POE-based encapsulant films help enhance glass/glass PV module reliability

Words: Andrew Yen, Marketing Manager, Dow Elastomers

Demand for glass/glass PV module construction is growing due to the inherent benefits that allow both the back and front panel of the module to produce electricity. This is especially true in highly reflective environments like deserts, near water, rooftops, and above parking lots.

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The dual layers of glass also reduce the need for bulky structures that often cause hot spots that degrade or even burn modules produced with traditional aluminium frames. According to the International Technology Roadmap for Photovoltaics (ITRPV), glass used as the back-side cover material will increase in the next decade, with roughly 25 percent of all c-Si modules produced with glass/glass construction by 2024.

Further, EnergyTrend reported that 'even though the dual-glass design is not a fresh innovation, its market acceptance has rapidly expanded. Shipments of dual-glass modules from Chinese manufacturers grew to about 800~900MW in 2016.' While more expensive than modules produced with plastic backsheet construction, glass/glass costs can be offset due to increased power output and predicted longer service life – including warranties of up to 30 years versus the usual warranty of 25 years for conventional modules.

These improvements, plus factors like reliability and durability, become important considerations when looking at overall lower levelized cost of electricity over the lifetime of the module.

The Case for POE-based Encapsulants

Virtually Zero PID

With all this in mind, choices for encapsulant film layers have become increasingly important in supporting glass/glass module growth. EVA-based encapsulant films have long been used in several types of PV modules. In constructions that contain glass fronts and plastic backsheets, some of the corrosive acetic acid produced from EVA can pass through the plastic backsheet. However, in glass/glass constructions, all acetic acid that is generated is trapped between layers of glass and can cause corrosion that negatively impacts module performance.

Polyolefin elastomer-based encapsulant films, like those made with ENGAGE™ PV POE from Dow, do not produce corrosive elements like acetic acid. In fact, POE-based encapsulant films exhibit virtually zero Potential Induced Degradation (PID). Encapsulant material resistance to PID takes on more importance in the field as solar cells under high-voltage stress can degrade significantly within a short amount of time. Higher levels of PID resistance result in sustained levels of module efficiency.

Detailed PID tests conducted in 2013 by the Fraunhofer Center for Silicon Photovoltaics CSP compared modules using ENGAGE™ PV POE-based encapsulant film to modules using EVA-based film. Testing shows that power degradation in modules using EVA-based encapsulant films is far more likely and

will occur much more rapidly than in modules using film made with ENGAGE PV POEs. See Figure 1.

