



**NEW
D15**

On the road to better backsheets

How innovation has driven the next performance/cost breakthrough

How can the solar industry continue on its cost-down roadmap of lowering the LCOE of solar energy, without sacrificing quality and performance? It's a challenge that applies to many aspects of solar technology, not least to backsheets. Over the past few years, DSM has developed a new generation of Endurance backsheets that help tackle this challenge. Now the global science-based company has raised the bar yet again with the launch of its Endurance Backsheet D15. PES sat down with the DSM Advanced Solar Technology Manager, Sunny Zhao, to discuss how and why this latest innovation came to the market.

PES: It's great to have this opportunity to talk with you. You work in research & development for DSM. Can you tell us more about your role?

Sunny Zhao: I am the Solar Technology Manager for DSM, based in China at our Research & Technology Development Center. My background is in materials science and I have specific responsibility for developing our backsheet technology.

PES: Before we get onto the new D15 backsheet, can you just give us some background on the philosophy behind the R&D work that you've been conducting in recent years?

SZ: It's now common knowledge that quite some backsheets are failing in the field. In fact, DuPont recently published a report which claims that 16% of the inspected modules in the field showed backsheet defects¹. This adds up to an estimated \$4.5 billion module investment being at stake in 2020 - and we expect this number to rise even higher in the future.

The numbers tell a story but so does the market. I often get the opportunity to visit solar plants and look at how traditional PET-based backsheets are performing in the field. I see a product with a 'powdery' feel at the surface and a 'snail trail' phenomena due to backsheet degradation and poor moisture barrier. PET has poor hydrolysis resistance.

In fact, in the lab, I've observed traditional PET backsheets cracking and falling apart completely when twisted after undergoing the severe PCT or longer damp/heat test. Furthermore, the moisture barrier of PET-based backsheets is not good. If more moisture gets into the module, the EVA

1 DuPont Global PV Reliability - 2020 Field Analysis Report (2020)

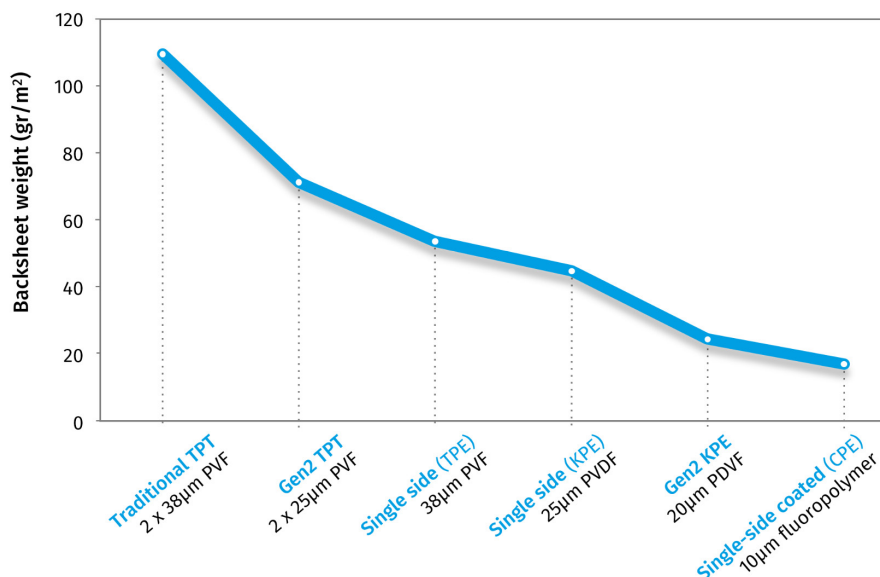


Figure 1. Decrease in thickness of the outer layer of typical backsheets (source DSM)

encapsulant will generate more acetic acid, which in turn corrodes the conductive metal of the solar cell - thus causing more power degradation. So, in summary: PET is not a good material for use in solar module backsheets.

At DSM we have invested lots of time and resources in rethinking how to support the solar industry in delivering long-term reliable backsheet performance – in all climates and at a competitive price. There is no doubt that great science and innovation holds the key to success in ultra-cost competitive markets like solar - and much of our work has focused on finding creative ways to apply proven technologies and better materials to solar modules. Which is how we came to create our Endurance backsheet family.

PES: How is the Endurance backsheet portfolio differentiated from traditional backsheets products in terms of technology and materials?

SZ: From a technology standpoint, continued cost pressure has resulted in a traditional laminated backsheet that is no longer designed and optimized for its purpose. For example, the protective fluoropolymer outer film has halved in thickness from more than 40 to less than 20 microns for most fluoro-based backsheets on the market today; while in some cases, the outer 'protective layer' is now little more than a polymer coating just a few microns thick. In combination with the weak PET core layer this leads to failures.

