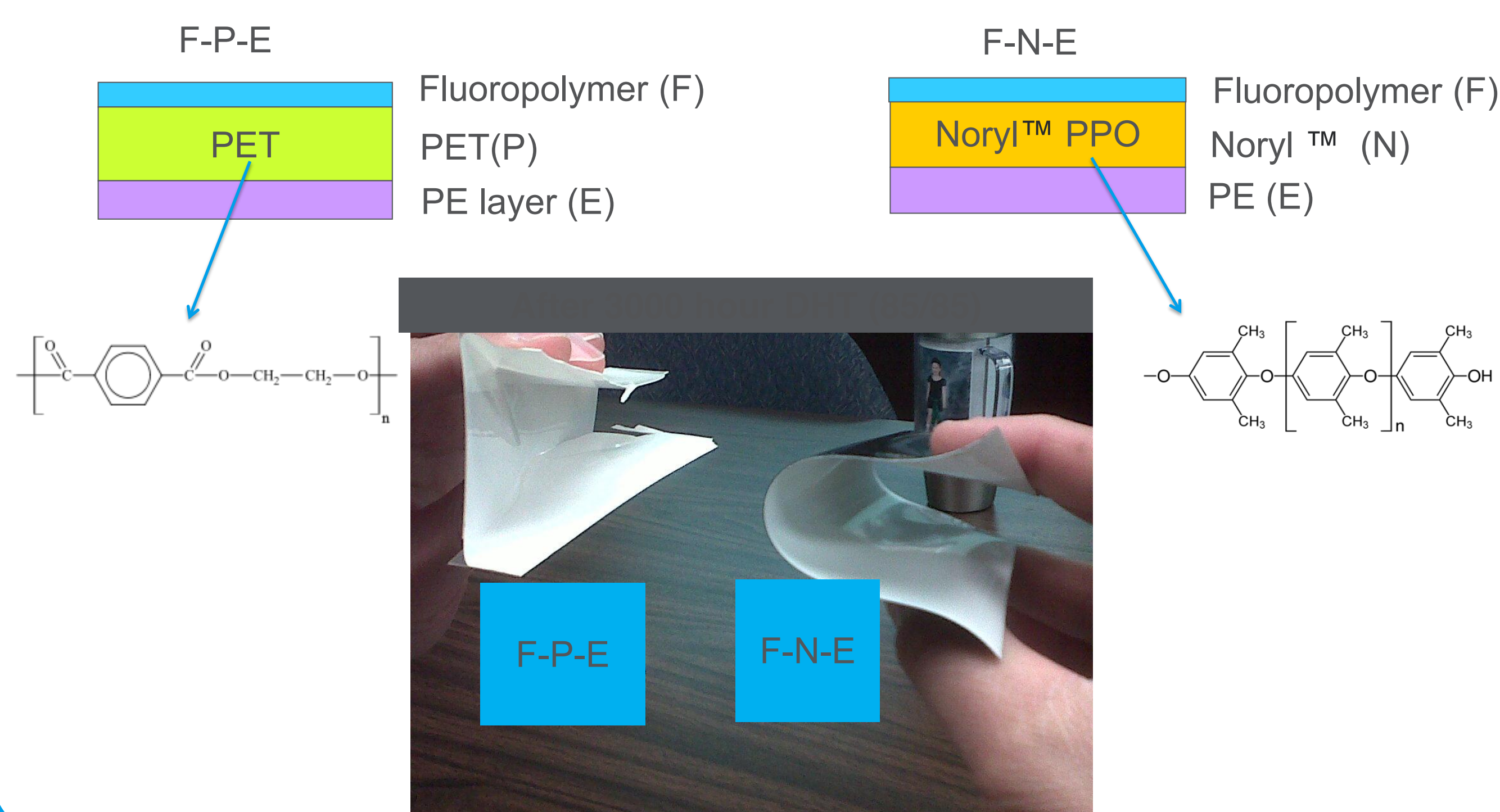


IMPROVED RELIABILITY OF PV MODULES WITH LEXAN™ (PC) SHEET - FRONT SHEET NORYL™ (PPE) SHEET - BACK SHEET

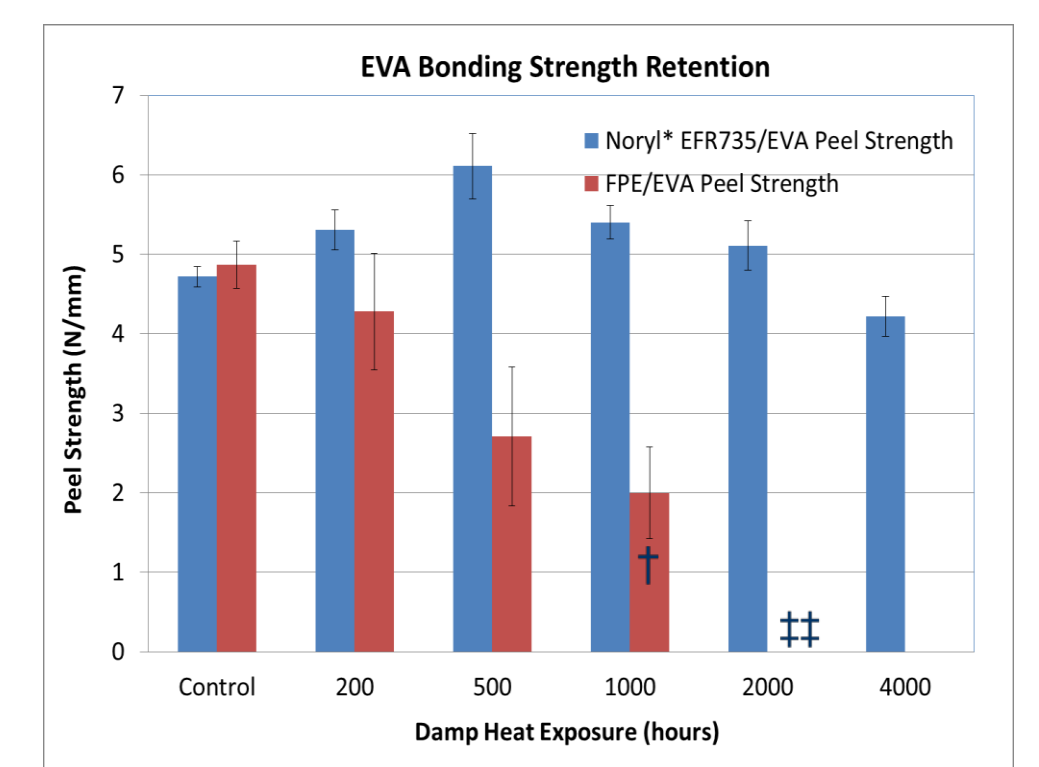
 NORYL™ Sheet for back sheet application  LEXAN™ sheet for front sheet application

