Isovoltaic AG

▶ Comeback: Isovoltaic from Austria, which claims it was the first company to introduce Tedlar-based backsheets for PV modules, thinks that demand for fluropolymer-containting products is starting to increase again, »but not heavily.« And not based on the original three-layer Tedlar/PET/Tedlar (TPT) composite, which it considers too expensive. Isovoltaic's products are based on polyamide.

Tedlar's backsheet comeback?

While Tedlar may be holding steady, non-fluoropolymers are showing more competition

Text: Dennis Richard

Highlights

- Survey covers 14 companies with 64 backsheets, 27 using Tedlar
- 3M introduces polyolefin-based backsheet
- Isovoltaic says its highly-reflective backsheets leads to a 1.5 percent increase in module performance relative
- Conductive backsheets for high-efficiency cells slowly entering the sector

What is the status of Tedlar? Hard to say. This polyvinyl fluoride (PVF) film, developed by US-based DuPont Photovoltaic Solutions, was once the most popular product in the layer sandwich for sheltering PV cells from the elements. The goal was to make them last for 25 years. Based on the results in our annual backsheet surveys over the years, Tedlar's percentage in the mix of backsheets based on fluoropolymers more than halved from a peak of nearly 93 percent in 2007 to just under 41 percent by 2012. The drop was due in part to questions about how economical the use of Tedlar was in the price-to-quality ratio. This opened a window of opportunity for suppliers of non-fluoropolymer products, which are competitive with fluoropolymers on UV and hydrolysis resistance.

But in this year's survey, the percentage of backsheet models incorporating Tedlar seems to have stabilized – indeed a little improved – to just over 42 percent. Does this mean that PVF-based Tedlar has again proved itself as a mainstay in backsheets? Maybe. In 2012, we reported on 21 companies with 93 backsheets, of which 38 were based on Tedlar. For this survey, the number of companies dropped by two-thirds to 14 with just 64 backsheets with 27 using Tedlar in the layer. Why the reduction in participation and product is unclear. And whether this skews the results is a judgment call.

Those judgments vary. For Alessandro Anderlini, the European business manager at Coveme S.P.A , the reason is that Tedlar is limited to »niche applications.« That claim is probably not surprising – the Italian-headquartered company only makes polyester-based films in the non-fluoropolymer segment. Whatever the case, Anderlini estimates the price of Tedlar-based backsheets at 20 percent above Coveme's polyethylene terephthalate (PET) products.

But Karlheinz Brust, the CEO of Krempel GmbH, a German company that sells four PVF-based backsheets, does not agree. Brust still strongly believes that Tedlar, which he considers highly UV and hydrolysis resistant, will maintain its ground as it once did in the past. For a period of time, he says, Krempel had less demand for Tedlar, »but now there are lots of orders.« Brust did not give any details of the sales.

Harald Lackner, the vice president of sales and marketing at Austria-headquartered Isovoltaic AG, which claims it was the first company to introduce Tedlar-based products for PV modules, thinks that demand for such backsheets is starting to increase again, »but not heavily.« And not based on the original three-layer Tedlar/PET/Tedlar (TPT) composite, a sandwich still offered by nine flouropolymer companies. »TPT,« says Lackner, »is just too expensive.«

Another company that is hot on fluoropolymers is Hangzhou First PV Material Co. Ltd. based in China, and today the world market leader for encapsulations. But since 2009 Hangzhou First has also backsheets on offer. As of 2011, it has two products – one with a fluorine coating

◀ Accepted: While several new pure polyester-based backsheets have been offered for the last few years, there is no new developments on these PET products. Though the competition has increased among the PET suppliers, market leader Coveme considers this is an indication of the material's acceptance as a standard backsheet.

and the other with a polyvinylidene fluoride (PVDF) film. Although he did not provide sales figures, CTO Danial Zhou says that for Hangzhou First, its biggest seller is its BEC-301, a backsheet with a fluorine coating on both sides of a PET. Nonetheless, he believes that film-based PVDF models are more preferred than products using coatings. The reason? Zhou says that earlier it was just TPT models, but now the market is flooded with Tedlar/PET/ethylene primers (TPE), a simpler solution aimed at reducing costs. However, Zhou adds that with newer products, there are new risks.

Evaluating data

While it is common among major companies to present the risks associated with other types of materials than its own during trade fairs, such data, which is often generated in-house and under non-standardized conditions, has to be looked at with caution.

However, we did look at some material properties for the different types of material we received for the survey and analyzed them. In the data on EVA peel strength (table on the top, p. 56), polyolefins are a clear winner with an average of 11.5 N/mm, followed by ethylene chlorotrifluoroethylene (ECTFE) films from Honeywell Specialty Chemicals Seelze GmbH and polyamides from Isovoltaic with average peel strengths of 6.4 and 6 respectively.

The peel strength between layers, an important parameter that determines the extent of adhesion, normally ranges from 0.3 to 1 N/mm (see center table, p. 56). However, Korea-based SFC Co. Ltd. has listed peel strength values of 5 N/mm, which puts its Tedlar-based products at the top with an average peel strength of 1.82 N/mm. But if the data from SFC is not included, the average peel strength for Tedlar-based products would be 0.59N/mm, making ECTFE material more adhesive with an average peel strength between layers of 0.66 N/mm, followed by polyamides and polyolefins at 0.60 N/mm. The lowest adhesion between is for PVDF-based backsheets of 0.45 N/mm.

Another important parameter is the water-vapor permeability of the backsheets (bottom table, p. 56), which prevents water or moisture from entering into the module package, perhaps the most harmful issue for thin-film modules. Leading the chart is polyamides with the lowest water permeability of 0.45 g/m²d. This is followed by polyolefins with double the water permeability at 0.90 g/m²d. The highest water permeability is shown for 3M's THV at 4.30 g/m²d, almost 10 times higher than polyamides.

New products with old and new polymers

As the 12 new products in this survey show, there are both companies going for less risk, as well those still looking for new alternatives. US-headquartered CPP Solar, for example, belongs to the group that has stayed on the flouropolymers side, although the composite has a somewhat different structure. It launched a new product, the TPE500, a Tedlar version of its Ky-

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Backsheets with fluoropolymers

Company	3M	3M	3M	3M	CPP Solar	CPP Solar
model	Scotchshield Film 17, 17T*1	Scotchshield Film 15T*1	Scotchshield Film 15T Black*1	Scotchshield Film 15HTT*1	Hemera GPE 500*1	Hemera GPE 1000b*1
market introduction	2006, 2008	2010	2011	2012	2010	2010
material composition	THV/PET/EVA	THV/PET/EVA	THV/PET/EVA	THV/PET/EVA	PVDF/PET/EP	PVDF/PET/EP
Foil size						
thickness	400 µm	360 µm	360 µm	360 µm	305 µm	345 µm
width range	815, 995, 1,010, 1,070 mm*2	815, 995, 1,010, 1,070 mm*2	1,010 mm*2	995, 1,010 mm*2	≤ 1,500 mm	≤ 1,500 mm
weight	480 g/m²	428 g/m²	451 g/m²	430 g/m²	379 g/m²	473 g/m²
density	–	–	–	–	–	–
colors (front / back)	w/w	w/w	b/w	w/w	w/w, w/b, b/b, cl	w/w, w/b, b/b, cl
Stability characteristics						
tensile strength at break (length)	33 MPa	32 MPa	39 MPa	32 MPa	2.3 N/mm	4.6 N/mm
tensile strength at break (cross)	39 MPa	38 MPa	45 MPa	38 MPa	3.3 N/mm	4.9 N/mm
elongation at break (length / cross)	116 / 83 %	94 / 83 %	143 / 106 %	94 / 83 %	104 %	104 %
tear strength (length / cross)	– / –	– / –	– / –	– / –	– / –	– / –
dimens. stability (length / cross)*1	< 1.2 / < 1 %	< 1.2 / < 1 %	< 1.2 / < 1 %	< 1.2 / < 1 %	< 0.87 / < 1 %	< 0.87 / < 1 %
EVA peel strength	Substrate failure	Substrate failure	Substrate failure	Substrate failure	> 4 N/mm	> 4 N/mm
peel strength of layers	0.7 N/mm*3	0.5 N/mm*3	0.5 N/mm*3	0.5 N/mm*3	> 0.4 N/mm	> 0.4 N/mm
water vapor permeability	4 g/m²d	4.4 g/m²d	4.4 g/m²d	4.4 g/m²d	< 2.5 g/m²d	< 2 g/m²d
breakdown voltage	25 kV	24 kV	24 kV	24 kV	14.9 kV	14.9 kV
max. system voltage	> 1,100 V	> 1,000 V	> 1,000 V	> 1,000 V	> 1,100 V	> 1,000 V
Delivery, order, warranty						
time of delivery	per supply agreement	per supply agreement	per supply agreement	per supply agreement	0 - 1 month	0 - 1 month
minimum order	per supply agreement	per supply agreement	per supply agreement	per supply agreement	100 m²	100 m²
warranty	–	–	–	–	12 months	12 months
Notes *1 at 150 °C for 30 min	*1 UL-recognized *2 other on req. *3 outer layer to PET (post-lam.)	*1 UL-recognized *2 other on req. *3 outer layer to PET (post-lam.)	*1 UL-recognized *2 other on req. *3 outer layer to PET (post-lam.)	*1 UL-recognized *2 other on req. *3 outer layer to PET (post-lam.)	*1 UL-recognized / QIHE2	*1 UL-recognized / QIHE2

