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The Effect of Subbandgap Illumination on the Bulk Resistivity of CdZnTe

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The variation in bulk resistivity during infrared (IR) illumination above 950 nm of state-of-the-art CdZnTe (CZT) crystals grown using the traveling heating method or the modified Bridgman method is documented. The change in steady-state current with and without illumination is also evaluated. The influence of secondary phases (SP) on current–voltage (*I*–*V*) characteristics is discussed using IR transmission microscopy to determine the defect concentration within the crystal bulk. SP present within the CZT are connected to the existence of deep, IR-excitable traps within the bandgap.

Key words: CdZnTe, bulk resistivity, IR illumination, defect distribution, secondary phases, current–voltage (*I*–*V*)

INTRODUCTION

The characteristics of $Cd_{1-x}Zn_xTe$ (CZT), including its high density, high resistivity, wide bandgap, and favorable charge transport properties, make it a promising candidate for room-temperature (RT) x-ray and gamma-ray detectors.[1,2] Improvements in crystal growth methods and postgrowth processing have significantly reduced defect levels throughout the crystal bulk, making CZT attractive for industrial use over traditional detector materials, including silicon and germanium.[3,4] Although the quality of bulk CZT is now commercial grade, postgrowth detector fabrication methods including surface chemical etching and Schottky contact deposition have led to reduced charge transport through the bulk crystal due to carrier trapping at the detector surface. Additionally, charge traps such as impurities and defects, including secondary phases (SP), may further limit charge transport through the bulk.[5] While numerous studies have been performed to characterize charge compensation and carrier transport both in the bulk and over surfaces of CZT detectors, the use of postgrowth, indirect methods to purposefully manipulate charge transport through CZT bulk crystal remains strictly an experimental oddity.

Previous work has shown that subbandgap, infrared (IR) illumination alters the charge transport dynamics through bulk CZT. Illumination has been shown to effectively increase the carrier concentration by detrapping deep-level carriers, thereby directly increasing the number of electron–hole pairs.[6,7] The effect of IR illumination on charge transport through bulk CZT may be inferred through evaluation of the bulk resistivity. IR illumination is known to lead to an effective reduction of the bulk resistivity of CZT; however, this idea is not thoroughly examined in literature.[8] Any influence of IR illumination on charge transport through the bulk would be apparent in current–voltage (*I*–*V*) resistivity curves under very low applied bias (e.g., under 10 V). At higher applied bias, the current across the device is determined by a combination between the barrier height of the surface contact and current transmission through the contact interface.[9] Although numerous models have been proposed to correlate charge traps due to impurities and defect states with effects on charge

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