HYDROTHERMAL RESISTANCE OF PET AND NORYL™ FILM AS CORE LAYER OF BACKSHEET

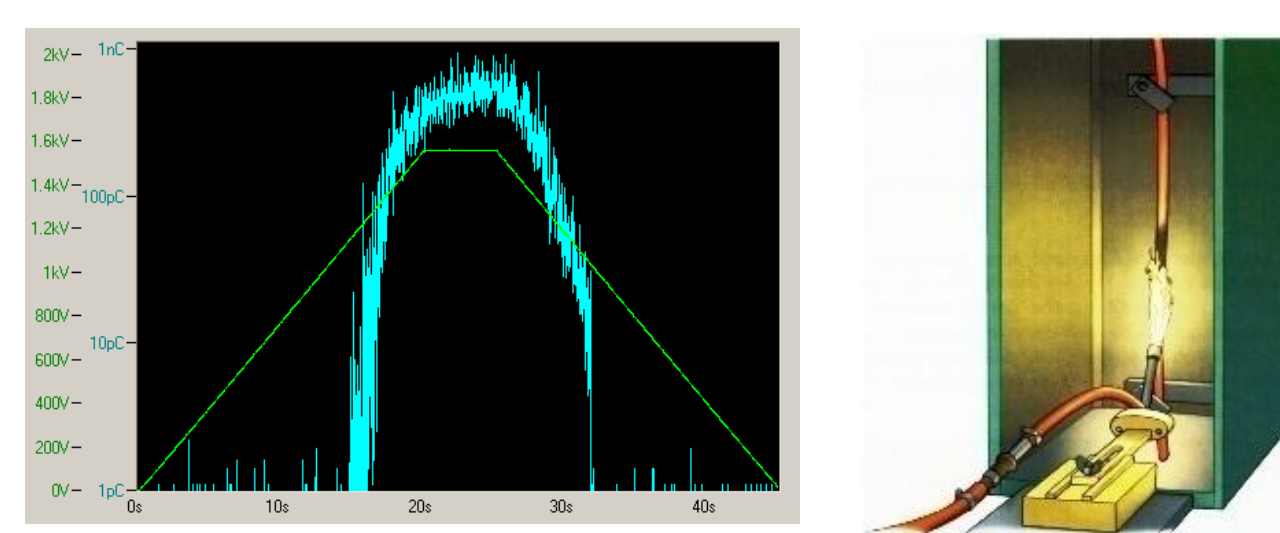


PROPERTIES COMPARISON OF PET AND NORYL™ BASED BACKSHEET

Property	Units	FPE	FNE
Outer layer gauge	micron	30	30
Core layer gauge	micron	177	250
Primer layer gauge	micron	100	140
Adhesive layer gauge	micron	15	30
Total gauge	micron	~320	~450
WVTR (at 38°C, 100%RH)	g/m ² ·24h	2.4	2.4
Partial Discharge Voltage (with / without E layer)	V	1045 / --	1310/1040
Shrinkage (MD/TD, 150°C/ 30min)	%/%	1.0 / 0.3	0.2 / 0.1