Backsheets with fluoropolymers

Company	Flexcon	Flexcon	Flexcon	Flexcon	Honeywell	Honeywell
model	TPT W12	KPK W12	KPE 12	KPE 156	PowerShield PV325	PowerShield PV270
market introduction	2010	2010	2010	2012	2008	2009
material composition	PVFcast/PET/PVFcast	PDVF/PET/PDVF	PDVF/PET/EVA	PDVF/PET/EVA	ECTFE*1/PET/ECTFE*1	ECTFE*1/PET/EVA
Foil size						
thickness	323 µm	333 µm	328 µm	322 µm	325 µm	270 µm
width range	508 - 1,524 mm	508 - 1,524 mm	508 - 1,524 mm	508 - 1,524 mm	25 - 1,520 mm	25 - 1,520 mm
weight	452 g/m²	470 g/m²	395 g/m²	385 g/m²	495 g/m²	333 g/m²
density	1.45 g/cm³	1.46 g/cm³	1.18 g/cm³	1.18 g/cm³	–	–
colors (front / back)	w/w	w/w	w/w, b/w	w/w, w/b, b/w, b/b	w/w*2	w/w*2
Stability characteristics						
tensile strength at break (length)	163 N/mm	154 N/mm	73 N/mm	81 N/mm	36 N/mm	25 N/mm
tensile strength at break (cross)	149 N/mm	146 N/mm	81 N/mm	90 N/mm	46 N/mm	32 N/mm
elongation at break (length / cross)	337 / 196 %	307 / 213 %	367 / 193 %	348 / 280 %	140 / 100 %	264 / 187 %
tear strength (length / cross)	11.3 / 10.2 N	13.1 / 11.5 N	7.2 / 6.8 N	6.3 / 5.1 N	– / –	– / –
dimens. stability (length / cross)*1	< 1.5 / 1 %	< 1.5 / 1 %	< 1.5 / 1 %	< 1.5 / 1 %	– / < 1 %	– / < 1 %
EVA peel strength	> 4 N/mm	> 4 N/mm	> 4 N/mm	> 4 N/mm	> 4 N/mm	> 4 N/mm
peel strength of layers	≥ 0.5 N/mm	≥ 0.5 N/mm	≥ 0.5 N/mm	≥ 0.5 N/mm	> 0.4 N/mm	> 0.5 N/mm
water vapor permeability	1.7 g/m²d	1.7 g/m²d	2.0 g/m²d	2.3 g/m²d	1.24 g/m²d	1.4 g/m²d
breakdown voltage	21.44 kV	27.16 kV	20.93 kV	20.93 kV	20 kV	17.4 kV
max. system voltage	1,147 V	1,124 V	1,080 V	1,042 V	> 1,000 V	> 1,000 V
Delivery, order, warranty						
time of delivery	< 1 month	< 1 month	< 1 month	< 1 month	0 - 2 months	0 - 2 months
minimum order	–	–	–	–	200 m²	200 m²
warranty	–	–	–	–	–	–
Notes *1 at 150 °C for 30 min					*1 high-performance F film, reflectivity: 82 % *2 other colors on req.	*1 high-performance F film, reflectivity: 85 % *2 other colors on req.

	CPP Solar	Dunmore	Dunmore	Dunmore	FERON	Hangzhou First	Hangzhou First
	TPE500	DUN-SOLAR TPT*1, *2	DUN-SOLAR TPE *1, *2	DUN-SOLAR TAPE*1	HelioX PV standardX TPT*1	BEC-301	BEC-303
	2013	2007	2008	2009	2011	2011	2009
	PVF/PET/EP	PVF/PET/PVF	PVF/PET/PE	PVF/Al/PET/PE	PVF/PET/PVF	Fluor coating/PET/Fluor coating	PVDF film/PET/Fluor coating
	300 µm	325 µm	270 µm	460 µm	325 µm ± 5 %	280 µm	290 µm
	≤ 1,500 mm	25 - 1,880 mm	25 - 1,880 mm	25 - 1,880 mm	depend. on customer	400 mm - 1,150 mm	400 mm - 1,150 mm
	372 g/m²	460 g/m²	330 g/m²	660 g/m²	470 g/m² ± 5 %	390 g/m²	400 g/m²
	–	–	–	–	–	1.4 g/cm³	1.4 g/cm³
	w/w, w/b	w/w, b/b	w/w, b/b, w/b	w/w, b/b	w/w	w/w	w/w
	2.3 N/mm	142 N/mm²	100 N/mm²	79 N/mm²	≥ 110 N/mm	29 N/mm	29 N/mm
	3.3 N/mm	175 N/mm²	115 N/mm²	98 N/mm²	≥ 110 N/mm	22 N/mm	22 N/mm
	104 %	258 / 200 %	220 / 180 %	73 / 69 %	≥ 100 / 90 %	> 80 / 60 %	> 50 / 50 %
	– / –	– / –	– / –	– / –	– / –	– / –	– / –
	< 0.87 / < 1 %	1.9 / 1.7 %	1.3 / 1.6 %	<1.0 / <0.8 %	≤ 1 / ≤ 1 %	< 0.5 / 0.5 %	< 0.5 / 0.5 %
	> 6 N/mm	destruct. bond	destruct. bond	destruct. bond	≥ 7 N/mm*2	> 8 N/mm	> 8 N/mm
	> 0.5 N/mm	6.0 N / 10 mm	6.0 N / 10 mm	destruct. bond	≥ 0.5 N/mm	–	> 0.5 N/mm
	< 2.5 g/m²d	< 2.0 g/m²d	<2.5 g/m²d	< 0.0005 g/m²d	≤ 2.4 g/m²d*3	2.4 g/m²d *1	2.5 g/m²d *1
	14.9 kV	21.8 kV	15.55 kV	22 kV	≥ 20 kV	> 25 kV	> 25 kV
	> 1,000 V	>1,000 VDC	>1,000 VDC	625 VDC	≥ 1,000 V	1,044 V	1,046 V
	0 - 1 month	1.5 months	1.5 months	1.5 months	1 - 4 months	2 weeks	2 weeks
	100 m²	200 m²	200 m²	200 m²	10,000 m²	150 m²	150 m²
	12 months	24 months	24 months	24 months	–	12 months	12 months
		*1 UL-recognized / QIHE2 *2 for crystallline modules	*1 UL-recognized / QIHE2 *2 for crystallline modules	*1 for CIGS modules	*1 damp heat perf.: 3,000 h *3 to Evasky S88 *3 at 38 °C 90 % RH	*1 Tested according to ASTM F1249, 38 &1 00 % RH *2 The length of rolls is 150m	*1 Tested according to ASTM F1249, 38 &1 00 % RH *2 The length of rolls is 150m

	Honeywell	Honeywell	Honeywell	Isovoltaic	Isovoltaic	Isovoltaic	Isovoltaic
	PowerShield 3W*3	PowerShield 3H*4	PowerShield Cool Black*3	ICOSOLAR FPA 3G*1	ICOSOLAR TPA 3G*1	ICOSOLAR TPA HR*1	ICOSOLAR 2442
	2012	2012	2012	2013	2013	2013	1995
	ECTFE*1/PET/bonding layer	ECTFE*1/PET*2/bonding layer	ECTFE*1/PET/Bonding layer	F/PET/mod. PA	PVF/PET/mod. PA	PVF/PET/mod. PA treated	PVF/PET/PVF treated
	309 µm	320 µm	309 µm	320 µm	340 µm	320 µm	170, 350 µm
	25 - 1,520 mm	25 - 1,520 mm	25 - 1,520 mm	10 - 2,040 mm	10 - 2,040 mm	10 - 2,040 mm	10 - 2,040 mm
	366 g/m²	413 g/m²	366 g/m²	424 g/m²	447 g/m²	433 g/m²	229, 474 g/m²
	–	–	–	~ 1.33 g/cm³	~ 1.31 g/cm³	~ 1.35 g/cm³	~ 1.35 g/cm³
	w/w*2	w/w*3	w/b*2	w/w, b/w	w/w, b/w	w/w	w/w, b/w, b/b
	30 N/mm	29 N/mm	30 N/mm	46 N/mm	46 N/mm	46 N/mm	46 N/mm*1
	29 N/mm	29 N/mm	29 N/mm	58 N/mm	58 N/mm	58 N/mm	58 N/mm*1
	266 / 196 %	266 / 196 %	266 / 196 %	160 / 120 %	160 / 120 %	160 / 120 %	160 / 120 %
	– / –	– / –	– / –	– / –	– / –	– / –	– / –
	– / < 1 %	– / < 1 %	– / < 1 %	≤1.5 % / ≤1.0 %	≤1.5 % / ≤1.0 %	≤1.5 % / ≤1.0 %	≤1.5 % / ≤1.0 %
	> 8 N/mm	> 8 N/mm	> 8 N/mm	≥ 6 N/mm*2	≥ 6 N/mm*2	≥ 6 N/mm*2	≥ 4 N/mm*2
	> 0.8 N/mm	> 0.8 N/mm	> 0.8 N/mm	≥ 0.8 N/mm	≥ 0.4 N/mm	≥ 0.4 N/mm	≥ 0.4 N/mm
	1.4 g/m²d	1.4 g/m²d	1.4 g/m²d	0.7 g/m²d*3	0.7 g/m²d*3	0.7 g/m²d*3	1.8, 0.7 g/m²d*3
	20 kV	20 kV	20 kV	21 kV	21 kV	21 kV	18, 23 kV
	> 1,000 V	> 1,000 V	> 1,000 V	1,000 V	1,000 V	1,000 V	650, 1,000 V
	0 - 2 months	0 - 2 months	0 - 2 months	0 - 2 months	0 - 2 months	0 - 2 months	0 - 2 months
	200 m²	200 m²	200 m²	–	–	–	–
	–	–	–	–	–	–	–
	*1 high-performance F film, reflectivity: 85 % *2 other colors on req. *3 designed for 3,000 h+	*1 high-performance F film, reflectivity: 85 % *2 Thicker PET *3 other colors on req. *4 designed for 3,000 h+	*1 high-performance F film, heat-reflective black *2 other colors on req. *3 designed for 3,000 h+ damp heat	*1 also available as »plus« and »complete« version *2 to Vista Solar 486 *3 ISO 15106-3	*1 also available as »plus« and »complete« version *2 to Vista Solar 486 *3 ISO 15106-3	*1 also available as »plus« and »complete« version *2 to Vista Solar 486 *3 ISO 15106-3	*1 for 350µm thickness *2 to Vista Solar 486 *3 ISO 15106-3

