Materials Matter™

The Criticality of Materials for the Long-Term Durability and Reliability of Solar Systems

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Intersolar Europe
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DuPont Photovoltaic Materials

Solamet®
Metallization Pastes

Driving higher energy conversion efficiency

Tedlar®
PVF Films for Backsheet

Protecting PV modules

DuPont Ionomer
Encapsulants

Delivering long-term protection of cells

+110 Over the last 7 years, DuPont has introduced more than 110 new Solamet® pastes designed to boost solar panel power output.

+30 YEARS Tedlar® film is the only backsheet material proven to protect solar panels for 30+ years in all weather conditions.

+50% More than half of the world's 700 million solar panels installed since 1975 have DuPont materials in them.

+11 TRILLION DuPont materials have been time-tested in >11 trillion panel-hours of solar installations across the globe since 1975.

Stress Factors Affecting Solar Panels

Ultra Violet (UV)

- Transmitted
- Reflected

Temperature

- Peak
- Cycling

Moisture

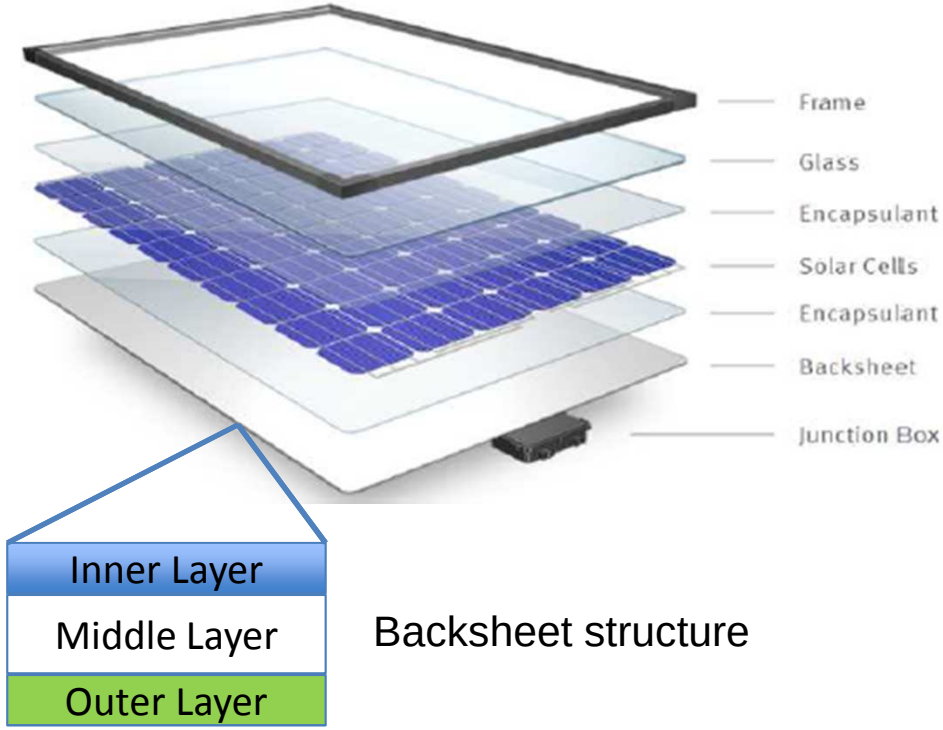
- Humidity
- Precipitation
- Condensation

Corrosive Environment

- Atmospheric chemicals
- Ammonia
- Marine environment

Physical Protection

- Abrasion
- Impact

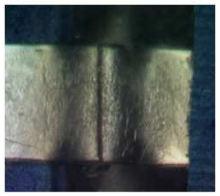


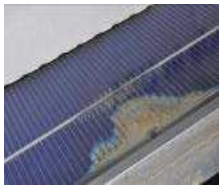
Backsheet structure

Backsheets must provide reliable electrical protection of panel over the expected lifetime (and beyond)