Tensile (Initial)	Strength Elongation	MPa %	105 247
Tensile (After 72hr PCT)	Strength Elongation	MPa %	37 65
Intra-layer bonding after 72hr PCT		PET cracks! No delamination	33 17
EVA Bonding (Initial)	N/mm	>7	>7



ELECTRICAL INSULATION AND FLAME RETARDATION FOR SAFETY



Film Sample	Gauge (mil)	Partial discharge voltage (V)	UL94 Flame Rating
PV grade PET	10	850~ 900	HB or worse
Noryl™ EFR735	10	1020	V0

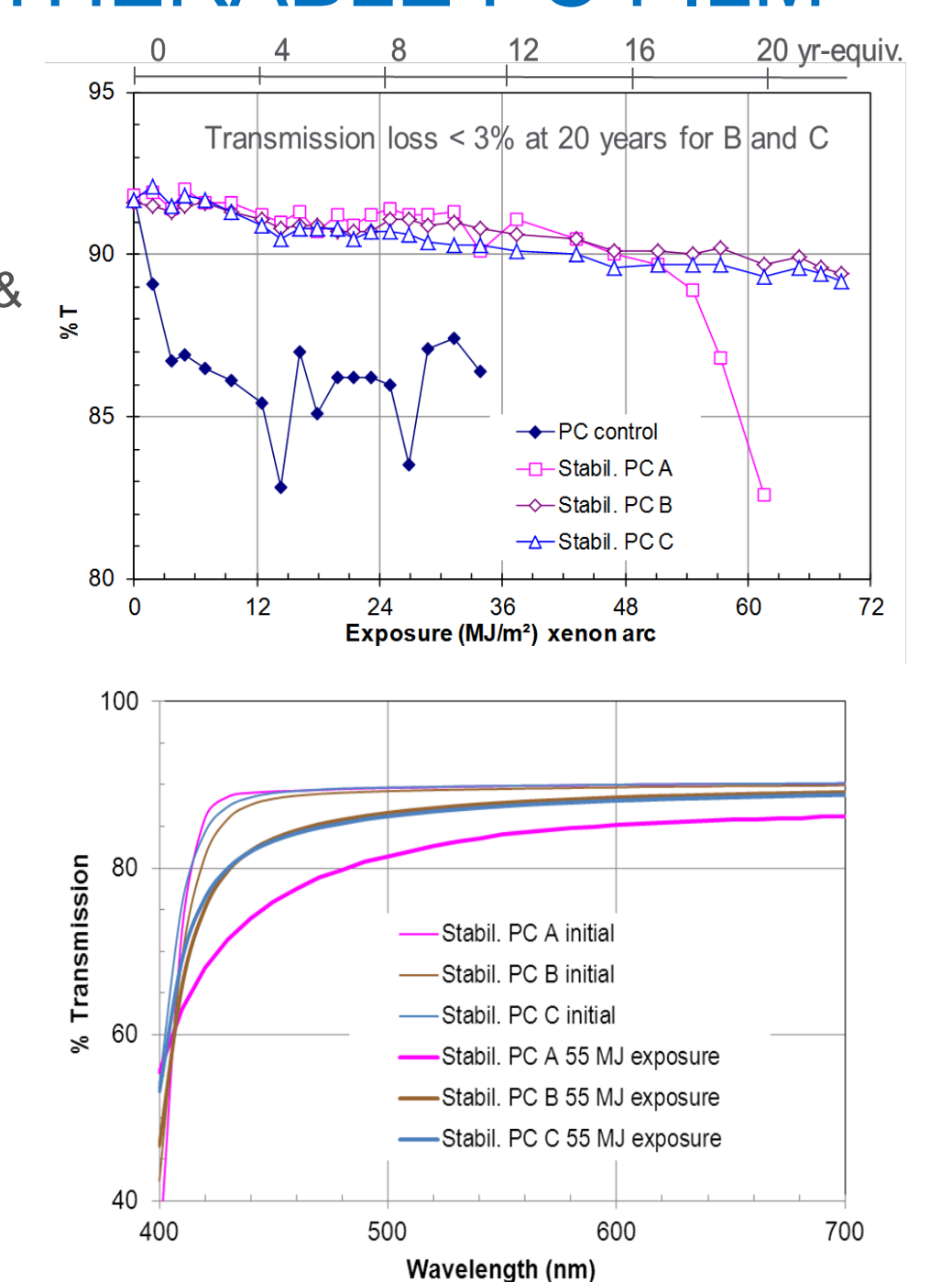
WHY POLYCARBONATE AS PV FRONT SHEET?