Backsheets with fluoropolymers

Company	Isovoltaic	Krempel	Krempel	Krempel	Krempel	Krempel
model	ICOSOLAR TPC 3480	AKASOL PTL 2-38/250 TWH/TCC + P	AKASOL PTL 3-38/250 TWH/TCC	AKASOL PTL 3-25/250 TUT	AKASOL PVL 1000 V	AKASOL KRT - repair tape
market introduction	2010	2012	2004	2006	2007	2011
material composition	PVF/PET/Cu	PVF/PET/Primer	PVF/PET/PVF	PVF/PET/PVF	PVDF/PET/PVDF	PVDF/PET/adhesive
Foil size						
thickness	340 µm	400 µm	340 µm	315 µm	325 µm	310 µm
width range	10 - 1,100 mm	≤ 2,000 mm	≤ 2,000 mm	≤ 1,650 mm	≤ 2,000 mm	≤ 2,000 mm
weight	746 g/m²	517 g/m²	480 g/m²	435 g/m²	470 g/m²	435 g/m²
density	~ 2.2 g/cm³	~ 1.3 g/cm³	~ 1.4 g/cm³	~ 1.4 g/cm³	~ 1.4 g/cm³	~ 1.4 g/cm³
colors (front / back)	w/Cu	w/w, b/b	w/w, b/b, w/b	transp.	w/w, b/b, red/red	w/w, b/b
Stability characteristics						
tensile strength at break (length)	46 N/mm	40 N/mm	38 N/mm	38 N/mm	38 N/mm	35 N/mm
tensile strength at break (cross)	58 N/mm	45 N/mm	41 N/mm	41 N/mm	41 N/mm	45 N/mm
elongation at break (length / cross)	160 / 120 %	100 / 100 %	100 / 100 %	100 / 90 %	100 / 100 %	100 / 100 %
tear strength (length / cross)	– / –	50 / 50 N*2	50 / 50 N*1	90 / 90 N*1	50 / 50 N*1	35 /35 N*1
dimens. stability (length / cross)*1	≤0.2 % / ≤0.2 %	≤ 1.2 %/ ≤ 1.2 %	≤ 1.2 %/ ≤ 1.2 %	≤ 1.2 %/ ≤ 1.2 %	≤ 1.1 %/ ≤ 1.1 %	≤ 1.2 %/ ≤ 1.2 %
EVA peel strength	–	> 4 N/mm	> 4 N/mm	> 4 N/mm	> 4 N/mm	> 4 N/mm
peel strength of layers	≥ 0.4 N/mm	*3	*2	0.5 N/mm	0.5 N/mm	0.5 N/mm
water vapor permeability	depending on design	0.6 g/m²d	0.8 g/m²d	< 0.8 g/m²d	< 0.9 g/m²d	0.6 g/m²d
breakdown voltage	22 kV	> 25 kV	> 28 kV	> 28 kV	> 28 kV	> 25 kV
max. system voltage	1,000 V	> 1,000 V	> 1,000 V	> 1,000 V	> 1,000 V	> 1,000 V
Delivery, order, warranty						
time of delivery	0 - 2 months	2 weeks	2 weeks	2 weeks	2 weeks	2 weeks
minimum order	–	100 m²	100 m²	100 m²	100 m²	100 m²
warranty	–	6 months	6 months	6 months	6 months	6 months
Notes *1 at 150 °C for 30 min		*1 P= primer *2 DIN 53515 *3 film damage bef. delam.	*1 DIN 53515 *2 film damage bef. delam.	*1 DIN 53515	*1 DIN 53515	*1 DIN 53515

Backsheets with fluoropolymers

Company	Madico	Madico	Madico	Madico	Madico	Madico
model	Reflekt	Reflekt Prime	VueTek	VueTek Prime	Protekt	Protekt HD
market introduction	2012		2012	2012	2007	2007
material composition	F-Coat/PET/Extr. DB layer	F-Coat/PET/Extr. DB layer	F-Coat/ PET/ EVA	F-Coat/ PET/ EVA	Protekt*1/PET/EVA*2	Protekt*1/PET/EVA*2
Foil size						
thickness	262 ± 26 µm	261 ± 26 µm	264 ± 26 µm	254 ± 25 µm	172 ± 26 µm	249 ± 25 µm
width range	≥ 50 mm*1	≥ 50 mm*1	≥ 50 mm*1	≥ 50 mm*1	≥ 50 mm*3	≥ 50 mm*3
weight	320 g/m²	311 g/m²	314 g/m²	305 g/m²	194 g/m²	279 g/m²
density	1.15 g/cm³	1.15 g/cm³	1.15 g/cm³	1.20 g/cm³	1.05 g/cm³	1.15 g/cm³
colors (front / back)	w/w	w/w	Clear	Clear	w/w, w/b, char/b, char/w	w/w, w/b, char/b char/w
Stability characteristics						
tensile strength at break (length)	83 MPa (N/mm²)	116 MPa (N/mm²)	96 MPa (N/mm²)	104 MPa (N/mm²)	58 MPa (N/mm²)	100 MPa (N/mm²)
tensile strength at break (cross)	84 MPa (N/mm²)	121 MPa (N/mm²)	113 MPa (N/mm²)	133 MPa (N/mm²)	67 MPa (N/mm²)	112 MPa (N/mm²)
elongation at break (length / cross)	115 % (MD) / 110 % (TD)	153 % (MD) / 110 % (TD)	140 % (MD) / 130 % (TD)	115 % (MD) / 90 % (TD)	124 / 63 %	110 / 120 %
tear strength (length / cross)	>11 N (MD) / >11 N (TD)	>13.1 N (MD) / >16.4 N (TD)	>6 N (MD) /13.0 N (TD)	>6.9 N (MD) /11.40 N (TD)	3.1 / 3.2 N	3.3 / 7.4 N
dimens. stability (length / cross)*1	<1.5 %	<1.5 %	<1.7 %	<1.7 %	< 1 %	< 1 %
EVA peel strength	≥ 40 N/cm	≥ 40 N/cm	≥ 40 N/cm	≥ 40 N/cm	≥ 40 N/cm	≥ 40 N/cm
peel strength of layers	≥ 0.5 N/mm	≥ 0.5 N/mm	≥ 0.5 N/mm	≥ 0.5 N/mm	≥ 0.5 N/mm	≥ 0.5 N/mm
water vapor permeability	≤ 2.5 g/m²d	≤ 2.5 g/m²d	≤ 2.5 g/m²d	≤ 2.5 g/m²d	≤ 2.5 g/m²d	≤ 2.5 g/m²d
breakdown voltage	–	≥18 kV	≥18 kV	–	≥ 13 kV	> 18 kV
max. system voltage	> 1,000 V	> 1,000 V	> 1,000 V	> 1,000 V	> 800 V	> 1,000 V
Delivery, order, warranty						
time of delivery	0.75 month*2	0.75 month*2	0.75 month*2	0.75 month*2	0.75 month*4	0.75 month*4
minimum order	200 m²	200 m²	200 m²	200 m²	200 m²	200 m²
warranty	6 months	6 months	6 months	6 months	6 months	6 months
Notes *1 at 150 °C for 30 min	*1 avail. in rolls or sheets *2 average lead-time	*1 avail. in rolls or sheets *2 average lead-time	*1 avail. in rolls or sheets *2 average lead-time	*1 avail. in rolls or sheets *2 average lead-time	*1 patent pending *2 patented technology *3 avail. in rolls or sheets *4 average lead-time	*1 patent pending *2 patented technology *3 avail. in rolls or sheets *4 average lead-time

	Krempel	Krempel	MA Packaging	MA Packaging	MA Packaging	Madico	Madico
	AKASOL TRT - repair tape	AKASOL PVAPL 1000V + P*1	ALTD*1, *2	PTD75*1, *2	PTD250*1, *2	Hytek	Hytek Prime
	2011	2007	–	–	–	2012	2012
	PVF/PET/adhesive	PVDF/Al/PET+primer	PVF/Al/PVF	PVF/PET/PVF	PVF/PET/PVF	F-Coat/PET/EVA	F-Coat/PET/EVA
	320 µm	420 µm	120 µm	160 µm	335 µm	250 ± 25 µm	262 ± 26 µm
	≤ 2,000 mm	≤ 2,000 mm	0 - 1,100 mm	0 - 1,100 mm	0 - 1,100 mm	27 - 1,700 mm	≥ 50 mm*1
	440 g/m²	520 g/m²	204 g/m²	227 g/m²	475 g/m²	320 g/m²	317 g/m²
	~ 1.4 g/cm³	~ 1.2 g/cm³	1.7 g/cm³	1.4 g/cm³	1.4 g/cm³	1.16 g/cm³	1.19 g/cm³
	w/w, b/b	w/w, b/b	as req., w/w, b/b	as req., w/w, b/b	as req., w/w, b/b	w/w, w/b	w/w, w/b
	35 N/mm	30 N/mm	–	–	–	100 MPa (N/mm²)	109 MPa (N/mm²)
	45 N/mm	30 N/mm	6, 8 N/mm	16, 21.3 N/mm	51 N/mm	110 MPa (N/mm²)	117 MPa (N/mm²)
	100 / 100 %	10 %	50 / 65 %	163 / 121 %	194 / 159 %	135 % (MD) / 119 % (TD)	138 % (MD) / 122 % (TD)
	35 /35 N*1	25 / 25 N *2	12 / 15 N	13 / 14 N	36 / 37 N	9 N (MD) / 15 N (TD)	3.5 N (MD) / 4.4 N (TD)
	≤ 1.2 %/ ≤ 1.2 %	0 %	0.2 / 0.1 %	1.2 / 0.5 %	1 / 0.5 %	≤1 %	<1 %
	> 4 N/mm	4 N/mm	–	–	–	≥ 40 N/cm	≥ 40 N/cm
	0.5 N/mm	0.5 N/mm	fracture of PVF film	fracture of PVF film	fracture of PVF film	≥ 0.5 N/mm	≥ 0.5 N/mm
	0.6 g/m²d	0.0005 g/m²d	0 g/m²d	1.5 g/m²d	1.5 g/m²d	≤ 2.5 g/m²d	≤ 2.5 g/m²d
	> 25 kV	> 10 kV	8 kV	17 kV	–	≥20 kV	≥18 kV
	> 1,000 V	> 1,000 V	–	–	1,170 V	> 1,000 V	> 1,000 V
	2 weeks	6 weeks	1 - 7 months	1 - 7 months	1 - 7 months	0.75 month*1	0.75 month*2
	100 m²	100 m²	1,000 m²	1,000 m²	1,000 m²	200 m²	200 m²
	6 months	6 months	–	–	–	6 months	6 months
	*1 DIN 53515	*1 P= primer *2 DIN 53515	*1 test. methods JIS *2 for water vapor-proof	*1 test. methods JIS *2 for voltage-proof	*1 test. methods JIS *2 for voltage-proof	*1 average lead-time	*1 avail. in rolls or sheets *2 average lead-time

