ELECTRICAL & COMPUTER ENGINEERING
UNIVERSITY OF MICHIGAN

Electrical and Computer Engineering

ECE Final PhD Defense

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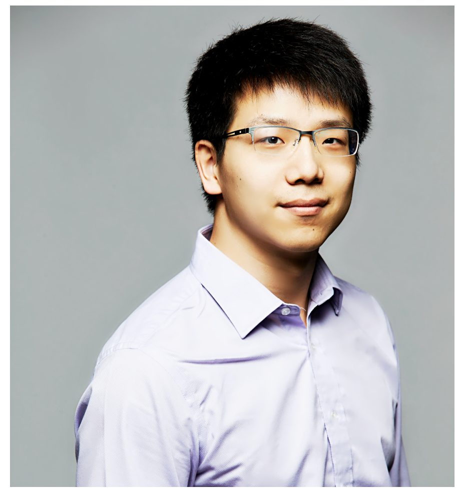

Enabling High Performance III-V Thin-Film Photodetectors on Unconventional Surfaces

Thursday, March 26th, 2020
2:00 pm – 4:00 pm • Remote/Virtual
https://bluejeans.com/804624715?src=calendarLink

Chair: Professor Stephen Forrest

Abstract: High performance optoelectronic devices made of III-V compound semiconductors are preferred over elemental semiconductors due to their superior optical and electronic properties. With the development of semiconductor fabrication technology, thin-film optoelectronics on *unconventional surfaces* have drawn attention due to the benefits of enhanced absorption/reflection, reduced fabrication cost, superior mechanical flexibility, opportunities for integration with dissimilar materials, etc. In this thesis, we demonstrate novel fabrication techniques that transfer the III-V optoelectronic devices, especially high-performance photodetectors focal plane arrays, from their bulky and rigid crystalline substrates, to unconventional lightweight, flexible, conformal, and non-developable surfaces without performance degradation. The demonstrations include a cylindrical and bendable 8×100 thin-film $In_{0.53}Ga_{0.47}As$ *p-i-n* photodiode array fabricated on a thin flexible plastic foil, and a hemispherical GaAs *p-n* junction focal plane array that mimics the size, form, and function of the human eye. In addition, we integrate an energy harvesting photodetector comprising an InGaAs-based thin-film thermophotovoltaic (TPV) cell with low index dielectrics and even air for enhanced out-of-band photon recycling. Specifically, an unconventional TPV cell is fabricated over an air cavity, showing 8% (absolute) power conversion efficiency improvement compared to conventional thin-film TPV cells, leading to a record-high TPV power conversion efficiency of > 30% at 1500K emitter temperature. The demonstrated high performance III-V thin-film photodetectors on *unconventional surfaces* unlock possibilities for future optoelectronics that are beyond current planar and lattice-matched substrates, and provide paths to their ubiquitous applications.