- Lighter weight and flexibility v.s. glass
- Compared to thin fluoropolymer film:
 - Superior toughness
 - Flame retardation desired for BIPV
 - Low cost

HIGHLY WEATHERABLE PC FILM

- Unprotected PC yellows & loses transmission in 1-2 years outdoors
- Highly weatherable PC demonstrates UV life capacity >20 year (equivalent Florida year)

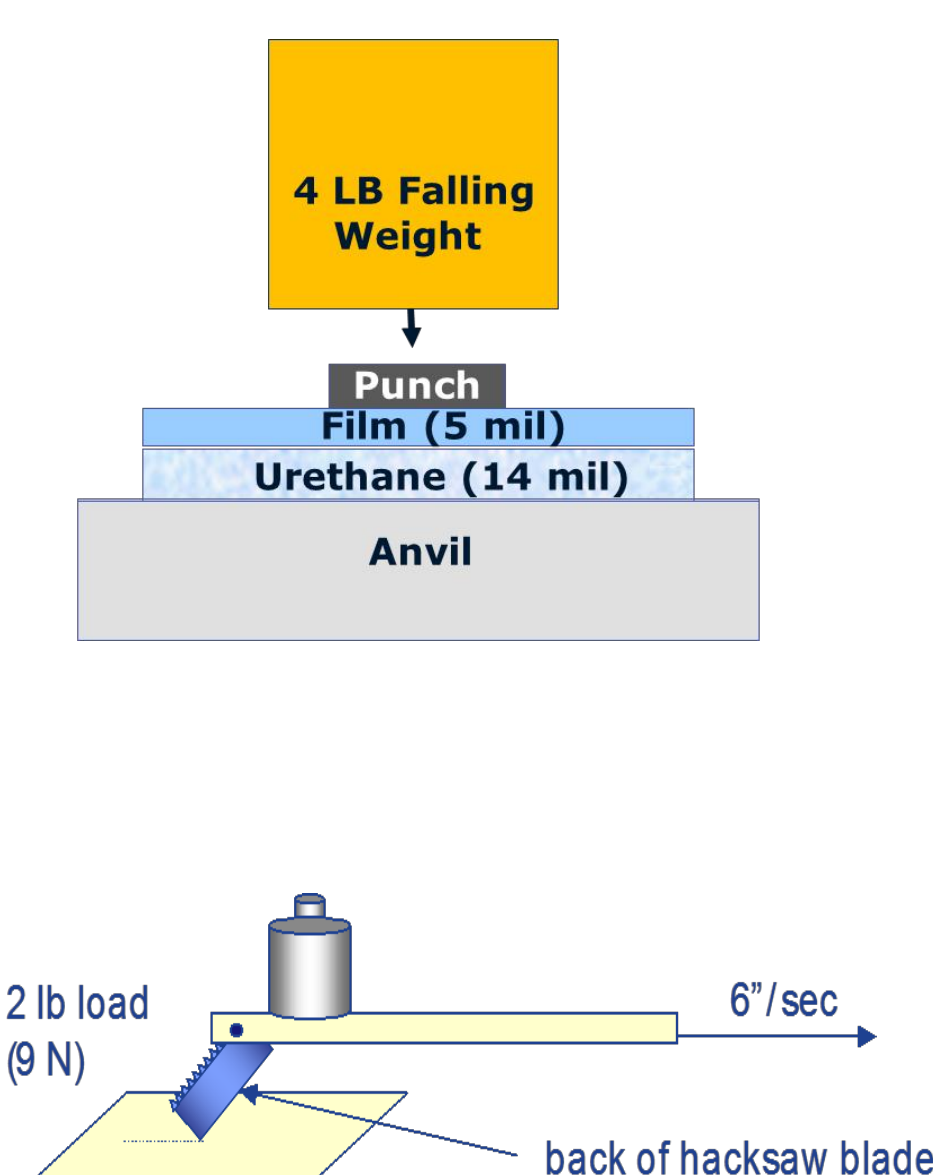


PUNCTURE & CUT RESISTANCE TEST OF PC FILM

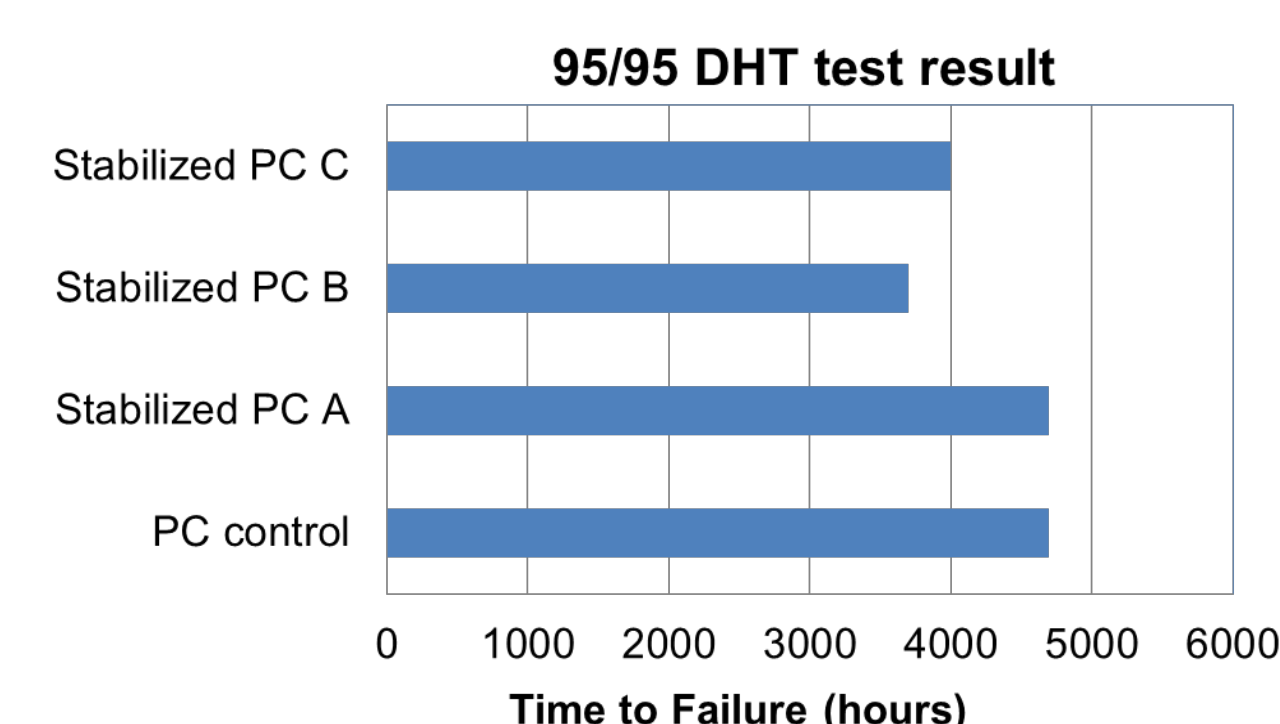
Energy inch-lb	Penetration	
	ETFE	PC
20	pass	pass
40	pass	pass
60	pass	pass
80	fail	pass

