

## **Ph.D. Defence**

**Theodore Lambert Hopman**

**Date: November 12, 2008**

**Time: 9:30 a.m.**

**Place: Science Complex Room 1511  
University of Guelph**

**THESIS TITLE: CHARACTERIZATION OF ENERGY DISPERSIVE  
SEMICONDUCTOR DETECTORS FOR X-RAY SPECTROSCOPY**

### **ABSTRACT:**

Since the development of the electron microprobe in the 1950s by Castaing, characteristic x-ray emission lines have been used to determine chemical compositions of samples. Energy dispersive detectors allow simultaneous multi-element analysis; continued improvements in detector technology have lowered limits of detection and allowed the effects of physical processes in the detector to become apparent. A well-characterized detector, in terms of its geometry and its response to x-rays, is essential for accurate and precise chemical analysis.

In this work, scans with a collimated  $^{55}\text{Fe}$  radionuclide source allowed the geometry of Si(Li) detectors to be determined. Across the surface of the detector the response function was uniform, indicating it is due primarily to detector physics and/or processing electronics. Monochromatized x-rays over an energy range of 1–10 keV were used to generate simple spectra in Si(Li) and silicon drift detectors with analog and digital pulse processing systems. Monte Carlo simulations of detector response allowed approximate contributions from physical processes to be seen individually.

Transport of energetic electrons, electron diffusion at metal-semiconductor junctions, and differences in detector structure together determine variation with energy of spectrum features. The Si K photoelectron escape step at about 1.8 keV, previously attributed to electron transport only, is found to be affected by diffusion. The diffusion tail to the low-energy side of the primary peak is found to have a component due to escape of Si L Auger electrons. Escape peak intensities in SDD and Si(Li) detectors agree only when contact photoelectron contributions are taken into account.

### **Examining Committee:**

**P. Garrett (Chair)**

**J.L. (Iain) Campbell (Advisor)**

**M.-C. Lépy (External)**

**J. O'Meara**

**S. Kycia**