Process-Specific Issues for Thin Edge-Defined, Film-Fed-Growth Octagons

ASE Americas, Inc. (formerly Mobil Solar Energy Corporation) participated in both Phase 1 and 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

ASE Americas, Inc.

Goals

The goals of ASE Americas, Inc., under the PVMaT Project have been to (1) produce 250-micrometer-thick wafers and solar cells using edge-defined, film-fed growth (EFG) technology, (2) increase production throughput at the laser cutting station by a factor of two, (3) develop a new encapsulant polymer to protect the module's PV cells against corrosion, and (4) develop a module that uses glass as the back covering for greater protection against cuts, tears, and penetrations.

Technology

ASE Americas employed a patented method of silicon crystal growth to produce the basic material from which its cells are made. This EFG process involves melting silicon pellets in large furnaces at a temperature greater than 1400°C, then pulling an eight-sided, hollow tube to a height of about 5 m. Conventional crystal-growth technologies produce silicon blocks that must be sliced into wafers. However, sawing the material results in a sawdust-like waste of the expensive silicon. In the EFG process, the thin-walled octagonal tube emerges directly from the molten silicon, with no sawing losses.

When the long, octagonal tubes are removed from the growth furnace, they are automatically conveyed on a monorail to a laser cutting station, where they are cut into square wafers that are 100 mm x 100 mm. This process is substantially more efficient in using silicon materials than conventional growth and sawing methods.

After cutting, the thin wafers are transferred to the cell processing line where they undergo proprietary processing steps to make them electrically active. The cells are then moved to the module fabrication line, where they are assembled in various configurations, depending on the size of the module being manufactured. The modules range in size from 50 watts (for battery charging applications) to more than 300 watts in a single module, suitable for electric utilities.

To fabricate the cells into modules, the company uses a newly developed encapsulant to replace the ethylene vinyl acetate (EVA) of conventional modules. To protect against environmental damage, a double-glass construction covers both the front and back of the module, ensuring durability and long life.

ASE Americas' production line for EFG crystal growth.

Results

Activities under the PVMaT Project have aimed at identifying potential problems and efficiency improvements in the manufacture of EFG wafers, cells, and finished modules. The issues identified included manufacturing thinner cells, eliminating wet-chemistry processing steps, developing an improved encapsulant material, and using glass as both the back and front laminate material.

In addressing the manufacture of thin cell materials, the company produced wafers meeting the PVMaT objectives in a technical readiness demonstration: 13.8%-efficient, 250-micrometer-thick solar cells from production-line materials. With the manufacturing process itself, the number of steps required was significantly reduced, virtually eliminating wet-chemistry processing, thus making the operation environmentally safe.

In a major achievement with ramifications for the entire PV industry, company researchers developed a new, radically different, non-EVA material that protects against corrosion and prevents moisture from getting inside the module. Extensive testing indicates that the thermoplastic material in the advanced solar encapsulant is inert and stable in modules at all operating temperatures, solving the browning problems associated with EVA.

Finally, the company's production engineers successfully produced a glass lamination for both the front and back of the module, providing far greater protection against cuts, tears, and penetrations than the back coverings typical in the PV industry. This product improvement also occurred during the PVMaT Project.

Company Profile

The EFG technology that is the basis of this PVMaT Project subcontract was developed more than 20 years ago and was moved to commercial production by Mobil Tyco, which later became Mobil Solar Energy Corporation (MSEC). During the term of the PVMaT subcontract, MSEC was purchased, with the new company renamed ASE Americas, Inc. ASE Americas is a wholly owned subsidiary of ASE GmbH, itself a recently formed venture of Deutsche Aerospace AG (DASA) and NUKEM GmbH. DASA is a subsidiary of Daimler-Benz AG, and NUKEM is owned by Germany's largest electric utility company, RWE AG. Both companies have a long history in developing and applying photovoltaics. Manufacturing operations remain in the Billerica, Massachusetts, facility formerly owned by Mobil Solar.

The new laser cutting station.

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