



**University
of Victoria**

Graduate Studies

Notice of the Final Oral Examination
for the Degree of Master of Applied Science

of

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BSc (Mansoura University, 2016)

“Photoluminescence Characterization of Cadmium Zinc Telluride”

Department of Electrical and Computer Engineering

Wednesday July 3, 2019

9:00 A.M.

Engineering Office Wing
Room 230

Supervisory Committee:

Dr. Thomas Tiedje, Department of Electrical and Computer Engineering, University of Victoria
(Supervisor)

Dr. Fayez Gebali, Department of Electrical and Computer Engineering, UVic (Member)

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Dr. Mohsen Akbari, Department of Mechanical Engineering, UVic

Chair of Oral Examination:

Dr. Matthew Moffitt, Department of Chemistry, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

The demand for wide bandgap semiconductors for radiation detector applications has significantly increased in recent years due to an ever-growing need for safeguard measures and medical imaging systems amongst other applications. The need for these devices to be portable and efficient, and to operate at room temperature is important for practical applications. For radiation detectors, the semiconductor materials are mainly required to have an optimal energy gap, high average atomic number, good electrical resistivity and charge transport properties as well as purity and homogeneity.

Cadmium zinc telluride (CZT) distinctly stands out among the other choices of semiconductor materials for radiation detector applications, due to its attractive material properties and the room temperature operation possibility.

A tremendous amount of research is being conducted to improve CZT technology and its implementation into more commercial systems. Applications of CZT detector technology in national security, high energy physics, nuclear spectroscopy, and medical imaging systems are of special interests. However, CZT devices still face challenges that need to be understood and overcome in order to have more efficient radiation detector systems. One such challenge lies in the understanding of the surfaces of CZT detectors and surface effects on detector quality and performance. Another common issue is the degradation of CZT detectors due to the presence of defects which can act as traps for the charge carriers and cause incomplete charge collection from the detectors. Thus, a major challenge is that, the commercial CZT crystals have large concentrations of defects and impurities that need to be characterized, and their effects on the detector performance should be studied.

Photoluminescence (PL) spectroscopy is a sensitive, non-contact and non-destructive method, suitable to characterize lower concentrations of point defects, such as substitutional impurities (donors, acceptors) and native defects in CZT crystals. A PL spectrum provides information regarding the defect nature of the crystal by determining the presence and the type of vacancies, interstitials, and impurities in the lattice.

The main objective of this thesis is to address the presence of the defects in CZT crystals, identify their types, and study their roles in the performance of x-ray radiation detectors using PL spectroscopy. Additionally, using PL method and different excitation sources including UV excitation, this thesis studies the surface of CZT samples and investigates the PL signature of the surface oxide of the samples, in an effort to optimize the surface processing and thereby improve CZT detector performance.