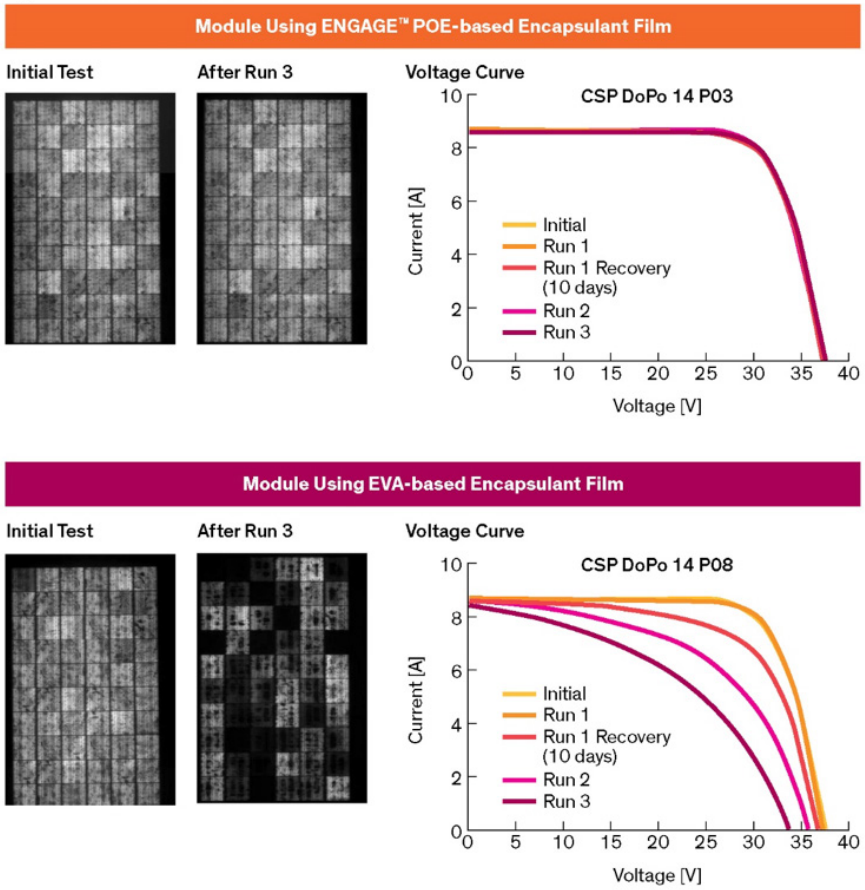
Excellent Optical Performance

Optical performance also is crucial to PV module performance. The more light that enters the active solar cell materials, the better the energy transmission from those cells. In the past, light transmittance has been an issue with glass/glass modules, due to glass thickness and opacity issues. However, new thinner glass materials have been introduced, with higher light transmittance capability. The use of POE-based encapsulant films, like those made with ENGAGE™ PV POE from Dow, further enhances glass/glass module performance due to the film's refractive index that is very close to that of glass. This reduces refractive losses and maximizes light transmission. Combined with high volume-resistivity levels, there is a positive effect on overall power generation and preservation.

Enhanced Power Retention

Glass/glass modules are seeing much wider use in coastal, fishery and agricultural areas. This is corroborated by a recent article from EnergyTrend that states, 'the dual-glass design is suitable for power plants located in coastal areas due to its ability to resist salt sprays. With higher light transmittance being its best advantage, this solution fits right into PV applications for agriculture and fishery. Indeed, this particular segment within the PV market is booming in China. Overall, EnergyTrend expects dual-glass module shipments to expand significantly in the Chinese market… on account of the rising demand from agricultural and fishery applications.'

This is particularly relevant in assessing encapsulant materials and their ability to withstand extended exposure to damp heat. The ability to do so can greatly extend module service life. Damp heat testing has demonstrated that a module made using ENGAGE™ POE-based encapsulant film can retain its initial efficiency level for a much longer period than a module using EVA-based film (see Figure 2).



(1) Tests conducted by the Fraunhofer Center for Silicon Photovoltaics CSP. Photographs and charts provided by Fraunhofer. Additional information available upon request.

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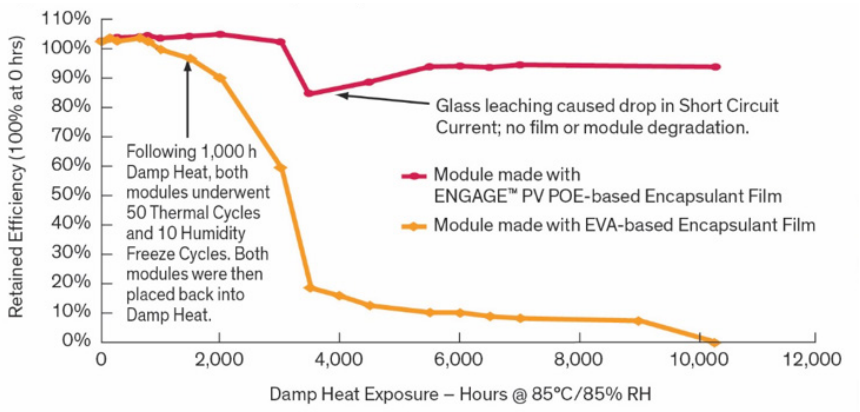
FIGURE 1: Resistance to PID



(1) Data per tests conducted by Dow. Additional information available upon request. Properties shown are typical, not to be construed as specifications. Users should confirm results by their own tests.

