Dimbach, Germany (1.4 MW); Blitzstrom / Beck Energy

CdTe ("cad tel") Photovoltaics

A new generation of photovoltaic (PV) technology is changing the world's perception of solar modules. PV technology has long held the promise of providing solutions to the world's energy problems, from both environmental and energy perspectives. However, large-scale deployment of solar modules has been traditionally inhibited by high costs.

Cadmium telluride (CdTe) technology, significantly refined over the past few years, is uniquely capable of producing high-volume, low-cost modules, making widespread, affordable solar electricity a reality. High-volume, affordable PV technology allows solar power to make a significant contribution to the world's energy supply, the goal of energy security, and the fight against climate change.

The unique advantages of CdTe PV technology include:

- Superior light absorption properties resulting in higher output, compared to traditional silicon modules, under cloudy and diffuse light conditions such as dawn and dusk[1]
- Better performance at the high temperatures that modules are subject to under direct sunlight, compared to traditional silicon modules[2]
- Enhanced suitability for production of modules – high volume and low cost
- Effective sequestration of cadmium in a stable compound for decades at a time
- Faster energy payback time – the fastest of existing PV technologies[3]
- Smallest carbon footprint among current PV technologies on a life cycle basis[4]

The physical characteristics of CdTe are such that it is almost perfectly matched to the solar spectrum. This allows CdTe modules to absorb more of the available solar energy in low and diffuse light situations – such as dawn and dusk and under cloudy skies – and convert it into electricity more efficiently than conventional cells. As a result, CdTe thin film modules will generally produce more electricity under real world conditions than conventional solar modules with similar power ratings.[5]

Because of CdTe's superior performance characteristics, thin film CdTe modules require just 1-2% of the semiconductor material needed by traditional crystalline modules to produce a comparable amount of power. Using CdTe permits simple device structures and manufacturing processes, alleviating the need for expensive clean rooms or other specialty equipment, and also facilitating high-volume, low-cost, energy-efficient module production.

Like other PV modules, CdTe modules can be deployed either in large-scale systems that feed into the grid just like traditional power plants, or as smaller-scale, distributed resources closer to customers, reducing the need for costly transmission investments.

The environmental benefits of CdTe PV technology are significant. Like other PV technologies, once deployed, CdTe modules generate electricity with no air emissions, no waste production and no water use. In fact, CdTe technology has the smallest carbon footprint of all current PV technologies when measured on a life cycle basis, primarily due to its lower energy use during module production. At least 89% of the air emissions on a life cycle basis (including carbon dioxide and cadmium) associated with electricity generation could be prevented if electricity from CdTe PV displaced electricity from the grid.[6]

Furthermore, CdTe modules use waste cadmium generated as a by-product of zinc refining, effectively sequestering the cadmium in the stable form of CdTe, and using it to produce affordable clean energy for the 25+ year lifetime of a module. In addition, First Solar has developed a recycling process that results in the recycling of 95% of the semiconductor material and 90% of the glass. As a result, First Solar's recycling process recovers about 90% (by mass) of any manufacturing scrap modules or returned modules (either warranty returns or end-of-life modules). First Solar is the first and only PV module manufacturer to establish a comprehensive, pre-funded module collection and recycling program.

CdTe's physical properties, including its extremely low vapor pressure and high boiling and melting points, along with its insolubility in water, limit its mobility. Furthermore, the very thin layer of CdTe in PV modules is encapsulated between two protective sheets of glass. As a result, the risk of health or environmental exposure in fires, from accidental breakage or from leaching is almost non-existent.

- A peer review of three major published studies on the environmental profile of CdTe PV organized by the European Commission, Joint Research Center and sponsored by the German Environment Ministry concluded, "…CdTe used in PV is in an environmental stable form that does not leak into the environment during normal use or foreseeable accidents, and therefore can be considered the environmental safest current use of cadmium."
- Independent analysis indicates that CdTe modules do not pose a risk during fires. CdTe has an extremely low vapor pressure, high boiling and melting points and is almost completely encapsulated by molten glass when exposed to fire. Exposure of pieces of CdTe PV modules to flame temperatures from 760 to 1100°C illustrated that CdTe diffuses into glass, rather than being released into the atmosphere. Higher temperatures produce further CdTe diffusion into the glass.
- Through outdoor leaching experiments with small fragments of CdTe modules, an independent study estimated that in a worst-case scenario materials leached from the modules into water would result in concentration levels that are no higher than the German drinking water concentration limit for cadmium.
- First Solar modules have been tested in accordance with standard waste protocols and are non-hazardous waste at end-of-life.

First Solar embraces the concepts of product life cycle management and extended producer responsibility. First Solar is a member of PV Cycle, the European industry group dedicated to the development and implementation of a voluntary agreement for the collection and recycling of waste PV modules. By combining the abundant resource of solar energy with low-cost PV technology and a comprehensive end-of-life module collection and recycling program, First Solar is providing truly sustainable energy solutions.

[1] Mohring, H.D., et al., "Outdoor Performance of Polycrystalline Thin Film PV Modules in Different European Climates," European project 'PYTHAGORAS."

[2] Ibid

[3] Fthenakis, V. M, Alsema, E., "Photovoltaics Energy Payback Times, Greenhouse Gas Emissions and External Costs: 2004 –Early 2005 status," Progress in Photovoltaics: Research and Applications, 2006; 14: 275-280.

[4] Fthenakis, V.M, Kim, H.C., Alsema, E., "Emissions from Photovoltaic Life Cycles," Environmental Science & Technology, 2008; 42: 2168-2174.

[5] Mohring, H.D., et al., "Outdoor Performance of Polycrystalline Thin Film PV Modules in Different European Climates," European project 'PYTHAGORAS."

[6] Fthenakis, V.M; Kim, H.C., Alsema, E., "Emissions from Photovoltaic Life Cycles," Environmental Science & Technology, 2008; 42: 2168-2174.

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