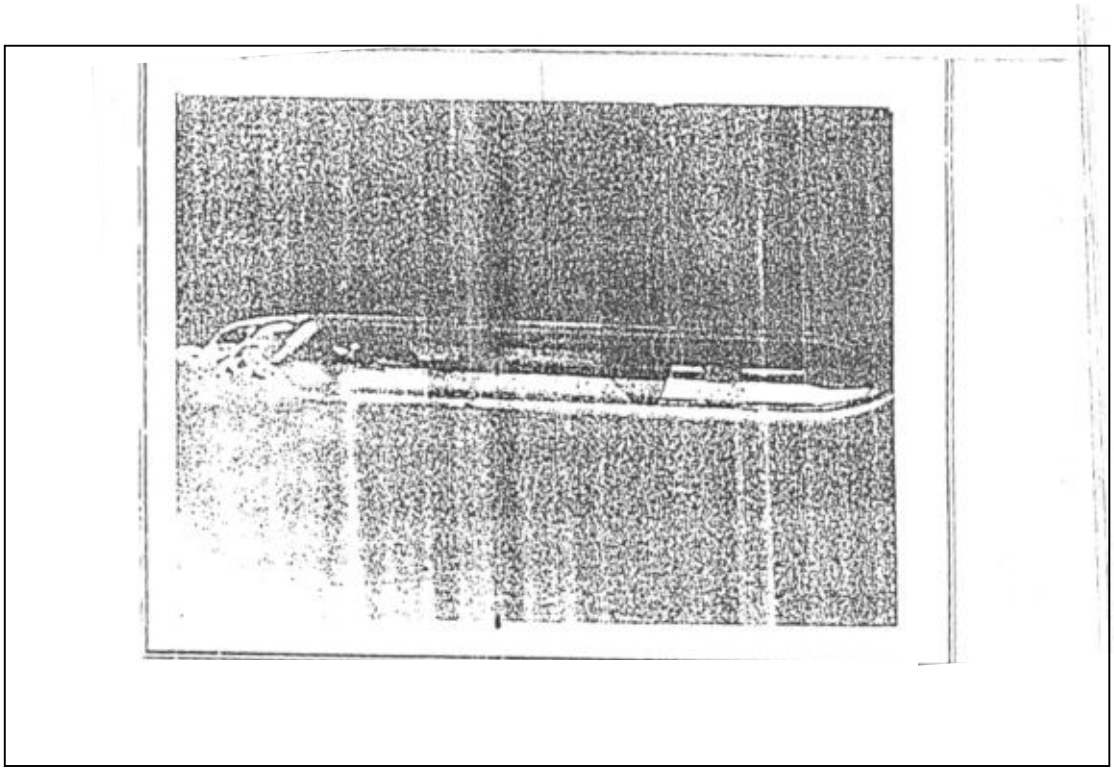

***Fig.(2):CdTe ingot inside Ampoule***

**Results and Discussion:**

The **CdTe** compound powder was analyzed by X-ray diffraction pattern and result show in table (1). Figure (3) shown X-ray diffraction pattern for powder compound **CdTe** which show it has single phase and it has been zinc blend structure in cubic unit cell and the direction (111) preferable which has high intensity, calculated the lattice parameters a= 6.478 $\overset{o}{A}$ by:

$$2d_{hkl}Sin\theta = n\lambda \qquad (1)$$

$$\left(\frac{1}{d_{hkl}}\right)^2 = \left(\frac{h^2+k^2+l^2}{a^2}\right)^2 \qquad (2)$$

$d_{hkl}$: distance spacing
hkl : meller indices
a=b=c : lattice parameters

Table (2) explain analyzed of X-ray diffraction pattern of **CdTe** thin films deposited at room temperature and annealing films in temperatures (200) $^oC$ and (250) $^oC$ . Figure (4) shown X-ray diffraction pattern for thin films deposited at room temperature and (111) was prefer orientation, Figure (5&6) show X-ray diffraction pattern for thin films annealing at temperatures (200) $^oC$ and (250) $^oC$ respectively if see crystallization these films and have some peaks, the direction (111) which is also prefer orientation to all films and other small peaks, annealing temperature is gave the chance to atoms motion that to increase period grains and fusion with some grains surrounding nearest neighbor [8,9], and increase growth grains which is appeared crystal grown in direction (220) and this is material film has polycrystalline structure. Calculated grain size from measure with beam at half intensity to prefer orientation for all films using Scherr's equation:

$$G = \frac{0.9\lambda}{BCos\ \theta_B} \qquad (3)$$

If $\lambda$ wave length for X-ray for Cu $K_\alpha$ 1.5405 $\overset{o}{A}$, B width beam at half intensity, $\theta_B$ angle diffraction, from through seen values parameters that shown in table (3) as seen effect the annealing temperature an increase grains size crystal began clear.