Our response was to create backsheets in a completely new way, using a co-extrusion manufacturing process and a strong polyolefin core layer. This is what we named the high performance polyolefin (HPO) backsheets technology. At DSM we've used co-extrusion for many years to replace traditional lamination in applications like



Sunny Zhao

multi-layer polymer film processing and thermoplastics used in packaging film or automotive parts. The benefits are indisputable: co-extrusion is a single-step process with no adhesives needed - which results in strongly coherent multi-material products.

PES: And what about the materials being used?

SZ: Traditional backsheets use low-stabilized PET as a core layer material. To help stabilize this, manufacturers have then added thin outer layers of weather-resistant fluoropolymers like PVF or PVDF. But, as I just explained, these outer layers are getting thinner, and can no longer properly protect the core layer PET core layer against hydrolysis from moisture or UV aging. [Figure 1]

This is precisely why our HPO technology is built around a core layer of modified polyolefin (PO) - instead of an inferior PET film. In fact, in our backsheets, both the protective layer and the core layer offer superior protection against moisture (water vapor transmission rate and hydrolysis) – as well as delivering excellent electrical insulation, superior crack resistance and UV aging. [Figure 2]

PES: Given all of this, why did you develop the new D15 Endurance backsheet in addition to the existing B-series?

SZ: From a commercial perspective, we saw a gap in the solar market for an 'all-rounder' type of backsheet that helps our customers combat this relentless cost-down roadmap by delivering superior protection for a wide range of solar modules - at an ideal performance-cost ratio.

So, for the past two years I have led an RTD team devoted to developing a new backsheet that meets this precise need and 'raises the bar' in terms of performance/cost. This is where being part of a global science brand

like DSM has been invaluable, by the way. We were able to apply DSM material science and knowhow on polymers through an extensive development and evaluation process. How weatherable are they? How do they perform when processed via co-extrusion? We then used this innovation knowledge to create the Endurance backsheet D15.

PES: What, specifically, is unique and different about this new product?

SZ: Our award-winning B-series² is widely recognized for its robustness and extreme reliability - but the stack of material made it suited to niche applications only. With our D15, we've applied our materials science and polymer knowledge to modify this stack to be more affordable. Specifically, my team has successfully replaced the Polyamide 12 layer with a highly weatherable modified polyolefin outer layer as a substitute. As a result, it now delivers a performance/cost ratio better than most mainstream backsheets: a genuine 'all-purpose backsheet' with excellent moisture protection and sand abrasion resistance coupled with outstanding mechanical, UV and chemical resistance. This is unique in the market.

PES: Has this new backsheet been tested in the field and if so, what were the results?

² TÜV Rheinland - PV Backsheet AQM Award 2018
<http://www.tuvaward.com/index.php/article/detail/aid/211.html>