	Madico	Madico	Madico	Micel Films	Micel Films	Micel Films	Micel Films
	Protekt TFB	Protekt TFB HD	TPE HD	MISOLAR TPT	MISOLAR K	MISOLAR TPM	MISOLAR KPM
	2007	2007	1990	2010	2010	2010	2010
	Protekt*1/Al/PET/EVA*2	Protekt*1/Al/PET/EVA*2	PVF/PET/EVA*1	PVF/PET/PVF	PVDF/PET/PVDF	PVF/PET/MHB film	PVDF/PET/MHB film
	254 ± 25 µm	431 ± 43 µm	277 ± 42 µm	340 µm ± 5 %	320 µm ± 5 %	275 µm ± 5 %	267 µm ± 5 %
	≥ 50 mm*3	≥ 50 mm*3	≥ 50 mm*2	≤ 1,020 mm	≤ 1,020 mm	≤ 1,020 mm	≤ 1,020 mm
	370 g/m²	610 g/m²	330 g/m²	300 g/m²	290 g/m²	342 g/m²	338 g/m²
	1.46 g/cm³	1.41 g/cm³	1.2 g/cm³	–	–	–	–
	w/w, w/b, char/b, char/w	w/w, w/b, char/b, char/w	w/w, char/b, cus/w, cus/b	w/w	w/w	all colors/w	all colors/w
	52 MPa (N/mm²)	64 MPa (N/mm²)	92 MPa (N/mm²)	46 N/mm	40 N/mm	23.8 N/mm	18.5 N/mm
	57 MPa (N/mm²)	111 MPa (N/mm²)	108 MPa (N/mm²)	53.9 N/mm	43 N/mm	31 N/mm	25 N/mm
	138 / 98 %	155 / 88 %	144 / 110 %	144 / 108 %	114 / 89 %	123 / 101 %	78 / 62 %
	4 / 3.2 N	15.3 / 13.4 N	4.4 / 5 N	– / –	– / –	– / –	– / –
	<1 %	< 0.5 %	<1 %	1.2 / 0.6 %	1.2 / 0.6 %	1.2 / 0.6 %	0.9 / 1.1 %
	≥ 40 N/cm	≥ 40 N/cm	≥ 40 N/cm	> 5 N/mm *1	> 5 N/mm *1	> 5 N/mm *1	> 5 N/mm *1
	≥ 0.5 N/mm	≥ 0.5 N/mm	≥ 0.5 N/mm	> 0.4 N/mm	> 0.4 N/mm	> 0.4 N/mm	> 0.4 N/mm
	≤ 0.005 g/m²d	≤ 0.005 g/m²d	≤ 4 g/m²d	<2 g/m².j*2	<2 g/m².j*2	<2 g/m².j*2	<2 g/m².j*2
	≥ 13 kV	≥ 13 kV	> 18 kV	32 kV	33 kV	22 kV	28 kV
	> 800 V	> 1,000 V	> 1,000 V	> 1,000 V	> 1,000 V	> 1,000 V	> 1,000 V
	0.75 month*4	0.75 month*4	0.75 months*3	1 - 2 months	1 - 2 months	1 - 2 months	1 - 2 months
	200 m²	200 m²	200 m²	500 m²	500 m²	500 m²	500 m²
	6 months	6 months	6 months	–	–	–	–
	*1 patent pending *2 patented technology *3 avail. in rolls or sheets *4 average lead-time	*1 patent pending *2 patented technology *3 avail. in rolls or sheets *4 average lead-time	*1 patented technology *2 avail. in rolls or sheets *3 average lead-time	*1 To Vista Solar 486 *2 ISO 2528	*1 To Vista Solar 486 *2 ISO 2528	*1 To Vista Solar 486 *2 ISO 2528	*1 To Vista Solar 486 *2 ISO 2528

Backsheets with fluoropolymers

Company	Micel Films	SFC	SFC	SFC	SFC	SFC
model	MISOLAR KPS	PP350	SS320	PS330	TPE-34	TPE-35
market introduction	2011	2006	2006	2009	2008	2009
material composition	PVDF/PET/MHB S	PVF/PTI/PVF	PVFcast/PTI/PVFcast	PVF/PTI/PVFcast	PVFcast/PTI/FPE	PVF/PTI/FPE
Foil size						
thickness	267 µm ± 5 %	346 µm	316 µm	331 µm	343 µm	358 µm
width range	≤ 1,020 mm	800 - 2,000 mm	800 - 2,000 mm	800 - 2,000 mm	800 - 2,000 mm	800 - 2,000 mm
weight	338 g/m²	484 ± 5 g/m²	458 ± 5 g/m²	471 ± 5 g/m²	462 ± 5 g/m²	475 ± 5 g/m²
density	–	1.39 g/cm³	1.4 g/cm³	1.42 g/cm³	1.35 g/cm³	1.33 g/cm³
colors (front / back)	all colors/w	w/w*1	w/w*1	w/w*1	w/w*1	w/w*1
Stability characteristics						
tensile strength at break (length)	21.6 N/mm	> 300 N/10mm	> 300 N/10mm	> 350 N/10mm	> 300 N/10mm	> 300 N/10mm
tensile strength at break (cross)	25 N/mm	> 400 N/10mm	> 400 N/10mm	> 400 N/10mm	> 300 N/10mm	> 300 N/10mm
elongation at break (length / cross)	144 / 91 %	> 120 / 100 %	> 100 / 80 %	> 120 / 100 %	> 120 / 100 %	> 120 / 100 %
tear strength (length / cross)	– / –	> 350 / > 450 N*2	> 350 / > 400 N*2	> 350 / > 450 N*2	> 350 / > 400 N*2	> 350 / > 400 N*2
dimens. stability (length / cross)*1	1.1 / 0.8 %	< 1.2 / < 1 %	< 1 / < 1 %	< 1 / < 1 %	< 1.2 / < 1 %	< 1.2 / < 1 %
EVA peel strength	> 4 N/mm*1	> 20 N/mm	> 40 N/mm	> 40 N/mm	> 50 N/mm	> 50 N/mm
peel strength of layers	> 0.4 N/mm	> 5 N/mm	> 5 N/mm	> 5 N/mm	> 5 N/mm	> 5 N/mm
water vapor permeability	<3 g/m².j*2	< 1.5 g/m²d*3	< 1.5 g/m²d*3	< 1.5 g/m²d*3	< 1.5 g/m²d*3	< 1.5 g/m²d*3
breakdown voltage	–	> 20 kV*4	> 20 kV*4	> 20 kV*4	> 20 kV*4	> 20 kV*4
max. system voltage	> 1,000 V	> 1,000 V*5	> 1,000 V*5	> 1,000 V*5	> 1,000 V*5	> 1,000 V*5
Delivery, order, warranty						
time of delivery	1 - 2 months	0.75 - 1.5 months	0.75 - 1.5 months	0.75 - 1.5 months	0.75 - 1.5 months	0.75 - 1.5 months
minimum order	500 m²	100 m²	100 m²	100 m²	100 m²	100 m²
warranty	–	–	–	–	–	–
Notes	*1 To Tectosil	*1 also custom. colors	*1 also custom. colors	*1 also custom. colors	*1 also custom. colors	*1 also custom. colors
*1 at 150 °C for 30 min	*2 ISO 2528	*2 DIN 53363	*2 DIN 53363	*2 DIN 53363	*2 DIN 53363	*2 DIN 53363
		*3 ASTM F-1249 90(± 2) % RH / 100 F	*3 ASTM F-1249 90(± 2) % RH / 100 F	*3 ASTM F-1249 90(± 2) % RH / 100 F	*3 ASTM F-1249 90(± 2) % RH / 100 F	*3 ASTM F-1249 90(± 2) % RH / 100 F
		*4 ASTM D 149	*4 ASTM D 149	*4 ASTM D 149	*4 ASTM D 149	*4 ASTM D 149
		*5 IEC 60664-1	*5 IEC 60664-1	*5 IEC 60664-1	*5 IEC 60664-1	*5 IEC 60664-1