5 mil films are tested for both ETFE and PC

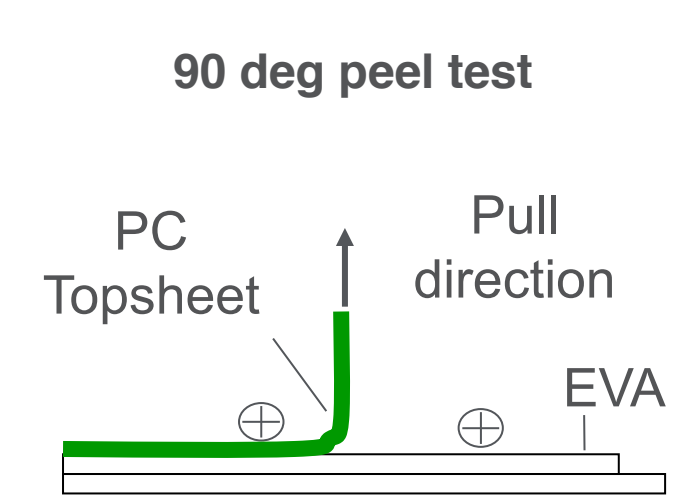
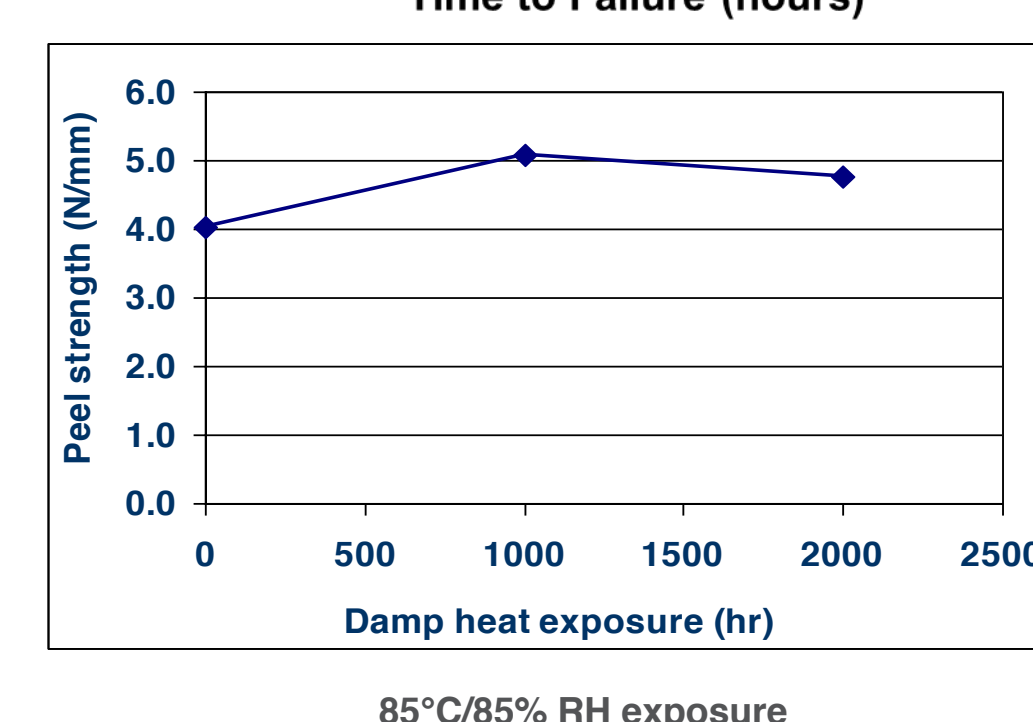
sample	load (pounds)					
	2	3	4	5	6	
2 mil ETFE/ EVA-glass	OK	cut				
5 mil ETFE/ EVA encapsulant	OK	OK	OK	cut		
2.5 mil PC/ EVA encapsulant	OK	OK	cut			
5 mil PC / TPU encapsulant backing	OK	OK	OK	OK	cut	
12 mil stabilized PC film	OK	OK	OK	OK	OK	



DAMP HEAT RESISTANCE AND EVA BONDING



Note: after 95°C/95%RH exposure; bend film around 1/4" mandrel (pass/fail)



SUMMARY

- Demonstrated superior hydrostability of Noryl* film compared to PET, with DH resistance > 4000 hours
- FNE backsheet outperforms FPE in hydrothermal resistance, shrinkage and electrical insulation
- Highly weatherable PC sheet as PV front cover can last >20 years outdoors, enabling flexible and durable PV modules
- Stabilized PC has puncture & cut resistance superior to fluoropolymers

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