BAPVC Thrust: High Performance and Multijunction Cells

Key Challenges

The goal of this thrust is to explore new growth processes, material systems, and device architectures for offering high device efficiencies at low processing costs. In particular, two parallel approaches are being explored, one relying on reducing the processing costs of III-V single junction solar cells and the other exploring tandem device architectures based on Si bottom cells. The key challenge for the field is developing disruptive growth and processing technologies that would drastically lower the cost without sacrificing the device efficiencies. In parallel, tremendous opportunities are present in exploring tandem cells based on Si (or CIGS, CdTe, or III-V) bottom cells to enhance the efficiency of the existing PV technologies, but with careful consideration of the costs to ensure a balance approach is developed. Cost analysis, device modeling, and experiments are being performed in parallel in a collaborative manner to ensure success.

Current Projects:

High Performance, Low Cost, III-V Photovoltaics on Metal Foils, Javey, Berkeley
Ultra high efficiency thin film multi-junction solar cell, Harris, Stanford
Thin Film Compound Semiconductor Solar Cells via Templated Growth, McIntyre, Stanford
Low-Cost Tandem Solar Cells With Greater than 20% Power Conversion Efficiency, McGehee, Stanford
High Voc Solar Absorbers for High-Efficiency, Spectral-Splitting, Solar Cells, Yablonovitch, Berkeley
Si/II-VI double-heterostructure solar cells, Zhang, Arizon State
Design principles and defect tolerances of silicon / III-V multijunction interfaces, Buonassisi, MIT
Exploratory Photovoltaic Modeling and Simulation, Bermel, Purdue

Potential Growth of BAPVC

- More cost analysis of the explored research projects in collaboration with NREL. Currently 2-3 of the projects within the thrust have had cost analysis discussions with NREL. More projects can follow this path.
- Exploring the device processing and manufacturability of the new III-V growth technologies, such as the thin-film VLS process.
- Exploring surface passivation effects and back-contact reflectors for the new III-V growth technologies, such as the thin-film VLS process.
- Better understanding (experiments and modeling) of the types of defects that their correlation to performance for the new III-V growth technologies, such as the thin-film VLS process.
- Development of high bandgap (III-V, II-VI, perovskite or other) solar cells for performance in tandem devices
- Defect mitigation during silicon cell fabrication, for improved multijunction bottom-cell performance.
- Defect recognition and characterization in high-quality Czochralski silicon for high-efficiency PV devices.
- Light management in tandem and other high performance solar cells.
- Development of tunnel junctions, recombination layers, polymer electrolytes, or other transparent contacts that will enable current matching between silicon solar cells and a high bandgap solar cell.