Backsheets with fluoropolymers

Company	SFC	SFC	Toppan	Toppan	Toppan	Toppan
model	TPE-36	PA310E	BS-TX-1001	BS-TX-3001	BS-TX-7001	BS-TX-7031
market introduction	2012	2008	2009	2012	2012	2012
material composition	PVF/PTI/FPE	PVF/AI/PTI/FPE	PV2400/PET/PV2400	PV2400/PET/PV2400	PV2400 /PET+primer	PV2400 /PET+primer
Foil size						
thickness	345 µm	373 µm	310 µm	290 µm	260 µm	335 µm
width range	800 - 2,000 mm	800 - 2,000 mm	0 - 2,400 mm	0 - 2,400 mm	0 - 2,400 mm	0 - 2,400 mm
weight	457 ± 5 g/m²	529 ± 5 g/m²	429 g/m²	410 g/m²	330 g/m²	465 g/m²
density	1.33 g/cm³	1.42 g/cm³	1.43 g/cm³	1.40 g/cm³	1.27 g/cm³	1.27 g/cm³
colors (front / back)	w/w*1	w/w*1	w/w	w/w	w/w	w/w
Stability characteristics						
tensile strength at break (length)	> 300 N/10mm	> 400 N/10mm	40 N/mm	35 N/mm	35 N/mm	35 N/mm
tensile strength at break (cross)	> 300 N/10mm	> 500 N/10mm	50 N/mm	42 N/mm	42 N/mm	42 N/mm
elongation at break (length / cross)	> 120 / 100 %	> 100 / 70 %	180 / 120 %	180 / 160 %	180 / 160 %	180 / 160 %
tear strength (length / cross)	> 350 / > 400 N*2	> 350 / > 450 N*2	– / –	– / –	– / –	– / –
dimens. stability (length / cross)*1	< 1.2 / < 1 %	< 1.0 / < 1.0 %	< 0.1 / 0 %	< 0.1 / 0.1 %	< 0.1 / 0.1 %	< 0.1 / 0.1 %
EVA peel strength	> 50 N/mm	> 40 N/mm	> 7 N/mm	> 7 N/mm	> 7 N/mm	> 7 N/mm
peel strength of layers	> 5 N/mm	> 5 N/mm	> 1 N/mm	> 1 N/mm	> 1 N/mm	> 1 N/mm
water vapor permeability	< 1.5 g/m²d*3	< 1.5 g/m²d*3	0.7 g/m²d*1	0.7 g/m²d*1	0.7 g/m²d*1	0.7 g/m²d*1
breakdown voltage	> 20 kV*4	> 20 kV*4	–	–	–	–
max. system voltage	> 1,000 V*5	> 1,000 V*5	> 1,100 V	> 1,000 V	> 1,000 V	> 1,000 V
Delivery, order, warranty						
time of delivery	0.75 - 1.5 months	0.75 - 1.5 months	0 - 4 months	0 - 4 months	0 - 4 months	0 - 4 months
minimum order	100 m²	100 m²	–	–	–	–
warranty	–	–	–	–	–	–
Notes	*1 also custom. colors	*1 also custom. colors	*1 IEC15106-3	*1 IEC15106-3	*1 IEC15106-3	*1 IEC15106-3
*1 at 150 °C for 30 min	*2 DIN 53363	*2 DIN 53363				
	*3 ASTM F-1249 90(± 2) % RH / 100 F	*3 ASTM F-1249 90(± 2) % RH / 100 F				
	*4 ASTM D 149	*4 ASTM D 149				
	*5 IEC 60664-1	*5 IEC 60664-1				

Backsheets without fluoropolymers

Company	3M	3M	Coveme	Coveme
model	Scotchshield Film 800*1 W/W	3M Scotchshield Film 800*1 W&B	dyMat PYE	dyMat PYE SPV
market introduction	Target 2013	Target 2013	2008	2010
material composition	PO/PO/PO	PO/PO/PO	PET/PET/primer	PET/PET/primer
Foil size				
thickness	450 µm	450 µm	295 µm ± 5 %	295 µm ± 5 %
width range	995, 1010 mm*2	995, 1010 mm*2	50 - 2,000 mm	50 - 2,000 mm
weight	440 g/m²	440 g/m²	360 g/m² ± 5 %	360 g/m² ± 5 %
density	–	–	1.22 g/cm³	1.22 g/cm³
colors (front / back)	w/w	w/b & b/w	w/w, w/b, w/blue*1	w/w, w/b, w/blue*1
Stability characteristics				
tensile strength at break (length)	22 MPa	22 MPa	29 N/mm	29 N/mm
tensile strength at break (cross)	23 MPa	23 MPa	31 N/mm	31 N/mm
elongation at break (length / cross)	300 / 300 %	300 / 300 %	110 / 100 %	110 / 100 %
tear strength (length / cross)	– / –	– / –	– / –	– / –
dimens. stability (length / cross)*1	< 1.2 / < 1 %	< 1.2 / < 1 %	1.2 / 0.6 %	1.2 / 0.6 %
EVA peel strength	Cohesive failure of encap.	Cohesive failure of encap.	> 4 N/mm	> 4 N/mm
peel strength of layers	*3	*3	> 0.5 N/mm	> 0.5 N/mm
water vapor permeability	0.4 - 0.6 g/m²d	0.4 - 0.6 g/m²d	< 2.2 g/m²d*2	< 2.2 g/m²d*2
breakdown voltage	25 kV	25 kV	> 20 kV	> 20 kV
max. system voltage	> 1,500 V	> 1,500 V	> 1,000 V	> 1,000 V
Delivery, order, warranty				
time of delivery	per supply agreement	per supply agreement	0 - 1 month	0 - 1 month
minimum order	per supply agreement	per supply agreement	100 m length roll	100 m length roll
warranty	–	–	24 months*3	24 months*3
Notes *1 at 150 °C for 30 min	*1 UL-recognized *2 other on req. *3 Not measurable, no failure, co-extruded polyolefin layers	*1 UL-recognized *2 other on req. *3 Not measurable, no failure, co-extruded polyolefin layers	*1 other on req. *2 at 38 °C 100 % RH *3 shelf life	*1 other on req. *2 at 38 °C 100 % RH *3 shelf life

Backsheets without fluoropolymers

Company	Coveme	Coveme	Coveme	Coveme
model	dyMat PYE 3000*1	dyMat Bk PYE	dyMat H PYE	dyMat A PYE
market introduction	2010	2009	2009	2008
material composition	PET/PET/primer	PET black/PET/primer	PET/PET/primer	PET/Al*1/PET/primer
Foil size				
thickness	295 µm ± 5 %	295 µm ± 5 %	365 µm ± 5 %	370 µm ± 5 %
width range	50 - 2,000 mm	50 - 2,000 mm	50 - 2,000 mm	50 - 2,000 mm
weight	360 g/m² ± 5 %	360 g/m² ± 5 %	460 g/m² ± 5 %	510 g/m² ± 5 %
density	1.22 g/cm³	1.22 g/cm³	1.26 g/cm³	1.38 g/cm³
colors (front / back)	w/w, w/b, w/blue*1	b/b*1	w/w, w/b, w/blue, b/b*1	w/w, w/b, w/blue, b/b*2
Stability characteristics				
tensile strength at break (length)	29 N/mm	30 N/mm	41 N/mm	31 N/mm
tensile strength at break (cross)	31 N/mm	35 N/mm	43 N/mm	31 N/mm
elongation at break (length / cross)	110 / 100 %	115 / 110 %	110 / 100 %	100 / 100 %
tear strength (length / cross)	– / –	– / –	– / –	– / –
dimens. stability (length / cross)*1	1.2 / 0.6 %	1.2 / 0.6 %	< 1.2 / 0.6 %	< 1 / 0.8 %
EVA peel strength	> 4 N/mm	> 4 N/mm	> 4 N/mm	> 4 N/mm
peel strength of layers	> 0.5 N/mm	> 0.5 N/mm	> 0.5 N/mm	> 0.5 N/mm
water vapor permeability	< 2.2 g/m²d*3	< 2.2 g/m²d*2	< 2 g/m²d*2	< 0.005 g/m²d*3
breakdown voltage	> 20 kV	> 20 kV	> 25 kV	> 20 kV
max. system voltage	> 1,000 V	> 1,000 V	> 1,100 V	> 1,000 V
Delivery, order, warranty				
time of delivery	0 - 1 month	0 - 1 month	0 - 1 month	0 - 1 month
minimum order	100 m length roll	100 m length roll	100 m length roll	100 m length roll
warranty	24 months*4	24 months*3	24 months*3	24 months*4
Notes *1 at 150 °C for 30 min	*1 over 3,000 hours of DHT *2 other on req. *3 at 38 °C 100 % RH *4 shelf life	*1 black/white on req. *2 at 38 °C 100 % RH *3 shelf life	*1 other on req. *2 at 38 °C 100 % RH *3 shelf life	*1 opt. 9, 20 and 50 µm Al *2 other on req. *3 at 38 °C 100 % RH *4 shelf life

Backsheets without fluoropolymers

Company	Coveme	CPP Solar	CPP Solar	Dunmore	
model	dyMat ClrPYE	Hemera EPE 500	Hemera PE 750	DUN-SOLAR EPE*1	
market introduction	2010	2010	2010	2009	
material composition	coating/PET/PET/primer	EP/PET/EP	PET/EP	PE/PET/PE	
Foil size					
thickness	300 µm ± 5 %	325 µm	288 µm	265 µm	
width range	50 - 2,000 mm	≤ 1,500 mm	≤ 1,500 mm	25 - 1,880 mm	
weight	360 g/m² ± 5 %	357 g/m²	372 g/m²	290 g/m²	
density	1.24 g/cm³	–	–	–	
colors (front / back)	transp.	w/w, b/b	w/w	w/w, w/b	
Stability characteristics					
tensile strength at break (length)	34 N/mm	7.5 N/mm	–	48 N/mm²	
tensile strength at break (cross)	42 N/mm	5.9 N/mm	–	50 N/mm²	
elongation at break (length / cross)	150 / 120 %	93 %	140 %	210 / 170 %	
tear strength (length / cross)	– / –	– / –	– / –	– / –	
dimens. stability (length / cross)*1	1.2 / 0.6 %	< 0.87 / < 1 %	– / –	<1.2 / <1.0 %	
EVA peel strength	> 4 N/mm	> 4 N/mm	> 4 N/mm	destruct. bond	
peel strength of layers	> 0.5 N/mm	> 0.4 N/mm	> 0.4 N/mm	–	
water vapor permeability	< 2.4 g/m²d*1	< 3.35 g/m²d	–	< 3.5 g/m²d	
breakdown voltage	> 20 kV	14.9 kV	17.8 kV	–	
max. system voltage	> 1,000 V	> 1,000 V	> 1,000 V	950 VDC	
Delivery, order, warranty					
time of delivery	0 - 1 month	0 - 1 month	0 - 1 month	1.5 months	
minimum order	100 m length roll	100 m²	100 m²	200 m²	
warranty	24 months*2	12 months	12 months	24 months	
Notes *1 at 150 °C for 30 min	*1 at 38 °C 100 % RH *2 shelf life			*1 for thin-film modules and c-Si insulation	