DuPont Field Surveys: Visual Degradation Observations

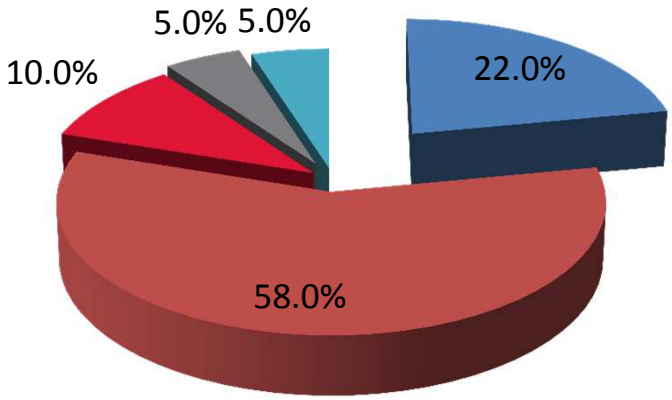
- Surveyed: >190 Installations in North America, Europe & Asia Pacific
- Figures reported below: 45 Module Manufacturers, >450 MW, > 1.9 MM Modules
- Range of Exposure: From Newly Commissioned Modules to 30 Years in the Service Environment
- Hot Arid, Temperate and Tropical





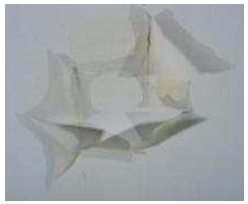
(Interim analysis - 2015)

~ 41% of panels affected
< 5 years old panels (average)



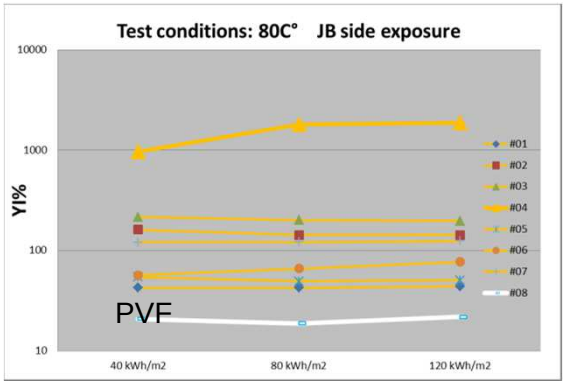
- Backsheet
- Cell
- Encapsulant
- Glass
- Other

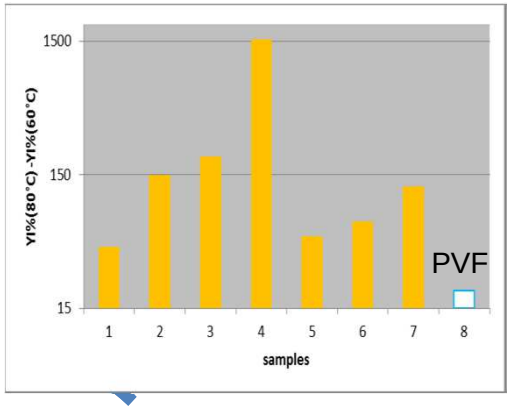
Backsheet is one of the main components affected



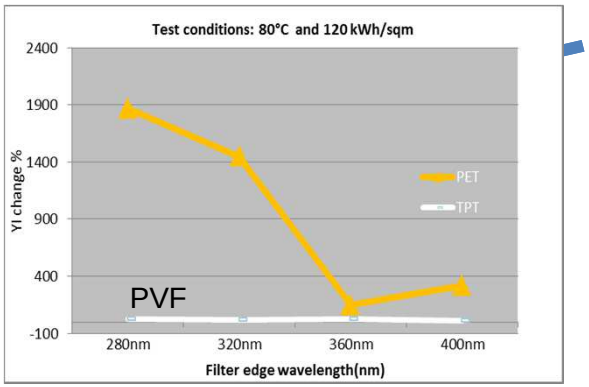
Source: DuPont Field Module Program
Note: All percentage numbers are based on MW

