A Comparative Study Of Band Gap Of Cadmium Telluride Thin Films At Various Thicknesses And Substrate Temperatures

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Abstract: Cadmium Telluride (CdTe) thin films for different thicknesses were prepared on clean glass substrate vacuum evaporation technique. Band gap of CdTe thin films of different thicknesses shows the band gap value increases as thickness of the film increases. Band gap of CdTe thin films at various substrate temperatures exhibit that band gap increases with the substrate temperature and thickness increase.

Index Terms **- Band gap, Cadmium Telluride, Thickness, Substrate temperature.**

I. INTRODUCTION:

Semi-conductor material Cadmium Telluride (CdTe) is considered as one of the most promising material for device application (Shaban et.al, 2009). Cadmium Telluride is most suitable semi-conductor for photo voltaic application because of its ideal band gap. It possesses some unique physical properties with potential application in optical devices such as lasers and photo detectors. CdTe has a direct band gap in the range of 1.45 eV at room temperature (Chander et.al, 2016). In this context, the present investigation aims at comparing various band gap of Cadmium Telluride thin film with the following specific objectives:

i) To compare band gap of CdTe thin films of various thicknesses.
ii) To compare band gap of CdTe thin films at various substrate temperatures.

II. REVIEW OF LITERATURE:

Although the study of thin film phenomena dates back well over a century, it is really only over the last four decades that they have been used to a significant extent in practical situations. The requirement of micro miniaturization made the use of thin and thick films virtually imperative. The development of computer technology led to a requirement for very high density storage techniques and it is this which has stimulated most of the research on the magnetic properties of thin films. Many thin film devices have been developed which have found themselves looking for an application or, perhaps more importantly market. In general these devices have resulted from research into the physical properties of thin films.

Secondly, as well as generating ideas for new devices, fundamental research has led to a dramatic improvement in understanding of thin films and surfaces. This in turn has resulted in a greater ability to fabricate devices with predictable, controllable and reproducible properties. The cleanliness and nature of the substrate, the deposition conditions, post deposition heat treatment and passivation are vital process variables in thin film fabrication. Therefore, prior to this improvement in our understanding of thin films, it has not really been possible to apply them to real devices.

Thirdly, much of the finance for early thin film research originated from space and defence programmes to which the device cost is less important than its lightweight and other advantages, the major applications of thin film technology are not now exclusively in these areas but rather often lie in the domestic sector in which low cost is essential (West, 2003 and Chopra, 1983).

The properties of thin films such as structural, chemical, metallurgical and physical are strongly dependent on a number of deposition parameters and may also be thickness dependent (Chopra et. al; 2004).

Cadmium telluride (CdTe) is a stable crystalline compound formed from cadmium and tellurium. It is mainly used as the semiconducting material in cadmium telluride photovoltaic and an infrared optical window (Wikipedia, the free encyclopedia).

III. METHODOLOGY:

a. Material used: CdTe powder

CdTe films were prepared from the high purity CdTe powder (99.99% pure grains from Sigma-Aldrich). h).

b. Technique used: Vacuum evaporation technique

Vacuum evaporation technique was found to be the most simple and economical among all other deposition methods. In the present investigation films were deposited on clean glass substrate with a high vacuum coating unit of 'ED' series manufactured by HINDHIVAC PRIVATE LIMITED, Bangalore.

c. Evaporation source:
As evaporation source, MO boats were used.

d. Vacuum pressure:
The vacuum pressure was maintained at 10~5 torr in the chamber.

e. Measurement of thickness:
The thickness of the deposited CdTe film was measured by gravitational method.

IV. RESULT AND DISCUSSION:

In the present work, CdTe thin films of (1) different thickness (2) different substrate temperatures have been prepared. CdTe thin films of various thicknesses of 254 nm, 482 nm and 810 nm were prepared without substrate temperatures.

Table1: Comparison of band gap of CdTe thin films of various thicknesses

Thickness (nm)	Band Gap (eV)
254	1.57
482	1.77
810	1.80

In the present investigation, it was observed that the band gap value increases as thickness of the film increases, as reported earlier by other researcher (Mandal et.al.; 2014, Shabaan et.al.; 2009, Geethalakshmi et.al.; 2012) with thickness grain size increases and strain decreases.

Table2: Comparison of band gap of CdTe thin films at various substrate temperatures

Substrate temperatures	Thickness (nm)	Band Gap (eV)	Reference
Room temperature	254	1.52	Present Work
100 °C	420	1.73	Present Work
200 °C	507	1.87	Present Work
300 °C	400	2.47	Reference (Rigana Begam et.al., 2013)
350 °C	400	2.07	Reference (Rigana Begam et.al., 2013)
450 °C	400	2.05	Reference (Rigana Begam et.al., 2013)

Band gap obtained at different substrate temperatures show that band gap increases with the substrate temperature and thickness increase. This may be due to increase in film thickness as crystallinity improves with film thickness. Again the literature of the above table reveals that controlled thickness and varying substrate temperature decreases band gap as substrate temperature increases.

V. CONCLUSION:

Cadmium Telluride (CdTe) is deposited on clean glass substrate by vacuum evaporation technique. Band gap value obtained at different thicknesses and substrate temperatures show that band gap increases with the thickness increase and substrate temperature.

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