DuraMAT
Durable Module Materials Consortium

Discover, Develop, and De-Risk module materials, architectures, accelerated testing protocols,data analytics, and financial models to reduce the LCOE of solar energy

BACKFLIP Project

Determination of BACKsheet material properties: a comparison of market-benchmark technologies to novel non-FLuoro-based co-extruded backsheet materials and their correlation and ImPact on PV module degradation rates

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DuraMAT Capabilities

1. Data Management & Analytics, DuraMAT Data Hub
2. Predictive Simulation
3. Advanced Characterization & Forensics
4. Module Testing
5. Field Deployment
6. Techno-Economic Analysis

This project

Industry Goals

- Study a variety of co-extruded, fluorine-free backsheet materials, and compared to benchmark market backsheets,
  as-is, artificially-weathered, and when-utilized in a PV module
- Evaluate the relative rate of degradation of commercial and experimental backsheets.
- Derive parametrized equation that describes degradation rates of backsheets to predict useful life from lab data.

Industry Motivations

- Quantifying degradation rate of backsheets will help procuring materials for 30+ years.
- Today most backsheets on the market have a laminated PET core; polyolefin materials may provide better properties for backsheets (barrier to water, mechanical properties through UV and hydrolytic environments, etc.)
- End-of-life regulations may require fluorine-free backsheet products in future global markets.

Expected Outcome and Impact

- Parametrized equation predicting the service life of backsheets, and validated by both lab and outdoor extensive testing.
- Technical and commercial confidence to the entire value chain: from backsheet and module manufacturers to the downstream community (IPP, banks, developers) that materials of higher quality can help reduce finance costs, therefore driving down LCOE.
- A fast track PV module market adaptation for novel high-quality materials, such as co-extruded polyolefin-core backsheets, by obtaining unbiased durability data.

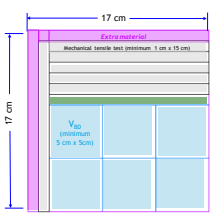
Project Outline

Commercial / Benchmark Backsheets:

(TPT, KPf, PPF, AAA)

R&D / Coextruded / Fluoro-free Backsheets:

(PA-PP, specialty polyester -PP, all polyolefinic)



Sheet-film backsheet coupons will be used to examine mechanical (tensile test), electrical (breakdown voltage), and material (crystallinity) characteristics.

BS Material Coupons

Mini-modules

1/4-cell mini-modules will be used for artificial weathering

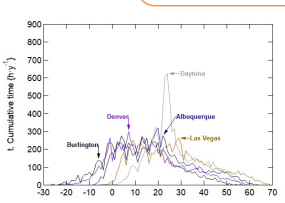
Four-cell mini-modules will be used for natural weathering

Outdoor Weathering:

- New Mexico – hot & dry
- Florida – hot & humid

Accelerated Aging:

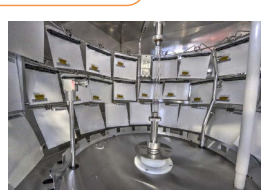
- Hydrolytic – Humidity, Temp.
- Photolytic – UV, Temp.



Representative annual time-temperature history for rack-mounted glass/polymer PV modules deployed at the DOE RTC sites.

Testing
Characterization
Analysis
Correlations

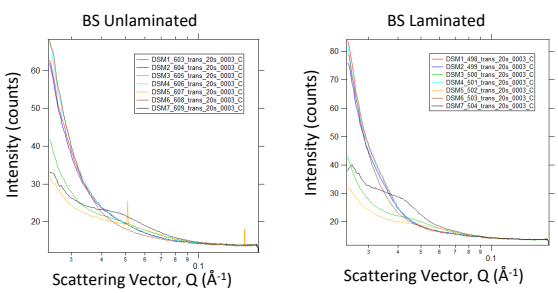
Parameterized equations defining degradation rates of backsheets to predict useful life from lab data



MiMo and coupon specimens in Xe Ci5000 chamber for IEC 62788-7-2 method A3 weathering.

Initial Characterization

Small Angle X-ray Scattering (SAXS)

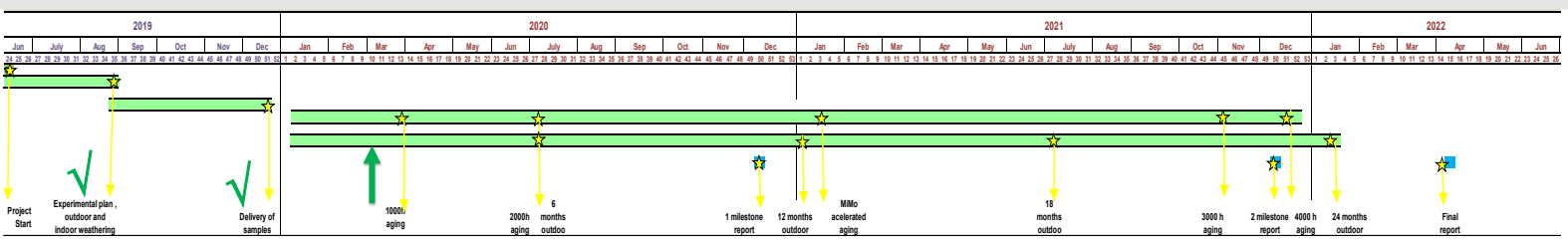


- Baseline SAXS completed on all seven backsheets
- Clear differences between laminated and unlaminated samples suggest microstructural changes happen during lamination
- Preliminary WAXS data also completed (not shown)

Backsheet	Isc (A)		Voc (V)		Imp (A)		Vmp (V)		Pmp (W)		FF (%)	
	Mean	1σ	Mean	1σ	Mean	1σ	Mean	1σ	Mean	1σ	Mean	1σ
1	9.52	0.03	2.71	0.01	8.92	0.01	2.06	0.01	18.4	0.1	71.2	0.3
2	9.53	0.02	2.70	0.01	8.93	0.02	2.05	0.01	18.3	0.1	71.2	0.2
3	9.46	0.03	2.70	0.00	8.86	0.02	2.05	0.00	18.2	0.1	71.2	0.1
4	9.52	0.02	2.70	0.01	8.93	0.01	2.05	0.01	18.3	0.1	71.3	0.2
5	9.46	0.09	2.69	0.02	8.87	0.04	2.05	0.01	18.1	0.1	71.3	0.5
6	9.52	0.02	2.71	0.01	8.92	0.01	2.06	0.01	18.4	0.1	71.3	0.2
7	9.50	0.02	2.71	0.01	8.91	0.01	2.06	0.01	18.3	0.1	71.3	0.2

- Baseline flash testing completed on all 4-cell mini-modules
- Inter-sample variation was generally 0.5% or less
- Two backsheet types displayed slightly lower Isc than others; this trend will be followed during field exposure

Timeline



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