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# MICRO-RAMAN AND UV-VIS STUDIES OF 100 MEV $Ni^{4+}$ IRRADIATED CADMIUM TELLURIDE THIN FILMS

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*CdTe thin films grown by thermal evaporation on quartz substrates were irradiated with Swift (*100 *MeV) Ni* $^{4+}$ *ions for fluences in the range* $1.0 \times 10^{11}$ - $1.0 \times 10^{13}$ *cm* $^{-2}$*. The modification in the structure and optical properties has been studied as a function of ion fluence using Micro-Raman spectroscopy and UV-VIS spectroscopy. In Micro Raman spectrum, weak LO and TO modes of CdTe and* $A_1$ *& E modes of Te were observed with blue shift which was found to increase with increase in fluence. Intensity of these modes decreased with increase in ion fluence. UV-transmission showed pronounced interference fringes, indicating a good quality of the films. The bandgap was found to increase in the range* 1.4-1.75 *eV with increase in fluence.*

***Keywords:*** *CdTe, THIN FILMS, SWIFT HEAVY ION IRRADIATION, MICRO-RAMAN, U V.*

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## 1. INTRODUCTION

Cadmium telluride is useful material for photovoltaic applications [1]. It has high absorption coefficient in the visible range of the solar spectrum and its band gap is close to the optimum value for efficient solar energy conversion. Swift heavy ion (SHI) beam irradiation of materials has been the subject of current research in materials to modify their optical, electrical and optoelectronic properties [2]. SHI irradiation induced defects in CdTe crystals and thin films have been studied [2-4]. In this paper, we report the studies of 100 MeV $Ni^{4+}$ ion irradiation induced modifications in the structure and optical properties of thermally evaporated CdTe thin films on quartz substrates.

## 2. EXPERIMENTAL DETAILS

CdTe thin films were deposited on quartz substrates by vacuum evaporation from a molybdenum boat at a pressure of $5.0 \times 10^{-7}$ mbar. The thickness of the film was monitored in situ by quartz crystal thickness monitor. CdTe films (100 nm thick) were subjected to 100 MeV $Ni^{4+}$ ion irradiation for different fluences $1.0 \times 10^{11}$, $5.0 \times 10^{11}$, $1.0 \times 10^{12}$, $5.0 \times 10^{12}$ and $1.0 \times 10^{13}$ cm$^{-2}$. Ion beam irradiation was done using 15 UD Pelletron tandem accelerator at Inter University Accelerator Centre (IUAC), New Delhi. The electronic and nuclear energy loss values for 100 MeV $Ni^{4+}$ ions in CdTe, estimated from the SRIM code simulation program (version 2003.26) are $1.2516 \times 10^{3}$ eV/Å and 2.7181 eV/Å respectively. Micro-Raman spectroscopy was done using Horiba Jobin Yvon Raman Spectrometer T 64000 and the measurements were performed at room temperature with a 514.5 nm line of an $Ar^{+}$ laser. UV-VIS spectroscopy measurements were carried on Shimadzu UV-3600 machine.

## 3. RESULTS AND DISCUSSIONS

### 3.1 Raman Spectroscopy Studies

Fig. 1 shows the Raman spectrum of pristine and SHI irradiated CdTe thin films. Raman modes with peak at 122 $cm^{-1}$, 135 $cm^{-1}$, 143 $cm^{-1}$, 160 $cm^{-1}$, 200 $cm^{-1}$ [5] are observed in as prepared sample. We observed stronger Te Raman peak in the spectrum. The CdTe scattered light is absorbed by the tellurium precipitates, resulting in relatively stronger Raman peak [5]. The intensity of Raman band decreases with increase in ion fluence and at the fluence of $5.0 \times 10^{12}$ $cm^{-2}$ the spectrum did not show all Raman band (Fig. 1), might be due to surface amorphization of the films [6]. Decrease in the intensity of the mode observed for Te at 122 $cm^{-1}$ suggests that irradiation prevents the formation of Te precipitates in the film.

