THESIS **DEFENSE**

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Demonstration of functional III-V photovoltaic cell via processing of porous Ge substrates

March 8th, 2019
12:00 PM
Hill Hall 300

Abstract: Substrate reuse technologies focus on reducing photovoltaic device costs via substrate utilization over multiple devices. The three common substrate reuse strategies include epitaxial lift-off, controlled spallingand porous lift-off. This work focuses on the porous lift-off substrate reuse for Ge substrates. The porous lift-off substrate reuse strategy involvesetchinga porous layer directly into the substrate, annealing the porous film to coalesce the surface while maintaining embedded pores underneath, epitaxy on the reformed surface and mechanical lift-off of the device via the weak embedded porous layer. The use of germanium (Ge) as a III-V epitaxial substrate for one-sun, terrestrial applications is inhibited due to the high substrate costs, so this thesis focuses on the development of a proof-of-concept III-V device on a porous Ge substrate.

The etching and annealing of porous Ge as well as epitaxy on porous Ge substrates is studied in this thesis. It is vital for the viability of the technology to be capable of producing a uniform and repeatable porous Ge film. Therefore, electrochemical etching of porous Ge films is studied in order to identify etching conditions which lead to stability and uniformity in porous Ge films. Additionally, an understanding of how different porous Ge microstructures evolve during high temperature annealing is necessary to enable epitaxy on porous Ge, so this work cataloged sample preparation, microstructural, and annealing parameters which enabled surface coalescence in porous Ge films. This thesis demonstrates epitaxy on as-etched and annealed porous Ge substrates, and the development of substrate processing strategies enabled the achievement of the first reported single-junction III-V photovoltaic cell on a porous Ge substrate with a short circuit current of 20.95 mA/cm^2, open circuit voltage of 0.74 V, fill factor of 37% and efficiency of 5.7%. Development of an operational photovoltaic cell on a porous Ge substrate demonstrates the feasibility of porous lift-off as a substrate reuse strategy for Ge substrates and enables future work into the optimization of this substrate reuse strategy.