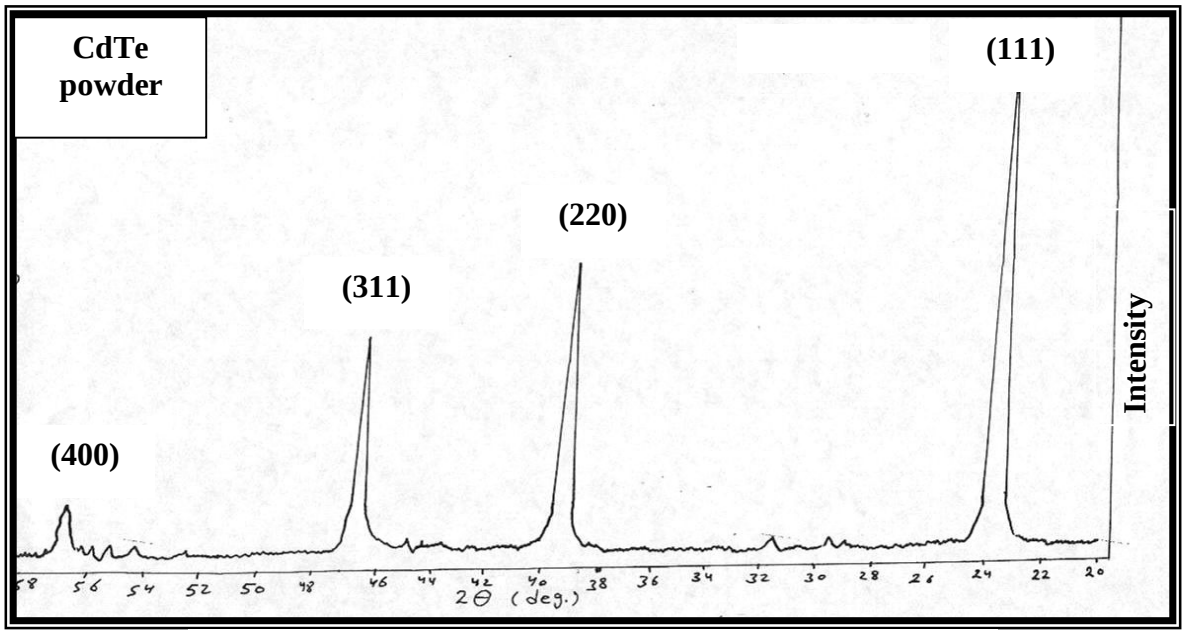


***Fig.(3)XRD patterns for CdTe powder***

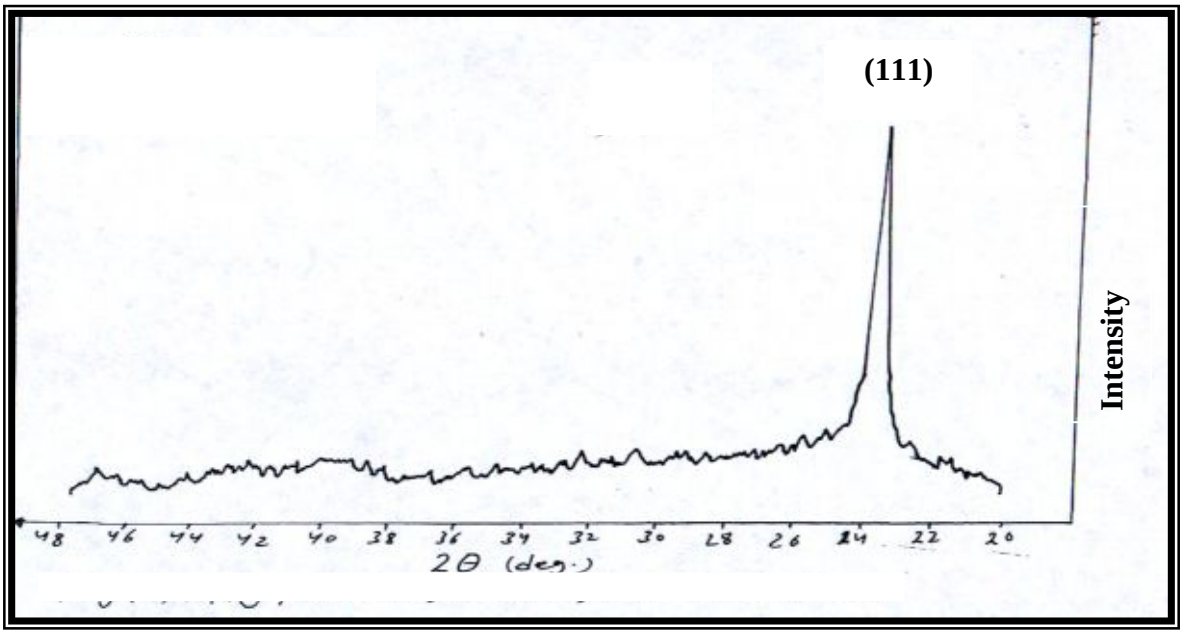


***Fig.(4)XRD patterns for CdTe thin film (Ts=R.T)***

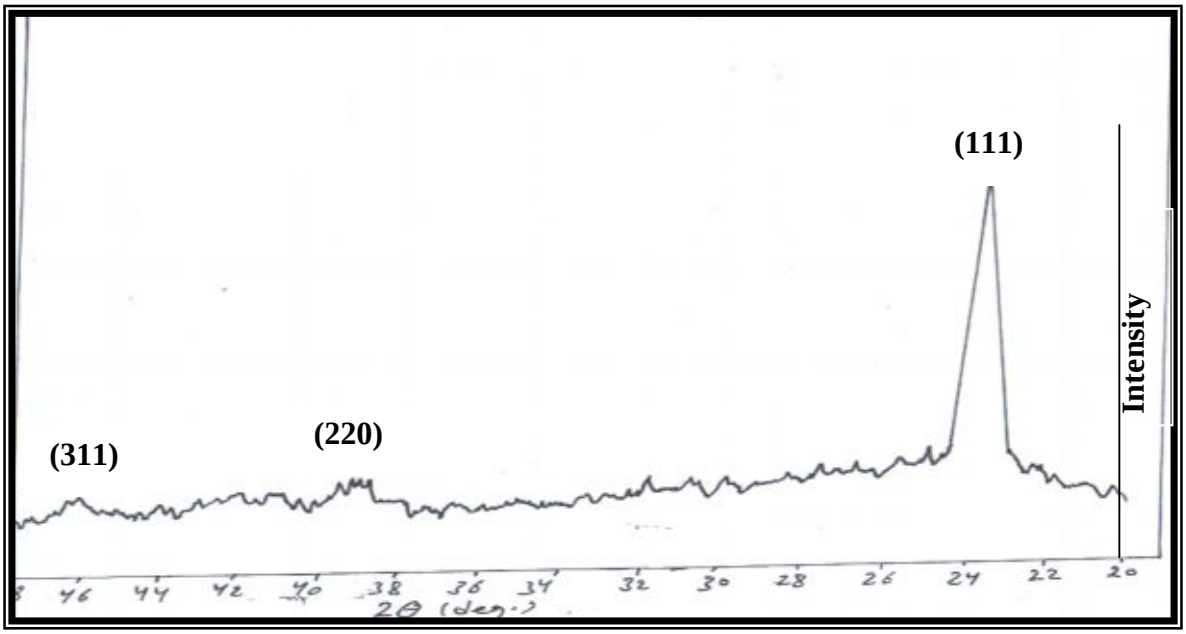


***Fig.(5 )XRD patterns for CdTe thin film (Ts=200°C)***

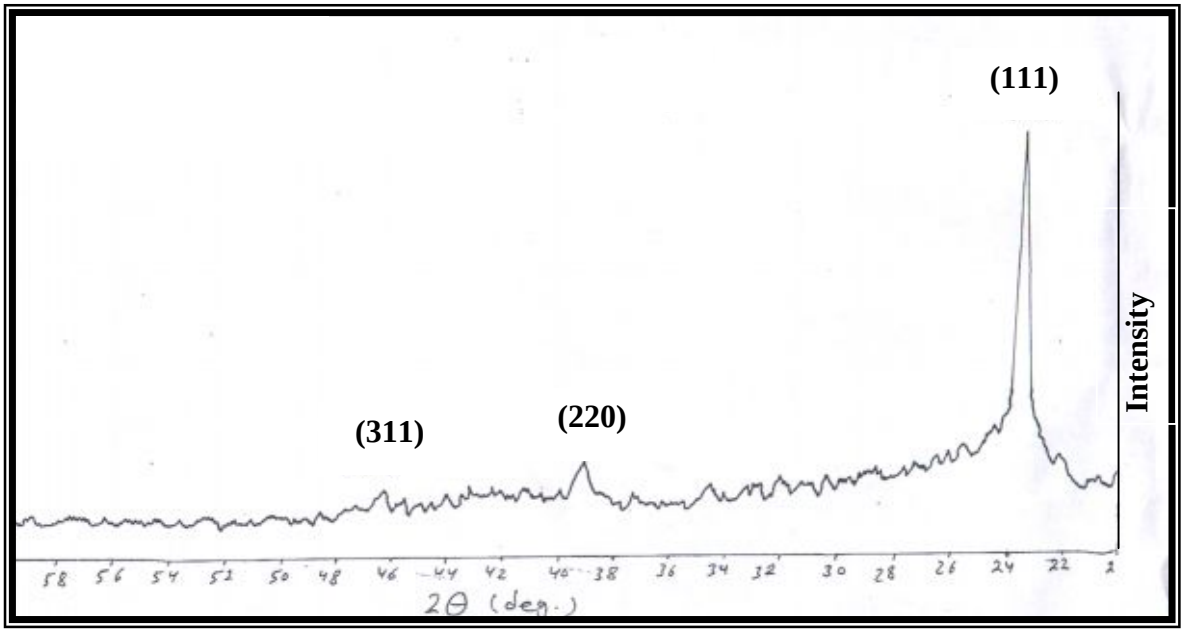


***Fig.(6) XRD patterns for CdTe thin film (Ts=250°C)***

***Table (1): The results of X-ray diffraction t CdTe thin films***

| This work | | | A.S.T.M. | | |
|---|---|---|---|---|---|
| **dÅ** | **$I/I_o$** | **hkl** | **dÅ** | **$I/I_o$** | **Hkl** |
| 3.7524 | 100 | 111 | 3.747 | 100 | 111 |
| 3.0867 | 1 | - | 2.294 | 62 | 220 |
| 3.0303 | 2 | - | 1.954 | 32 | 311 |
| 2.8376 | 3 | - | 1.619 | 6 | 400 |
| 2.2990 | 65 | 220 | 1.458 | 10 | 331 |
| 1.9588 | 48 | 311 | 1.323 | 10 | 422 |
| 1.7445 | 3 | - | 1.247 | 4 | 511 |