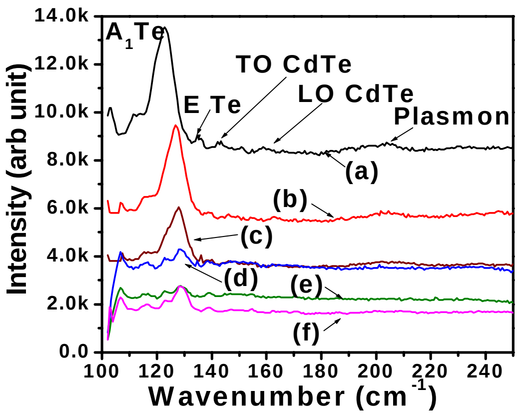


***Fig. 1** – Micro Raman studies – (a) Pristine, (b)* $1.0 \times 10^{11}$, *(c)* $5.0 \times 10^{11}$, *(d)* $1.0 \times 10^{12}$, *(e)* $5.0 \times 10^{12}$, *(f)* $1.0 \times 10^{13}$ $cm^{-2}$

### 3.2 UV-VIS Spectroscopy studies

Fig. 2 shows the optical transmittance spectra of as grown and irradiated CdTe films. The observed interference fringe pattern reveals good crystalline nature of the films. It was observed that transmission decreased with increase in fluence. This decrease could arise due to increase in absorption associated with the creation of intermediate energy levels during irradiation. Fig. 3 shows linear relation of absorption coefficient against energy, which indicates that the absorption mechanism is in this system is non-transition. The bandgap was estimated from the intercept of the energy axis of $(\alpha h\nu)^{2}$ vs. $h\nu$ plots and found to vary from 1.4 to 1.75 eV (Fig. 3). Change in the optical bandgap could be directly related to the change in grain size reported earlier (6).

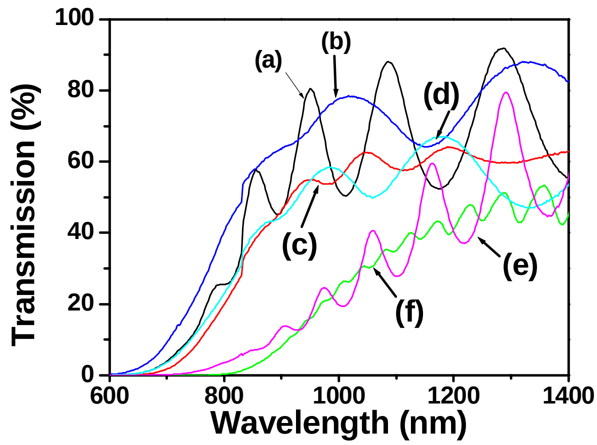


***Fig. 2*** – *Transmission spectra – (a) Pristine, (b)* $1.0 \times 10^{11}$ *(c)* $5.0 \times 10^{11}$, *(d)* $1.0 \times 10^{12}$, *(e)* $5.0 \times 10^{12}$, *(f)* $1.0 \times 10^{13}$ $cm^{-2}$

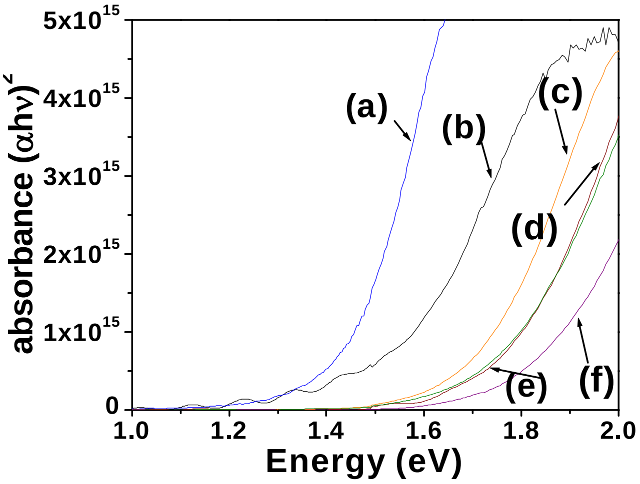


***Fig. 3*** – *Absorbance Vs Energy – (a) Pristine, (b)* $1.0 \times 10^{11}$, *(c)* $5.0 \times 10^{11}$, *(d)* $1.0 \times 10^{12}$, *(e)* $5.0 \times 10^{12}$, *(f)* $1.0 \times 10^{13}$ $cm^{-2}$

## 4. CONCLUSION

The effect of SHI irradiation with 100 MeV $Ni^{4+}$ ions at different fluences on CdTe thin films has been investigated using Micro-Raman Spectroscopy and UV-VIS Spectroscopy. Study of Micro Raman spectra showed the intensity of the Raman bands decreased with increase in fluence. Formation of Te precipitates reduced with increase in fluence. The UV transmittance was found to decrease with increase in fluence. Bandgap was observed to increase with increase in fluence in the range 1.4-1.75 eV.

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