Comparison of free-carrier absorption in <110> CdTe and ZnTe crystals at terahertz region

Yadong Xu[1, 2], Hang Liu[1], Ningbo Jia[1], Jiawei Li[1], Wei Bai[1], Caihong Zhang[2], Biaobing Jin[2], Wanqi Jie[1]

1. State Key Laboratory of Solidification Processing, Northwestern Polytechnical University, Xi'an 710072, China

2. Laboratory of Solid State Microstructures, Nanjing University, 210093, China

***Abstract*—ZnTe and CdTe bulk single crystals grown under Te-saturated conditions from the solution and melt, respectively, are adopted in this work. To give an insight into the variation of the THz-TDS spectroscopy response, the resistivities of both tellurides are discussed. Te_i and V_{Zn} are proposed as the dominant grown-in defects, account for the low resistivity of p-type ZnTe. However, Te_{Cd} as the principle grown-in defect, leads to the high resistivity of light n-type CdTe. It suggests that the refractive index increase with the increase resistivity for both ZnTe and CdTe in THz region.**

I. INTRODUCTION

CdTe and ZnTe have attracted much attention in the fields of far-infrared and room temperature radiation detectors, solar cells, terahertz and photorefractive devices, etc. due to its excellent photoelectric properties [1, 2]. Recently, there has been a significant effort in developing CdTe and ZnTe single crystal growth. However, duo to the high melting point, abundance of structure imperfections usually positioned in the crystals when grown under stoichiometric conditions [3]. Therefore, the resistivity and charge transport behaviors of the crystals were degraded, which has consequently reduced the availability and prevented the wide-spread adoption of CdTe and ZnTe for various general applications.

In this work, CdTe and ZnTe crystals grown by the Te-solvent-vertical Bridgman method were evaluated. The size and density distributions of Te inclusions in CdTe and ZnTe crystals were examined using IR transmission microscopy. Current-voltage curves were measured at room temperature using a Kiethley 6517b picoammeter/ voltage supply. Charge transport mobility and conduction type was identified by Hall-effect measurements at room temperature.Upon comparing the corresponding electric properties and charge transport performance, the terahertz time-domain spectroscopy was evaluated. In addition, low-temperature (8.6 K) photoluminescence spectra of both tellurides were obtained to discuss the possible defect levels wherein.

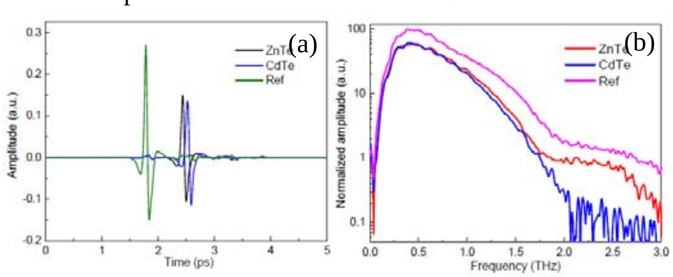

Fig. 1. THz response spectra of ZnTe and CdTe,(a) temporal domain pulse, (b) amplitude in the frequency domain.

II. RESULTS

Fig. 1 shows the typical THz-TDS spectra of ZnTe and CdTe, with a high transmission in the range of 0.1 THz~1.75 THz. A significant absorption for CdTe crystals was observed beyond 1.75 THz different from ZnTe, which possible attributed to the characteristic defect-assistant absorption.

Typical PL spectra for ZnTe and CdTe were obtained at low temperature, as seen in Fig. 2. The characteristic photo-peaks in both tellurides demonstrate that the grown-in defects properties are distinct.

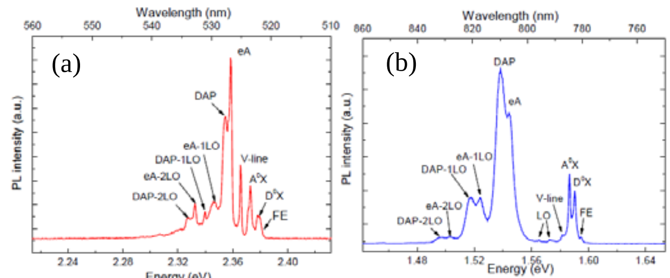

Fig. 2. PL spectra measured at 8.6 K for undoped ZnTe (a) and undoped CdTe (b)

Further, the refractive indexes of both tellurides linear increased as a function of the frequency, as seen Fig. 3. A knee point was found for ZnTe at ~1.75 THz. It suggests that the refractive index increase with the increase resistivity for both ZnTe and CdTe in THz region.

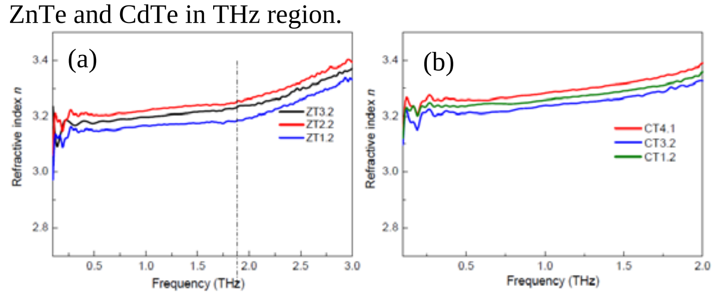

Fig. 3. Refractive index a function of frequency (a) ZnTe, and (b) CdTe.

III. SUMMARY

Variation of the THz-TDS spectra for ZnTe and CdTe were observed in the range of 1.75-3 THz, which possible attributed to the different grown-in point defects. The refractive index increase with the increase resistivity for both tellurides potentially related with the free carrier absorption.

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