Continuous Roll-to-Roll Amorphous Silicon Photovoltaic Manufacturing Technology

Energy Conversion Devices participated in both Phase 1 and Phase 2A of PVMaT.

PVMaT is a 5-year, cost-shared partnership between the U.S. Department of Energy and the U.S. PV industry to improve the worldwide competitiveness of U.S. commercial PV manufacturing.

PVMaT Fact Sheet

Photovoltaic Manufacturing Technology

Energy Conversion Devices, Inc.

Goals

The overall goal of Energy Conversion Devices, Inc. (ECD) under the PVMaT Project has been to improve its amorphous silicon (a-Si) alloy solar-cell manufacturing technology, which uses a continuous roll-to-roll deposition process. The specific goal has been to develop a large-scale manufacturing technology capable of producing modules with stable efficiencies greater than 10%, in high volume, at a cost of about $1 per peak watt. Successfully implementing this project supports ECD's ultimate goal of building a roll-to-roll, automated, a-Si module manufacturing facility with a production capacity of 100 megawatts per year.

ECD's continuous roll-to-roll production line for a-Si.

Technology

ECD's technology focuses on producing a-Si PV modules using a continuous roll-to-roll process, depositing nine layers of a-Si alloys in a single pass onto a 762-m-long stainless-steel substrate. This substrate is 5 mil thick, 0.35 m wide, and has many advantages compared to glass substrates, including

- Stainless steel will not shatter during manufacturing operation and handling.
- Stainless steel is lightweight and flexible.
- The transport mechanism is simple, reliable, and produces minimal component wear, keeping maintenance costs low.
- The thin stainless-steel substrate can be heated and cooled quickly during deposition.

ECD's continuous roll-to-roll production features the use of triple-junction, multiple-bandgap solar cells with high-quality, bandgap-profiled a-Si:Ge as the bottom intrinsic layer. Using this a-Si/a-Si/a-Si:Ge triple-junction design, ECD has demonstrated conversion efficiency of 13.7% for small-area solar cells. The manufacturing line was designed and engineered to produce solar cells incorporating this most-advanced cell design to obtain modules with high conversion efficiency and good stability.

The encapsulation system for these PV modules comprises ethylene vinyl acetate (EVA)/Tefzel. This construction makes the modules flexible, lightweight, and shatterproof.

Results

This stable, steady-state process is reliable and provides uniform cells with excellent yields. The operating cost, which includes maintenance and labor, is low. Under the PVMaT contract, ECD

- Completed improvements to the a-Si:Ge alloy deposition system
- Established the first roll-to-roll, a-Si:Ge production line
- Demonstrated production solar cells with 11.1% initial conversion efficiency
- Demonstrated 8% stabilized efficiency on triple-junction a-Si alloy production modules with a total area of at least 0.37 m^2
- Made significant progress toward increasing the effective manufacturing throughput

- Made full production runs (762 m) with 99.7% subcell yield and high uniformity
- Reduced material costs by 77% for germane, 58% for disilane, and 30% in assembly material cost for module design
- Designed a new grid/bus-bar that uses thin wire grids to improve the efficiency by about 3%–4% and reduced the cost of the grid/bus-bar by 50%
- Developed a new 200-kilowatt, multi-purpose, semicontinuous roll-to-roll, a-Si-alloy solar-cell deposition machine for depositing back-reflector, triple-junction solar cells, and transparent-conducting-oxide layers in multiple passes
- Designed and constructed a serpentine web, continuous roll-to-roll chamber, to be used to demonstrate a compact, low-cost deposition machine design with improved handling and gas utilization factors for high-throughput deposition
- Demonstrated a 9.5% triple-junction cell using serpentine technology
- Developed a concept design for a 100-megawatt, continuous roll-to-roll, PV module manufacturing plant to produce large-area, lightweight, frameless PV modules with 10% stable efficiency at less than $1 per watt.

Company Profile

Energy Conversion Devices, Inc., is a leader in synthesizing new materials and developing advanced production technologies and innovative products. Since being founded in 1960, ECD's research and development efforts have focused on amorphous and disordered materials. ECD has developed its Ovonic materials, production technology, and products in the areas of energy, information, and synthetic materials.

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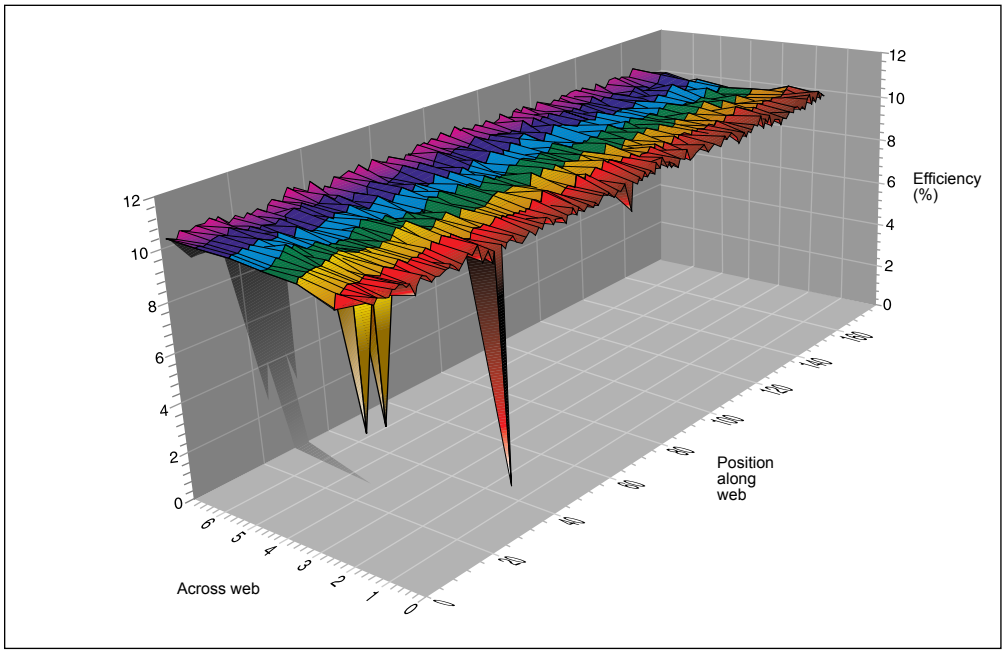

Cell efficiency of a 600-m production run.

PVMaT
Photovoltaic Manufacturing Technology

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