Backsheets without fluoropolymers

Company	Feron	Flexcon	Flexcon	Isovoltaic	
model	HelioX PV neoX CPC bp plus*1	PPE 11	EPE 10	ICOSOLAR APA 3G*1	
market introduction	2012	2010	2011	2012	
material composition	coating*2/PET/coating*2	PET/PET/EVA	EVA/PET/EVA	mod. PA/PET/mod. PA	
Foil size					
thickness	315 µm ± 5 %	297 µm	272 µm	350 µm	
width range	depend. on customer	508 - 1,524 mm	508 - 1,524 mm	10 - 2,040 mm	
weight	450 g/m² ± 5 %	357 g/m²	285 g/m²	458 g/m²	
density	–	1.25 g/cm³	1.05 g/cm³	~ 1.31 g/cm³	
colors (front / back)	w/w - w/b - b/w*3	w/w, b/w	w/w, b/b	w/w, b/w, w/b, b/b	
Stability characteristics					
tensile strength at break (length)	≥ 110 N/mm	82 N/mm	45 N/mm	46 N/mm	
tensile strength at break (cross)	≥ 130 N/mm	100 N/mm	53 N/mm	58 N/mm	
elongation at break (length / cross)	≥ 90 / 90 %	110 / 93 %	319 / 224 %	160 / 120 %	
tear strength (length / cross)	– / –	4.6 / 4.5 N	2.1 / 3.3 N	– / –	
dimens. stability (length / cross)*1	≤ 1,5 / ≤ 1 %	< 1.5 / 1 %	< 1.5 / 1 %	≤1.5 / ≤1.0 %	
EVA peel strength	≥ 5 N/mm*4	> 4 N/mm	> 4 N/mm	≥ 6 N/mm*2	
peel strength of layers	inseparable (mono-film)	≥ 0.5 N/mm	≥ 0.5 N/mm	≥ 0.8 N/mm	
water vapor permeability	≤ 2.4 g/m²d*5	1.8 g/m²d	–	0.7 g/m²d*3	
breakdown voltage	≥ 20 kV	19.63 kV	–	21 kV	
max. system voltage	≥ 1,000 V	1,057 V	–	1,000 V	
Delivery, order, warranty					
time of delivery	1 - 4 months	< 1 month	< 1 month	0 - 2 months	
minimum order	10,000 m²	–	–	–	
warranty	–	–	–	–	
Notes *1 at 150 °C for 30 min	*1 damp heat perf.: 3,500 h *2 halogen-free coating *3 other colours on request *4 to Evasky S88 *5 at 38 °C 90 % RH			*1 »plus« and »complete« *2 to Vista Solar 486 *3 ISO 15106-3	

	Dunmore	Dunmore	Dunmore	Feron	Feron	Feron
	DUN-SOLAR PPE+*1	DUN-SOLAR PPE+ Black*1	DUN-SOLAR Ultraclear PPE+	HelioX PV neoX CPC bp*1	HelioX PV neoX CPC ap*1	HelioX PV neoX CPE *1
	2008	2008	2010	2011	2011	2013
	PET/PET/PE	PET/PET/PE	PET/PET/PE	coating*2/PET/coating*2	coating*2/PET/coating*2	coating*2/PET/Promoter*2
	360 µm	360 µm	360 µm	315 µm ± 5 %	315 µm ± 5 %	345 µm ± 5 %
	25 - 1,880 mm	25 - 1,880 mm	25 - 1,880 mm	depend. on customer	depend. on customer	depend. on customer
	–	–	–	450 g/m² ± 5 %	450 g/m² ± 5 %	400 g/m² ± 5 %
	–	–	–	–	–	–
	w/w, spec.	b/b, spec.	cl	w/w - w/b - b/w*3	w/w - w/b - b/w*3	w/w - w/b - b/w*3
	100 N/mm²	95 N/mm²	110 N/mm²	≥ 110 N/mm	≥ 110 N/mm	≥ 110 N/mm
	135 N/mm²	120 N/mm²	130 N/mm²	≥ 130 N/mm	≥ 130 N/mm	≥ 130 N/mm
	155 / 90 %	125 / 75 %	120 / 80 %	≥ 90 / 90 %	≥ 100 / 90 %	≥ 100 / 90 %
	– / –	– / –	– / –	– / –	– / –	– / –
	< 1.2 / < 0.4 %	< 1.0 / < 0.3 %	< 1.4 / < 0.7 %	≤ 1,5 / ≤ 1 %	≤ 1,5 / ≤ 1 %	≤ 1,5 / ≤ 1 %
	destruct. bond	destruct. bond	destruct. bond	≥ 5 N/mm*4	≥ 5 N/mm*4	≥ 5 N/mm*4
	destruct. bond	destruct. bond	destruct. bond	inseparable (mono-film)	inseparable (mono-film)	≥ 1 N/mm
	< 2.1 g/m²d	< 2.2 g/m²d	< 2 g/m²d	≤ 2.4 g/m²d*5	≤ 2.4 g/m²d*5	≤ 2.4 g/m²d*5
	–	–	–	≥ 20 kV	≥ 20 kV	≥ 20 kV
	> 1,000 VDC	> 1,000 VDC	> 1,000 VDC	≥ 1,000 V	≥ 1,000 V	≥ 1,000 V
	1.5 months	1.5 months	1.5 months	1 - 4 months	1 - 4 months	1 - 4 months
	200 m²	200 m²	200 m²	10,000 m²	10,000 m²	10,000 m²
	24 months	24 months	24 months	–	–	–
	*1 for crystallline modules	*1 for crystallline modules		*1 damp heat perf.: 3,000 h *2 halogen-free coating *3 other colours on request *4 to Evasky S88 *5 at 38 °C 90 % RH	*1 damp heat perf.: 4,000 h *2 halogen-free coating *3 other colours on request *4 to Evasky S88 *5 at 38 °C 90 % RH	*1 damp heat perf.: 3,000 h *2 halogen-free coating *3 other colours on request *4 to Evasky S88 *5 at 38 °C 90 % RH

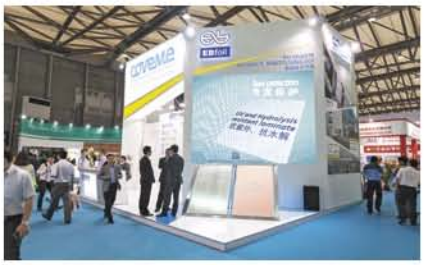
	Isovoltaic	Isovoltaic	Isovoltaic	Krempel	Micel Films	Skultuna Flexible
	ICOSOLAR APA 4004*1	ICOSOLAR AAA 3554*1	ICOSOLAR APA 3G alu*1	AKALIGHT ECS	MISOLAR XPM	2P190
	2011	2009	2013	2011	2011	2010
	mod. PA/PET/mod. PA treated	mod. PA/mod. PA/mod. PA treated	mod. PA/Al/PET/mod. PA	PET/PET/ Primer	PET/PET/MHB film	mod. EVA primer/PET/PET*1
	310 µm	250, 350, 420 µm	390 µm	300 µm	287 µm ± 5 %	375 µm
	10 - 2,040 mm	10 - 2,040 mm	10 - 2,040 mm	≤ 2,000 mm	≤ 1,020 mm	depend. on cust.
	420 g/m²	280, 395, 458 g/m²	528 g/m²	380 g/m²	356 g/m²	454 g/m²
	~ 1.35 g/cm³	~ 1.1 g/cm³	~ 1.35 g/cm³	~ 1.3 g/cm³	–	1.22 g/cm³
	w/w	w/w, b/b	w/w, b/w, w/b, b/b	w/w	all colors/w	w/w, w/b, b/b, b/w
	46 N/mm	12 N/mm*2	52 N/mm	25 N/mm	30 N/mm	33.5 N/mm
	58 N/mm	8 N/mm*2	60 N/mm	35 N/mm	37.8 N/mm	47 N/mm
	160 / 120 %	350 / 80 %	160 / 120 %	120 / 100 %	119 / 63 %	120 / 65 %
	– / –	– / –	– / –	35 / 35 N*1	– / –	– / –
	≤1.5 / ≤1.0 %	≤1.5 / ≤1.0 %	≤1.5 / ≤1.0 %	≤ 1.2 / ≤ 1.2 %	1.6 / 0.3 %	1 / < 0.2 %
	≥ 6 N/mm*2	≥ 6 N/mm*2	≥ 6 N/mm*2	> 4 N/mm	> 5 N/mm*1	> 400 N/10mm
	≥ 0.6 N/mm	*4	≥ 0.4 N/mm	0.5 N/mm	> 0.4 N/mm	> 400 N/10mm
	0.5 g/m²d*3	1.1, 0.7, 0.6 g/m²d*5	0.0 g/m²d*3	< 0.8 g/m²d	<2 g/m².j*2	< 0.7 g/m²d
	21 kV	21, 21, 23 kV	20 kV	> 30 kV	22 kV	> 25 kV
	1,000 V	600, 1,000, 1,200 V	1,000 V	> 1,000 V	> 1,000 V	> 1,050 V
	0 - 2 months	0 - 2 months	0 - 2 months	2 weeks	1 - 2 months	0.5 months
	–	–	–	100 m²	500 m²	100 m²
	–	–	–	6 months	–	18 months
	*1 »plus« and »complete« *2 to Vista Solar 486 *3 ISO 15106-3	*1 »plus« and »complete« *2 for 350µm thickness *3 to Vista Solar 486 *4 not seperable due to coextrusion *5 ISO 15106-3	*1 »plus« and »complete« *2 to Vista Solar 486 *3 ISO 15106-3	*1 DIN 53515	*1 To Vista Solar 486 *2 ISO 2528	*1 hydr + UV res

