Low-Dimensional Materials for Terahertz Optoelectronic Device Applications

Abstract

The thesis explores low-dimensional materials for developing efficient terahertz (THz) emitters and detectors operating at room temperature. It demonstrates spintronic THz emission from $PtTe_2$/Co and $MoTe_2$/Co heterostructures through efficient spin-to-charge conversion mechanisms. The $PtTe_2$/Co emitter produces stronger THz emission than a conventional Pt/Co device, while the $MoTe_2$/Co structure provides broadband emission through an interface-driven inverse Rashba–Edelstein effect. The work also presents a WSe_2-based, zero-bias THz detector integrated with a planar log-periodic antenna, operating over 0.1–1.2 THz with a maximum responsivity of approximately 68 mA/W. Overall, the thesis highlights the potential of semimetallic and semiconducting transition-metal dichalcogenides for next-generation THz technologies.