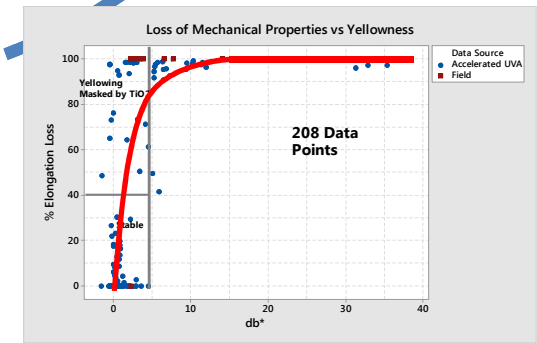
Backsheet Degradation Under UV & Thermal Stress





- **UV + Temperature => Yellowing**
- **Sensitivity:**
  - UV < 360nm
  - Limited impact with respect to UV intensity
  - Strong with temperature
- **Tedlar® PVF demonstrated strongest stability**





Yellowing = Polymer Degradation

Source: EU-Project SOPHIA - Fraunhofer Institute of Solar Energy System: round robin on UV-testing with different radiation sources (started in 2012). 10 Backsheets tested; DuPont loss of mechanical strength study.

Field Observations: Material Sensitivity

	Tedlar® PVF	PVDF	PET	FEVE
Profile of Sample Size	**30 installations 122K modules**	**24 installations 403K modules**	**15 installations 112K modules**	**4 installations 102K modules**
Average System Age	**10.5 years**	**3.2 years**	**6.5 years**	**3.7 years**
Type of Defects	Cracking(*)	Inner Layer Yellowing Cracking	Yellowing (Front / Back) Delamination/Cracking	Yellowing Delamination/Cracking
Percentage of panels affected by defects	**<1%**	**58%**	**30%**	**11%**

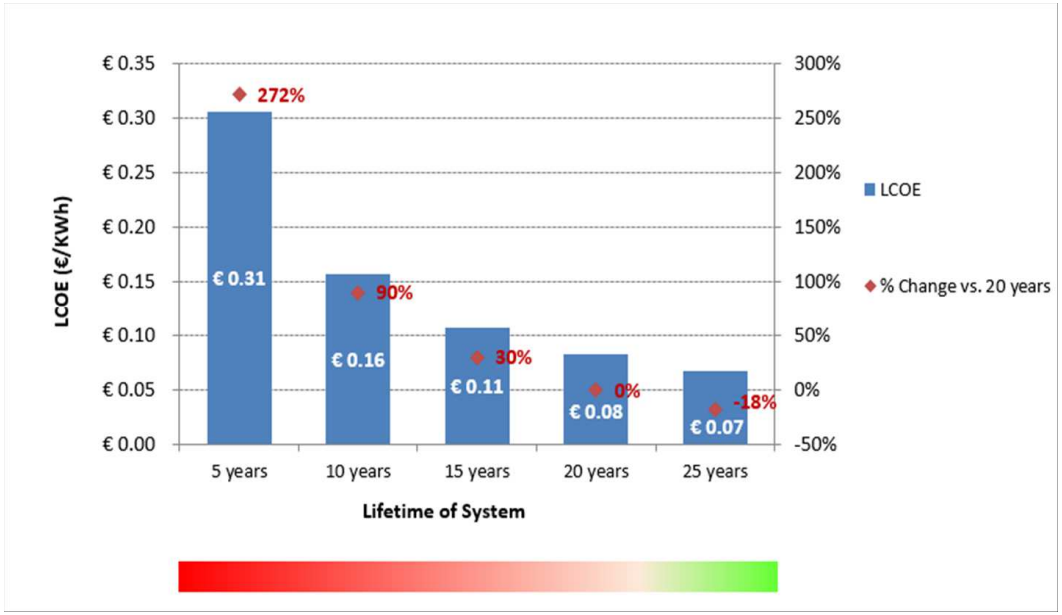
(*) 4mil single layer

Tedlar® PVF (Polyvinyl Fluoride)
PVDF (Polyvinylidene Fluoride)
PET (Polyethylene Terephthalate)

Note: Interim DuPont Data - 2015

Summary

- Panel degradation can strongly affect LCOE and investment return
- IEC certification does not predict the long-term performance of the panel
- Backsheet degradation can impact panel integrity & safety (replacement is then required)
- Selecting the most robust backsheet materials with respect to thermal stress (and UV), to help mitigate risks of degradation



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