Backsheets without fluoropolymers

Company	Skultuna Flexible	Skultuna Flexible	Skultuna Flexible	Skultuna Flexible
model	SF09S2*2	3P250	1P200	1P200 Plus
market introduction	2010	2008	2011	2011
material composition	mod. EVA primer/PET*1	mod. EVA primer/PET/PET/PET*1	mod. Polyolefin/PET*1	mod. Polyolefin/PET/PET*1
Foil size				
thickness	285 µm	408 µm	255 µm	310 µm
width range	customer spec.	customer spec.	customer spec.	customer spec.
weight	332 g/m²	543 g/m²	255 g/m²	310 g/m²
density	1.21 g/cm³	1.33 g/cm³	1 g/cm³	1 g/cm³
colors (front / back)	w/w, w/b, b/b, b/w	w/w, w/b, b/b, b/w	w/w, w/b, b/b, b/w,*2	w/w, w/b, b/b, b/w
Stability characteristics				
tensile strength at break (length)	34 N/mm	58 N/mm	120 N/10 mm	215 N/10 mm
tensile strength at break (cross)	35 N/mm	60 N/mm	120 N/10mm	270 N/10mm
elongation at break (length / cross)	150 / 150 %	110 / 60 %	130 / 95 %	105 / 80 %
tear strength (length / cross)	– / –	– / –	– / –	– / –
dimens. stability (length / cross)*1	0.5 / < 0.3 %	1.2 / < 0.6 %	2 / < 0.5 %	1.2 / <0.01 %
EVA peel strength	> 400 N/10mm	> 400 N/10mm	> 115 N/10mm	> 115 N/10mm
peel strength of layers	> 400 N/10mm	> 400 N/10mm	>600 N/m	>600 N/m
water vapor permeability	< 1.6 g/m²d	< 1.05 g/m²d	< 1.3 g/m²d	< 1.3 g/m²d
breakdown voltage	> 25 kV	> 25 kV	> 29 kV	> 29 kV
max. system voltage	> 1,110 V	> 1,140 V	> 1,038 V	> 1,084 V
Delivery, order, warranty				
time of delivery	0.5 months	0.5 months	1 - 4 weeks	1 - 4 weeks
minimum order	100 m²	100 m²	100 m²	100 m²
warranty	18 months	18 months	>18 months	>18 months
Notes *1 at 150 °C for 30 min	*1 hydr + UV res	*1 hydr + UV res	*1 hydr + UV res *2 other colours on request	*1 hydr + UV res

Backsheets without fluoropolymers

Company	Skultuna Flexible	Toppan	Toppan	
model	1P200 Al	BS-TA-PV	BS-SP-VW-1116	
market introduction	2011	2009	2010	
material composition	mod. Polyolefi–I/PET*2	PET /Al /PET+primer	PET /PET+primer	
Foil size				
thickness	270 µm	375 µm	290 µm	
width range	customer spec.	0 - 1,200 mm	0 - 2,000 mm	
weight	280 g/m²	456 g/m²	365 g/m²	
density	1 g/cm³	1.27 g/cm³	1.26 g/cm³	
colors (front / back)	w/w, w/b, b/b, b/w	w/b, w/w	w/w	
Stability characteristics				
tensile strength at break (length)	120 N/10 mm	30 N/mm	30 N/mm	
tensile strength at break (cross)	120 N/10 mm	37 N/mm	35 N/mm	
elongation at break (length / cross)	130 / 95 %	130 / 110 %	75 / 110 %	
tear strength (length / cross)	– / –	– / –	– / –	
dimens. stability (length / cross)*1	2 / < 0.5 %	– / –	< 1.3 / 0.3 %	
EVA peel strength	> 115 N/10mm	> 7 N/mm	> 7 N/mm	
peel strength of layers	>600 N/m	> 0.3 N/mm	> 0.3 N/mm	
water vapor permeability	< 0.05 g/m²d	⊠0.01 g/m²d*1	0.7 g/m²d*1	
breakdown voltage	> 29 kV	–	–	
max. system voltage	> 1,038 V	> 1,000 V	> 1,000 V	
Delivery, order, warranty				
time of delivery	1 - 4 weeks	0 - 4 months	0 - 4 months	
minimum order	100 m²	–	–	
warranty	>18 months	–	–	
Notes *1 at 150 °C for 30 min	*1 hydr + UV res	*1 IEC15106-3	*1 IEC15106-3	



Xian Shai / photon-pictures.com (2)

▲ Dual role: While backsheets have traditionally been a passive part of the module, offering electrical insulation and protection, they are now also being designed for the conductivity of high-efficiency cell concepts such as back-contact cells. At the recent SNEC trade fair in Shanghai, Italy-based Coveme announced a first conductive backsheet for modules made of back-contact cells.


CPP Solar

▲ More economical: US-based CPP's new product, the TPE 500, is a less costly version of the traditional TPT backsheet, in which the inner Tedlar layer is replaced by an ethylene primer.

nar-based Herema GPE 500 (this year, CPP has not listed its Hemera EPAG 1000 for thin-film applications and Hemera GPP 1000 (SIL) used with silicone encapsulation material). As with all of CPP's products, the TPE500 is composed of PET sandwiched between Tedlar on the outside and ethylene primer on the inner side.

But Werner Krumlacher, the vice president of research and development at Isovoltaic, says that while the use of ethylene layers on the inner side are known to reduce the cost of backsheets, his company prefers polyamides. Ethylene, he says, is in danger of melting when temperatures go up to 175°C during lamination, meaning that the three-layered backsheet is just left with two layers.

Isovoltaic also has a new product, its ICOSOLAR APA 3G alu, which exhibits zero water-vapor permeability for thin-film applications. The ICOSOLAR APA 3G alu is similar to the ICOSOLAR APA 3G, which was launched in 2012, but has an aluminum layer between the outer polyamide and the PET layer. The additional aluminum layer eliminates water permeability, but increases the weight of the backsheet by 70 g per m² to 528 g per m², which makes it the second most heaviest product among the non-fluoropolymers in the survey. The heaviest product is Skultuna Flexible's 3P250 – launched in 2008, which contains a modified EVA primer/PET/PET/PET – and weighs 543 g per m².

Isovoltaic, which last year started using modified polyamide for a few models, has now replaced treated polyamide in the backsheet with the modified version for all of its products as a way of reducing manufacturing cost. However, Isovoltaic did not say by how much. The company, which was using a special surface treatment to improve adhesion of the polyamide to the encapsulation, now achieves the same by modifying the properties of the material, thus eliminating one process step.

However, the company still uses a surface treatment on one of its backsheets – its ICOSOLAR TPA HR – but this time to promote reflectivity. Lackner says that this can increase the performance of the module by approximately 1.5 percent relative.

Another provider of flouropolymer-based backsheet products is US-based backsheet supplier, FLEXcon Inc., which has listed a product that it launched late last year but which appears for the first time in this survey, its KPE 156, a Kynar and EVA sandwiching a PET film. The KPE 156 comes in a thickness of 322 µm and is available in color combinations of black and white on the inner and outer sides. Since it is 6 µm thinner than the KPE 12 (launched in 2010), the new product has a higher water-vapor permeability of 2.3 g/m²d, compared to the KPE 12 with 2 g/m²d.

Honeywell has also listed a product that it launched late last year, its PowerShield Cool Black, which is similar to its existing white-colored PowerShield 3W, but black on the inner side. The PowerShield Cool Black is a PET film sandwiched between ECTFE on the outer side and a bonding layer on the inner side. This backsheet, available in a thickness of 309 µm, has a water-vapor permeability of 1.4 g/m²d. The company puts the maximum system voltage at 1,000 V and claims it can withstand 3,000-plus hours of damp heat.

Multinational technology corporation 3M, which still sells fluoropolymer-based backsheets (without Tedlar), has entered the non-fluoropolymer segment with its polyolefin-based 3M Scotchshield Film 800. This material is not new to the PV industry, as polyolefin-based encapsulation material is already available on the market, offered by both Mitsui and Spain-based Novo-Genio SL. In addition, Sweden-based Skultuna Flexible AB has been offering polyolefin-based backsheets – its 1P200 Al for thin-film applications and 1P200 Plus and 1P200 for crystalline applications – since 2011. However, all of the polyolefin-based backsheets from Skultana Flexible use PET as the core layer.

3M's new product is a co-extruded backsheet that eliminates adhesives and the possibility of delamination. The 3M Scotchshield Film 800 comes in two variations, with black or white on the inner side. 3M's material of choice enables it to withstand a maximum system voltage of up to 1,500 V, by far the highest in the survey. Another benefit is its water-vapor permeability of 0.4 to 0.6 g/m²d, better than many non-fluoropolymers that range between 1.8 to 3.5 g/m²d.

Backsheets for high-efficiency cells

In this survey, Isovoltaic is the only company to have listed a conductive backsheet for back-contact cells. Its ICOSOLAR TPC 3480, a PET film sandwiched between Tedlar and copper, not only protects the module, but also provides the necessary contacts for these high-efficiency cells where all of the metal on the sunny side of the cell has been moved to the underside. However, such cell concepts are still at an early stage of commercialization and thus backsheets have to be customized according to the cell metallization pattern. Krumlacher says Isovoltaic is working in close cooperation with several R&D groups. While conductive backsheets may soon be technically ready for the market, the major drawback is cost. Krumlacher claims that the company is working on what he calls an »ambitious cost-down roadmap.«

Though Krempel did not list any such product in the survey, it claims to be the leader for conductive backsheets. Brust notes that the challenge is not laminating Tedlar, PET and copper together – »that can be done by anyone,« he believes – but rather patterning, protecting copper and ensuring good adhesion to the contacts. And unlike the standard variety, such backsheets must provide both insulation and conductivity as well, says Brust. While Krempel supplies China's Tianwei New Energy, one of the few companies with commercial modules made of metal wrap-through (MWT) cells, the sales numbers for this product are still very low. »There is no real market for MWT,« Brust believes.

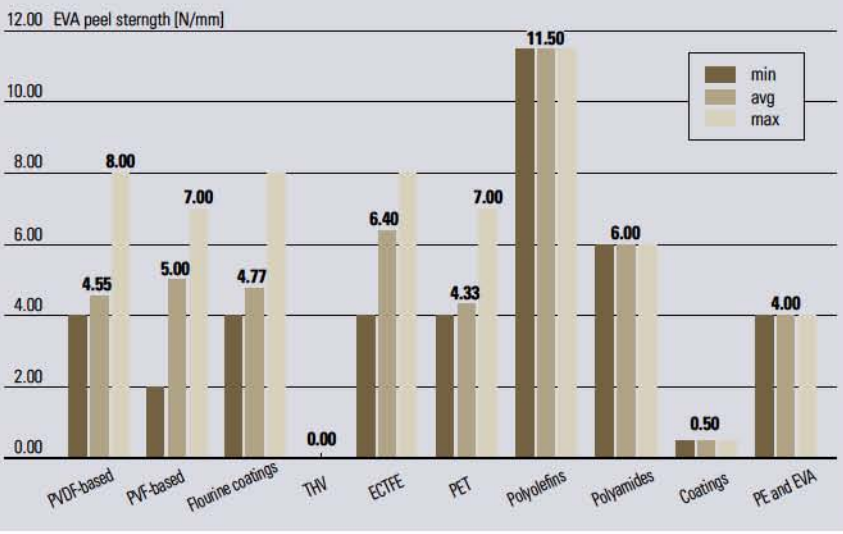
Still, it seems that at least backsheet suppliers are preparing to contribute their part for this to change. Coveme is another company that has started offering a conductive backsheet, but it also did not list it in this survey. The Italian company offers its EB Foil, a new customized product, intensively promoted at recent trade fairs, where Coveme patterns the copper according to the customer's requirements.

