InP substrate recycling via non-destructive epitaxial lift-off for high efficiency thermophotovoltaic cells

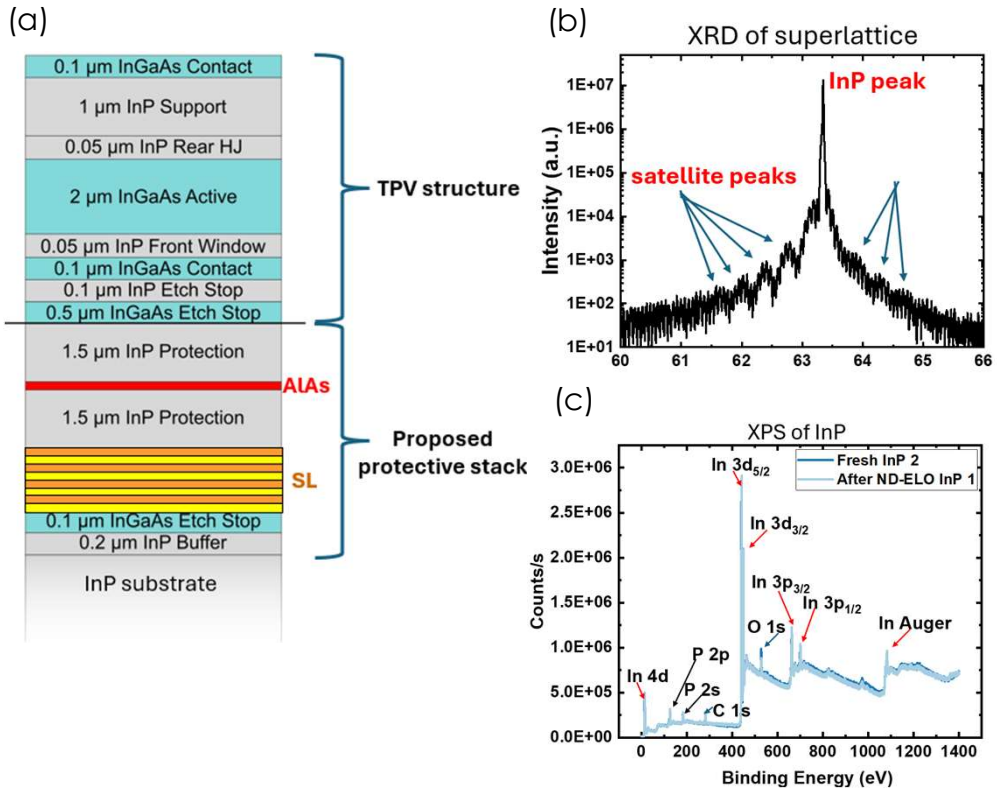

Figure: (a) Proposed ND-ELO heterostructure with protective stack. (b) XRD of superlattice showing sharp interfaces without intermixing. (c) XPS of fresh and recovered InP after ND-ELO showing no change in chemical composition.

Objective

➢ To demonstrate InP substrate reuse for the growth of multiple high efficiency III-V based TPV cells via non-destructive epitaxial lift-off

Impact

III-V based semiconductors are forerunners for air bridge thermophotovoltaic (TPV) cells with power conversion efficiencies reaching ~45%. However, their practical adoption remains limited by the prohibitively high InP substrate cost. The aim of this project is to demonstrate InP substrate recycling to drastically reduce the substrate cost. We use non-destructive epitaxial lift-off to transfer the TPV heterostructures to a secondary silicon substrate and recover the parent InP wafer for the next growth. We have designed a strained-short-period-superlattice protective stack to suppress defect propagation into active layers during successive growths.

Facilities and Methods Used

- Molecular Beam Epitaxy (MBE)
- Photolithography
- Chemical Etching
- Vacuum thermal evaporation
- Thermocompression bonding
- Metrology – SEM, AFM, XPS, XRD, FTIR
- JV setup (dark and illuminated conditions)

Relevant Papers

- K. Lee, et al., Appl. Phys. Lett., DOI: 10.1063/1.3479906

Funding

- US Space Force, Heat2Power

Collaborators

- Seungwon Rha, Emory Townsend

Contact

- Sritoma Paul (sritoma@umich.edu)

Optoelectronic Components and Materials Group OCM