| 1.6195 | 6 | 400 | 1.145 | 2 | 440 |
| 1.4888 | 10 | 331 | 1.097 | 4 | 531 |
| 1.3239 | 8 | 422 | 1.025 | 4 | 620 |
| 1.2480 | 5 | 511 | .9884 | 2 | 533 |

***Table (2) : The results of analysis X-ray diffraction to all thin films CdTe compound***

| Thin film without annealing | | | Thin film with annealing at 200 $^oC$ | | | Thin film with annealing at 250 $^oC$ | | |
|---|---|---|---|---|---|---|---|---|
| **dÅ** | **$I/I_o$** | **hkl** | **dÅ** | **$I/I_o$** | **hkl** | **dÅ** | **$I/I_o$** | **hkl** |
| 3.939 | 1 | - | 4.000 | 1 | - | 4.000 | 1 | - |
| 3.752 | 100 | 111 | 3.766 | 100 | 111 | 3.752 | 100 | 111 |
| 3.139 | 2 | - | 3.558 | 2 | - | 3.463 | 1 | - |
| 3.030 | 1 | - | 3.450 | 1 | - | 2.947 | 1 | - |
| 2.928 | 2 | - | 2.811 | 1 | - | 2.785 | 1 | - |
| 2.777 | 3 | - | 2.318 | 4 | - | 2.590 | 1 | - |
| 2.273 | 2 | - | 2.290 | 4 | 220 | 2.284 | 10 | 220 |
| | | | | | | 1.959 | 4 | 311 |

***Table (3) : The results of anlysis x-ray diffraction to all thin films CdTe compound***

| Thin film without annealing | | | Thin film with annealing at 200 C | | | Thin film with annealing at 250 C | | |
|---|---|---|---|---|---|---|---|---|
| **dÅ** | **$I/I_o$** | **hkl** | **dÅ** | **$I/I_o$** | **hkl** | **dÅ** | **$I/I_o$** | **hkl** |
| 3.939 | 1 | - | 4.000 | 1 | - | 4.000 | 1 | - |
| 3.752 | 100 | 111 | 3.766 | 100 | 111 | 3.752 | 100 | 111 |
| 3.139 | 2 | - | 3.558 | 2 | - | 3.463 | 1 | - |
| 3.030 | 1 | - | 3.450 | 1 | - | 2.947 | 1 | - |
| 2.928 | 2 | - | 2.811 | 1 | - | 2.785 | 1 | - |
| 2.777 | 3 | - | 2.318 | 4 | - | 2.590 | 1 | - |
| 2.273 | 2 | - | 2.290 | 4 | 220 | 2.284 | 10 | 220 |
| | | | | | | 1.959 | 4 | 311 |

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