Abstract
Solar energy being a limitless source of energy all around the globe has been difficult to harness. This is due to the direct solar-electric conversion efficiency which is very low and has upper limit set to the Shockley-Queisser limit. Solar thermophotovoltaics (STPV) is a much more efficient solar energy harvesting technology as it has the potential to overcome the Shockley-Queisser limit, by absorbing the broad-spectrum solar energy and emitting a narrowband matched infrared spectrum radiation to the PV cell. Despite having the potential to surpass the Shockley-Queisser limit, very few experimental results have reported high system level efficiency. The objective of the thesis is to experimentally study the STPV conversion performance with selective metafilm absorber and emitter paired with a commercial GaSb cell at different solar concentrations. Absorber and Emitter metafilm thickness was optimized and fabricated. The fabricated metafilm optical properties showed good agreement with the theoretically determined properties. The experiment setup was completed and validated by measuring the heat transfer rate across the test setup and comparing with theoretical calculations. A novel method for maintaining gap between the emitter and PV cell was developed using glass microspheres. Theoretical calculations show that the use of glass of microspheres reduced the conduction losses from the emitter. This research work will help enhance the fundamental understanding in the development of the high efficiency solar thermophotovoltaic system.