Damp-heat test a marketing gimmick?

One difficulty in trusting the usefulness of testing backsheets for weatherability is that the International Electrotechnical Commission (IEC) only requires a test of 1,000 hours under 85 °C at 85 percent relative humidity. Coveme's Anderlini says that many module manufacturers – especially in Europe – are demanding twice that as a minimum requirement. He claims that

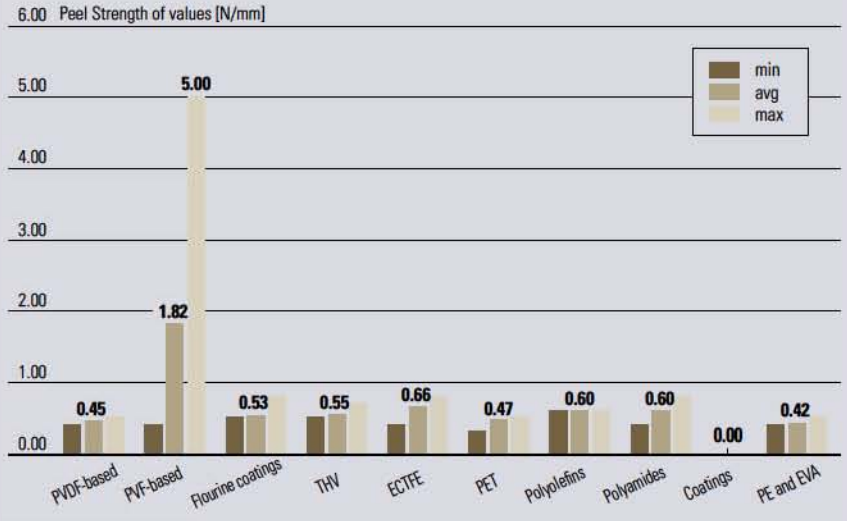
▶ Different materials, different strengths: In the data we received from companies on EVA peel strength, polyolefins are a clear winner with an average of 11.5 N/mm (left). The peel strength between layers is an important parameter that determines the extent of adhesion; SFC has listed peel strength values of 5 N/mm, which puts its Tedlar-based products at the top with an average peel strength of 1.82 N/mm (middle). Another important parameter is the water-vapor permeability of the backsheets (right); leading the chart is polyamides with the lowest water permeability of 0.45 g/m²d.

Comparison of peel strength with EVA

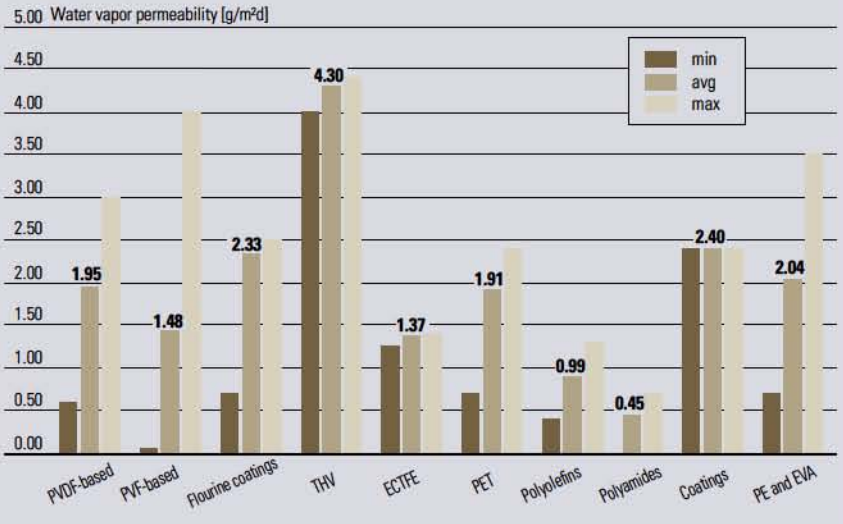


Source: PHOTON International (3)

Comparison of peel strength of layers



Comparison of water vapor permeability



◀ Modified: Isovoltaic, which last year started using modified polyamide for a few models, has now replaced treated polyamide in the backsheet with the modified version for all of its products as a way of reducing manufacturing cost. The company, which was using a special surface treatment to improve adhesion of the polyamide to the encapsulation, now achieves the same by modifying the properties of the material, thus eliminating one process step.

all of Coveme's backsheets can withstand 2,000 hours of damp heat and that its PET-based dyMat PYE 3000 can go up to 3,000 hours. Lackner, who claims that Isovoltaic was the first company to go to 2,000 hours, believes that higher damp-heat resistance tests than what the IEC requires are an important figure, as it »shows the quality of the material.«

Krempel's Brust says that some researchers think that the current damp-heat test might not be the best test to determine the weatherability of the material. »They are looking for combined tests in which the backsheets are exposed to UV, humidity and temperature under electrical load to simulate real-life conditions.« As it is now, says Brust, the damp-heat test »is more or less a marketing strategy.« For him – as probably for all the suppliers – the most important factor is »the power output at the end of the life of the module.«

However, after the idea for a special standard for back- and frontsheets was first born 5 years ago, when a working group was started in Germany. In March of this year, the IEC TC 82 positively voted on a New Work Item Proposal for IEC 62788-2 Edition 1 with the Title Measurement Procedures for Materials used in Photovoltaic Materials – Part 2: Polymeric Materials used for Frontsheets and Backsheets.

Increasing module performance

Regarding power output, this is one place even backsheets can help a bit. While the backsheet is generally considered a passive component of the module configuration, it can still be vital in improving module performance. Backsheet manufacturers are working on increasing the reflectivity of the sheets. Lackner says that Isovoltaic's ICOSOLAR TPA HR, a PET sandwiched between Tedlar and a polyamide with a special surface treatment that enhances reflectivity, has a reflectance of 83 percent, while Tedlar alone just has 71 percent. As mentioned earlier, he claims this benefit can result in increased performance of the modules by approximately 1.5 percent relative.

Anderlini says that Coveme can go further, claiming that all of its non-fluoropolymer products have a reflectivity of above 85 percent (Honeywell also says it can reach 85 percent for some of its fluoropolymer models). He says the company is still investigating the addition of white-layered films on the inner side that can improve the reflectivity to as high as 95 percent.

New polyolefins – high quality and low-cost?

In the past two years, wafer, cell and module makers have strongly pushed material suppliers to contribute their part in bringing down cost to be able to cope at least somewhat with strongly dropping module prices – and backsheets are no exception, in spite of contributing only a small fraction of the total module cost. However, there are several trends to cut on backsheet cost. Firstly, the inner fluoropolymer can be replaced with a primer layer, as fluoropolymer layers are more expensive than primer layers. Secondly, the fluoropolymer films with halogen coatings can be replaced – while coatings need high uniformity, it is still more economical than any fluoropolymer layer. Finally, fluoropolymers, which are the most expensive part of backsheet composites, can be completely replaced with materials as shown in the table for non-fluoropolymer based backsheets (see table, p. 51 – 54). However, the ruling is still out to what extent products without fluoropolymers can match the quality of fluoropolymers containing composites. There are as many opinions as suppliers of different products.

Another effective cost cutting method is the co-extrusion process. In this survey there are two companies that offer co-extruded products, 3M and US-based Madico. 3M's new products – its 3M Scotchshield Film 800 White/White and 3M Scotchshield Film 800 White/Black contain three layers of polyolefins that have been co-extruded. Such a process eliminates two adhesive layers to reduce the cost. In addition, the whole backsheet becomes a single layer, which eliminates the probability of delamination inside that product. Still, the lamination process has to be adapted to make sure the polyolefin sticks well to the EVA.

However, in the case of Madico's Reflekt and Reflekt Prime, only one layer of adhesive is eliminated – just two layers (PET and EVA) are co-extruded, while the outer layer is a fluoropolymer coating. The water permeability of the 3M products is in the range of 0.4 to 0.6 g/m²d, depending on the thickness. Madico's backsheets have a water permeability of 2.5 g/m²d for a thickness of 262 ± 26 µm.

What about polyester?

While several new pure polyester-based backsheets have been offered for the last few years, there is no new developments on these PET products. All of the polyester-based backsheet suppliers commonly offer PET/PET/primer as a standard product with varying thicknesses resulting in different backsheet properties. 'While 11 of the 15 products listed in the survey use the PET/PET/primer composition, leading PET-based backsheet supplier Coveme offers seven PETs of which five are based on this composition.

A total of seven companies in this survey are offering PET-based products. However, the first company to launch PET-based backsheets was Coveme in 2008, followed by US-based Dunmore Corporation in the same year. In 2010, CPP, FLEXcon and UK-based Toppan Printing Co. UK Ltd. launched their respective PET-based backsheets. The last to enter this market in 2011 were France-based MICEL Films and Krempel, the latter being still a strong proponent of flouropolymer based composites. Though the competition has increased among the PET suppliers, Coveme's Anderlini says this is an indication of the material's acceptance as a standard backsheet.

What the future holds for the different technologies used for backsheets is not completely clear. It is quite evident from the current market conditions that the most important driver is the price-to-quality ratio. While the supporters of the somewhat more expensive Tedlar-based backsheets can point to a slight uptick for Dupont's PVF product over the last survey after years of decline, fluoropolymers in general are finding increasing competition. Not are they inherently more expensive than PET-based non-fluoropolymer backsheets, there is also new competition through US-based giant 3M, which is introducing a product based on polyolefins that promises to be – at least when produced in large quantities – significantly cheaper than even high-quality PET. ●

Further information

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The detailed product descriptions are exclusively available to subscribers is an extended PDF version (see appendix, p. 122-128), which can be downloaded at www.photon.info