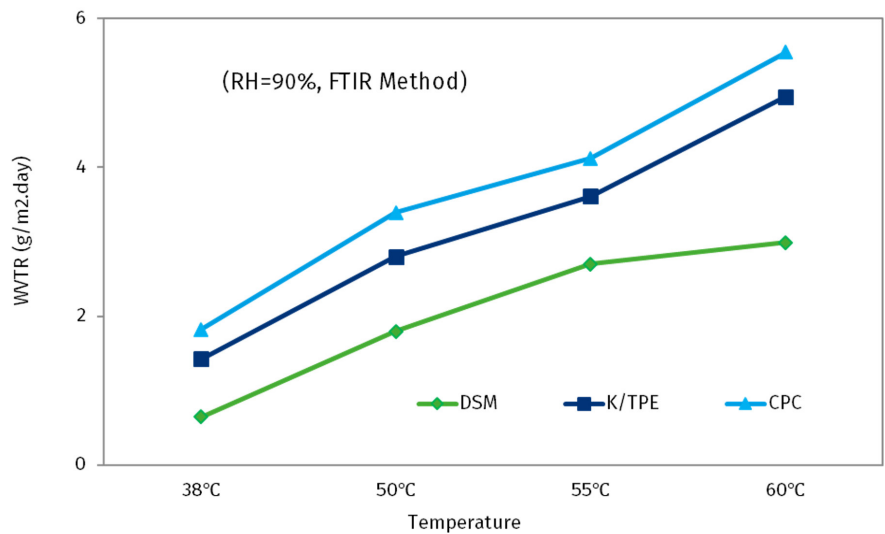


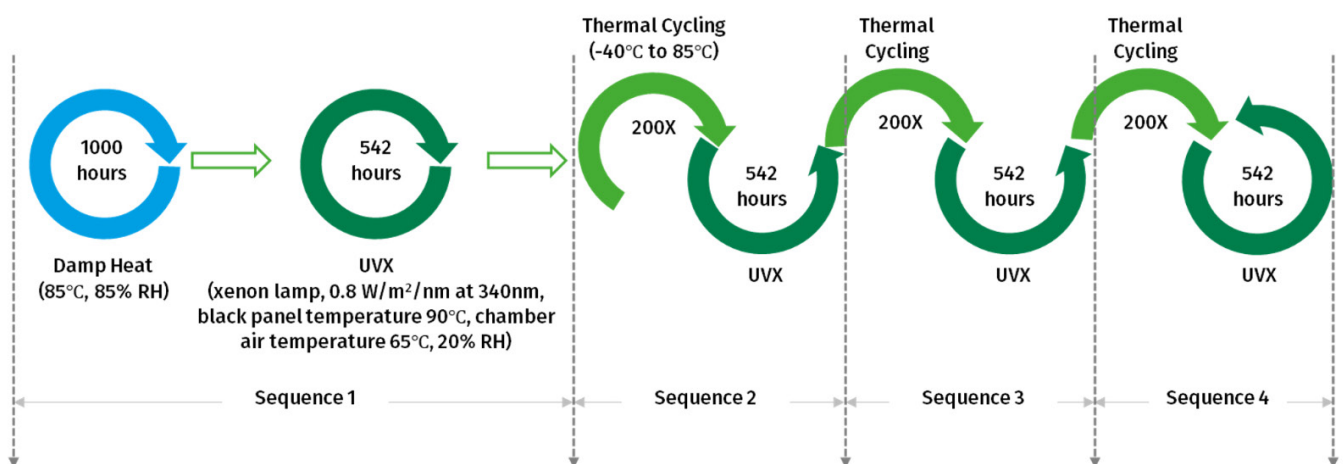
Figure 2. Water Vapor Transmission Rates (WVTR) of various backsheets (source DSM)

SZ: Our polyolefin-based co-extruded backsheets have been performing in the field for the past six years...with zero defects. Our new D15 is simply an extension of the same backsheet technology. In fact, the Endurance backsheet D15 recently became the recipient of the world's first integrated stress sequence accelerated aging certificate - from industry leading third-party testing and certification organization, TÜV SÜD. This tough material evaluation simulates natural conditions through a combination of damp

heat aging, ultraviolet aging, high-and-low temperature cycle aging, and other sequences. [Figure 3]

PES: What do you see as the greatest threats to backsheet performance going forward?

SZ: Aging and weatherability! They cause molecular changes in the product - not just from heat, but also UV, moisture and abrasion. Our D15 has superior UV aging resistance. In fact, it passed the UV300kwh aging test (and



	DSM B10	DSM D15
Chemical stability (yellowness)	✓	✓
Mechanical stability (cracks)	✓	✓

Figure 3. Integrated stress sequence accelerated aging test for backsheets (source TÜV-SÜD)



more) - which is comparable to a fluoropolymer outer layer. The D15 also brings superior hydrolysis resistance and has passed the PCT 96hr test. Sand abrasion is another big challenge, especially for solar parks in desert-like climates - and our Endurance backsheet D15 is superior to our major competitors in terms of abrasion resistance.

Then of course we need to consider moisture. We know that moisture ingress causes power loss; and the D15 is very strong here, providing a high moisture barrier.

PES: What other innovations are you working on at DSM?

SZ: The use of co-extrusion in backsheets is a real game-changer and we are expecting its widespread adoption across the solar industry. As for the next innovation, we are now working on a transparent backsheet that could make a real impact. Having invested heavily in backsheet innovation at DSM, we now have a clear ambition to achieve a leadership position in the industry:

not only in terms of performance and price, but also sustainability.

PES: Just how important is sustainability to the new generation of backsheets?

SZ: At DSM we take sustainability very seriously – in fact, we’ve even integrated the UN Sustainable Development Goals into the company strategy. Furthermore, we are noticing a growing awareness around sustainable PV in the market - supported by regulations and standards like the EPEAT eco-label recently released³ in the US; or the Eco-design policy being developed in Europe, which advocates backsheet recyclability and low environmental impact. In other words, if you want to make a fully future-proofed, next-generation backsheet...you must take sustainability into account.

This is why our Endurance backsheet D15 is fluorine free with up to a 30% lower carbon footprint than traditional equivalent products;

3 Greenelectronicscouncil.org/epeat-criteria

as well as being fully recyclable with no production waste. In fact, we already received industry recognition for the sustainability value of our Endurance backsheet family from the Solar Impulse Foundation - who certified our product as ‘one of the #1000 solutions that change the world’.

In terms of transparency and traceability, the co-extrusion process we use gives us complete control of the backsheet supply chain. We know precisely which ingredients are used; how much is used; and how these ingredients are processed. After all, there is no point in being in the renewable energy business if the products we produce contribute to waste and pollution!

PES: Is there anything else you would like to add?

SZ: Ultimately, our goal at DSM is to create clean, affordable solar energy for all. The new Endurance backsheet D15 can really help the industry stay on the road to achieving it.

For more information: www.dsm.com/solar