III-V High-Efficiency Multijunction Photovoltaics

Scope. The III-V High-Efficiency Multijunction Photovoltaics (MJ PV) Group develops advanced multijiunction cell technology and transfers the resulting intellectual property to industry. The group's distinguished record of accomplishments include the following:

- Invented the original GaInP/GaAs multijunction cell
- Developed the GaInP/GaAs cell and transferred it to the high-efficiency-cell industry
- Demonstrated the first monolithic cell ever to exceed 30% efficiency
- Developed, demonstrated, and transferred technology of the new Inverted Metamorphic Multijunction cell technology.

The MJ PV Group addresses the full range of multijunction development issues, including:

- Design of new cell concepts
- Development of methods for practical implementation of these concepts
- Proof of concept via demonstration of record-efficiency devices at the laboratory scale.

In addition to publication of our work in the scientific literature, we use two other mechanisms to transfer this technology to industry partners:

- Licensing of the intellectual property.
- Cooperative Research and Development Agreements. In CRADAs, our group works together with an industry partner to develop the innovations needed to commercialize our technology. We have had CRADA partnerships with virtually all U.S. multijunction industry leaders. Our basic criteria for CRADA projects are the following:
  - Potential to have a significant impact on the industry
  - Advancement of the technology
  - Strong connection to the group's core competency of multijunction cells.

Core Competencies and Capabilities. The capabilities and tools we bring to bear on developing and transferring multijunction cell technology include the following:

- Cluster tool, which comprises a metal-organic vapor-phase epitaxy (MOVPE) growth system connected via load locks to a molecular-beam epitaxy (MBE) growth system and an analytical chamber
- Two stand-alone MOVPE growth systems
- Stand-alone MBE growth system
- Clean room in which epitaxial wafers can be processed into full devices
- Suite of cell testing techniques, including current-voltage (I-V) and quantum-efficiency (QE) testing of full multijunction cells
- Numerical modeling of cell performance issues relevant for incorporation into real-world systems, including inhomogeneous illumination, cell heating, and three-dimensional flow of electrical current.

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