INFORMATION SHEET
RENEWABLE DEVELOPMENT FUND

Investing in Renewable Energy

COST-EFFECTIVE PILOT LINE FOR FLEXIBLE PV MODULES

Executive Summary

InterPhases Solar launched a pilot-scale manufacturing process to fabricate copper indium selenide (CIS) photovoltaic (PV) cells. This method will produce an endless flexible roll of PV material that can be cut to size, which will allow direct integration in buildings or modules of variable shapes and sizes. CIS thin film PV has potential to exceed silicon based PV technology because of greater film efficiency, improved reliability and lower manufacturing costs. Besides these attributes, CIS PV offers potential for excellent performance under Minnesota's extreme weather – hot and cold temperatures, ice and snow– and various climate conditions: dappled shading, cloudy weather and diffused light.

Project Description

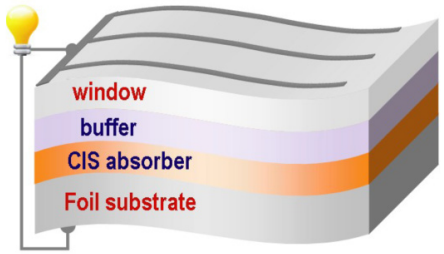
InterPhases Solar designed, constructed and tested a PV fabrication process that produced PV material on metal foil. The process was achieved at a smaller, pilot-scale but test results indicate that the technology can be transferred directly to large-scale capacity necessary for commercial manufacturing. The project involved a three step approach:

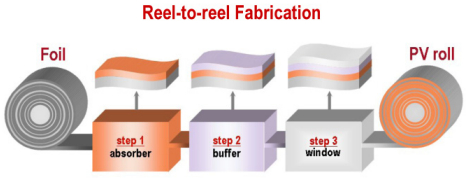
1) System parameters were identified for high speed fabrication;
2) The manufacturing process and component layout was designed and constructed;
3) The components for the reel-to-reel (R2R) process were assembled and the system was operated to produce a thin-film, PV product.

The film was tested for composition, conductivity, structural disorder, photovoltage, quantum efficiency and device efficiency.

Methodology

The project demonstrated research findings from a second cycle RDF project which had developed a prototype CIS thin-film manufacturing process. During this third cycle, a pilot-scale manufacturing line was designed, constructed and operated which produced functional CIS thin-film PV material. Project effort focused on transitioning the critical steps for substrate preparation and absorber deposition to a continuous R2R processing line and the subsequent steps for thermal annealing and PV device fabrication.





Grantee: InterPhases Solar
Project Dates: 8/7/2009 – 7/20/2012
RDF Funding Cycle: 3
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Project ID: RD3-53
RDF Mission: To increase renewable energy market penetration, assist renewable energy projects and companies, and support emerging renewable energy technology through research and development.

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Benefits

Low manufacturing cost, as compared to traditional silicon PV technology, is the primary driver for developing CIS PV technology. The R2R manufacturing method produces a thin, uniform material, does not require a vacuum and does not produce the hazardous waste materials. The advantages of the process are as follows:

- Simplified manufacturing process that can be easily scaled-up
- Water-based, 90 percent cheaper atmospheric process with less stringent regulation of parameters
- No hazardous materials produced during process which reduces manufacturing disposal costs
- Environmentally safer process that avoids hazardous gases and waste reactants
- PV material can be deposited on curved, non-planar and irregular surfaces of a wide range of consumer and building products.

Lessons Learned

- R2R manufacturing provides a single-step process for manufacturing CIS cells, which reduces the complexity and tool footprint by at least three times as compared to a multi-step, multi-metal sequential approach.
- 10 percent efficient CIS PV modules could be manufactured for 58¢ per watt and higher efficiency of 15 per cent would lower the cost to 39¢ per watt.
- CIS PV reduces installed PV cost to $1.76 per watt.

Outcomes

- The R2R manufacturing line produced an endless ribbon of PV material that can be cut and assembled into light-weight, flexible solar panels for electricity generation.
- CIS PV provides excellent performance in cooler climates, cloudy weather and adverse environments.
- CIS cells can be integrated into solar consumer products such as shingles, lighting, battery chargers, automobiles, boats and recreational vehicles.

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