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PHOTOVOLTAIC MARKETS & TECHNOLOGY

Fast track to high power

Next steps in absorbing the switch to large-format modules

Life after PERC

It's TOPCon vs. HJT as cell makers look ahead to the next generation

Supply chain transparency

Responsible procurement practices and how to verify them

Traceability via a 'crystalline fingerprint'

Pi4 Robotics – PV-Ident

PV-Ident stores a unique set of data on each PV module, gathered from inline flashing and production tools. This promises to protect manufacturers against warranty claims for products damaged in transport or handling, as well as providing additional data for quality control.

Data stored by PV-Ident includes date of inspection, condition before shipment, shape of gridfingers, native silicon defects, and production related defects/features. Characteristics are saved as a data vector compressed to just a few bytes. No additional hardware is required, and Pi4 states that the solution offers savings in comparison to methods such as RFID tags or laser marking.

Nines PV

ADE Poly-Si etch

Nines PV's dry/gaseous process to remove parasitic polysilicon left over during amorphous silicon deposition in passivated contact cells promises several advantages over wet chemical processes. Etching is performed using molecular fluorine gas, which can be produced on site. The process chemistry is selective, ensuring that the emitter layer is preserved and the edges of the wafers are effectively targeted.

ADE poly-Si runs at atmospheric allows continuous processing and high throughput, and does not involve plasma, removing the possibility of damage to the substrate. "The tool provides a real opportunity for the solar industry to start moving away from incumbent wet processes, and start reducing their water footprint by adopting a dry process that has been designed to meet all the industrial requirements of solar manufacturing," the company states.

Rewarding performance, durability

Developing PV cells and modules that can achieve high performance and durability can be challenging – particularly in the cost-competitive solar marketplace. Officials in Taiwan have sought to promote both goals through its Taiwan Excellence PV Award, which in its eighth year continues to attract the cream of the country's solar manufacturers.

With its tropical climate – heat, humidity, and typhoons – Taiwan presents a challenging environment in which to install PV modules. Being a relatively small and highly populated island, there are additional complications in that the available land or rooftops can be close to the coast, exposing modules to salinity. And ground-mounted arrays may be installed on former industrial sites, where toxins may be present in the soil.

Given this, the country's solar cell and module producers must supply solar products that are designed and tested to withstand the worst of conditions when it comes to heat, humidity, wind loads, heavy rains and salt spray. But despite the challenges, the country has enjoyed considerable success in fostering PV development, with some 5 GW of solar having been installed by the end of 2020, according to local analysts PV InfoLink. The solar, wind and energy storage research and consultancy outfit expects between 1.5 and 1.7 GW of PV to installed in the country in 2021, up from 1.2 GW in 2020.

Taiwan Excellence PV

An important way in which the durability bona fides of a solar manufacturer's cells and modules can be demonstrated is through rigorous testing. In 2013, Taiwan's Bureau of Energy (BOE), working alongside its Ministry of Economic Affairs (MOEA), introduced the Taiwan Excellence PV Award (TEPV). The program put in place a transparent, third-party testing program through which Taiwanese PV manufacturers could demonstrate both their efficiency and durability credentials – and differentiate themselves from rival producers.

Taiwanese President Tsai Ing-wen presents the winners with the Taiwan Excellence PV award at Energy Taiwan 2020.

Photos: BOE / MOEA

Since its inception, the TEPV has proven popular with Taiwan's PV manufacturers, with 77 entrants having submitted PV cells and modules in its first seven years of operation.

"At the program inception, there were only four products submitted," explained Chun-Li Lee, deputy director general of Taiwan's Bureau of Energy. "That grew to 16 the following year. Depending on the testing categories and threshold, the number of applications remained around 10 each year."

Raising standards

As the PV manufacturing sector remains a dynamic one, and new failure modes and forms of degradation have emerged, the TEPV program was designed to change with the times, with testing specifications evolving alongside the industry. It tests not only for module durability beyond current industry standards, but also for efficiency, prompting manufacturers to pursue high performance alongside reliability.

"In this year's TEPV award program, the testing threshold of the power conversion efficiency was raised to 19.5% for PV module and 21.2% for solar cell," said Teng-Chun Wu, the division director, energy and environment metrology division, center for measurement standards, ITRI. Additionally, the TEPV testing program in 2021 includes testing for light and elevated temperature degradation (LeTID), in accordance with the draft IEC-TS-63342, with twice the injection current value, he said. "Since LeTID is a long-standing issue, the new test criteria emphasize that manufacturers need to develop or introduce new technologies that can reduce or minimize this challenge," he added.

In terms of cell and module sizes, the TEPV program in 2021 sets a size limit of 2.4 m in length and width of 1.25 m for modules. For cells, the limit is set at the M6 format, which the organizers note is in line with mainstream industry development, and in accordance with the International Technology Roadmap for Photovoltaic (ITRPV) analysis. "The decision as to keep expanding the size or upgrading to n-type solar cells in the future has yet to be decided," said Wu.

Participation benchmark

The success and traction that the TEPV program has achieved thus far is evident when we see that more than half of Taiwan's solar PV manufacturers have participated to date. "The top three solar PV manufacturing firms in Taiwan have participated in almost every year's TEPV award," added Lee.

The failure rate over the lifetime of the program is 10% for modules and 8% for cells – with the most common cause of failure being potential induced degradation (PID). The TEPV PID testing runs for 300 hours for modules and 192 hours for cells. "It is often challenging for new industrial technology products to achieve both high efficiency and high reliability at the same time," noted Lee.

TEPV awardees have their efforts recognized in a ceremony at the Energy Taiwan event, held in October of each year and organized by SEMI. In 2020, the winners of the 8th TEPV program were presented with their award by Taiwanese President Tsai Ing-wen. *pv magazine*

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>
> **Chun-Li Lee**

Winners of the 8th TEPV award

Silicon solar cell qualified product model	
TSEC Corporation	TSS65TNG
United Renewable Energy Co., Ltd.	NSAW

Silicon photovoltaic module qualified product module	
TSEC Corporation	TS60-6MH-340 HT
	TS72-6MH-410 HT
AU Optronics Corp.	PM06MW6_350
Win Win Precision Technology Co., Ltd.	WSP-330M6G
United Renewable Energy Co., Ltd.	D2K410H8A

More rigorous testing criteria of TEPV program

High salt moisture test	IEC 61701: 2011 Severity 6
Damp heat test	3000 hours
Thermal cycling test	6000 cycles
Combination test	DML-TC50-HF10