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FIGURE 2: Extended module reliability - damp heat

'Significant increases in module efficiency, reliability and life expectancy is anticipated in all module types in which POE-based encapsulants are used'

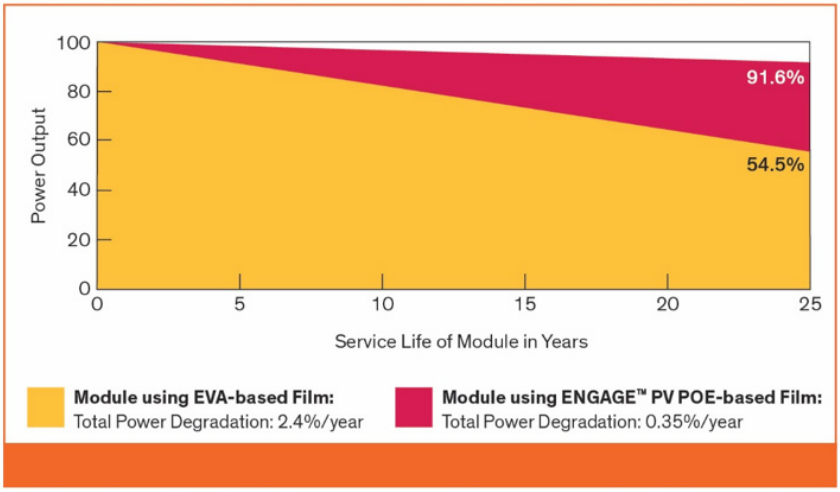

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FIGURE 3: Projected power output over 25 years

Long-term weathering tests show that modules using encapsulant film made with POE-based resins can provide enhanced power retention following alternating cycles of damp heat and QUV exposure over extended periods. Additionally, modules featuring ENGAGE™ POE-based encapsulant film exhibit excellent colour stability and help resist yellowing after extended damp heat testing, while those with EVA-based film show yellowing and increased degradation levels. Yellowing decreases the ability to both absorb and refract light, thus affecting both energy transmission and retention.

Other Key Benefits

Global module producers including Trina Solar, Canadian Solar and BYD, are now mass producing glass/glass modules. So, benefits that can be provided by materials suppliers to help make manufacturing more efficient will be widely sought. ENGAGE™ PV POEs have a stable chemical composition that provides module manufacturers with ease of processing with the possibility of reduced conversion costs when switching from traditional encapsulant materials like EVA. In addition, use of ENGAGE™ PV POEs can potentially eliminate edge sealing due to better water vapor transmission rates, compared with EVA. This also enables overall lower cost for glass/glass modules, compared with conventional glass/backsheet modules.

Moreover, modules made with POE-based encapsulant films outperform those made with EVA in these other critical areas:

- Volume resistivity and leakage current
- Water vapour transmission rate (WVTR)
- Optical transmission/yellowing
- UV and weather resistance
- Energy output, operating efficiency, reliability
- Service life (including lifetime cost of energy/total lifetime system costs)

Therefore, significant increases in module efficiency, reliability and life expectancy are anticipated in all module types in which POE-based encapsulants are used, including glass/glass. This all results in projected power output using POE-based encapsulant films that far outpaces modules produced with EVA-based films. See Figure 3.

With glass/glass module demand clearly on the rise, material selection for module construction has an increasing degree of impact. POE-based encapsulant films, like those made with ENGAGE™ PV POEs, become a much clearer choice when considering module and system performance, longevity, reliability and long-service life.

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Andrew began his career with h-UCC Singapore in 1996. In 2001, he joined h-Dow/UCC Singapore. Since then, he's held various positions such as Chemist, Account Manager, Technical Service & Development (TS&D) from Specialty Polymers to Specialty Chemicals businesses within Dow at its Midland, Michigan; Shanghai, PRC and Singapore locations.

In 2011, Andrew returned to Dow Singapore to assume the Regional Marketing Manager role, for Dow Elastomers. He was recently named Marketing Manager, Asia Pacific for Dow Elastomers, Electrical & Telecommunications.

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