Enhanced Durability from Glass-Aluminum PV Module Package

Tim Johnson / Dallas Meyer
tenKsolar

Design Objectives

Design a more durable PV module that can achieve robustness and durability of glass-glass PV modules without the weight of glass and cost of conventional backsheets.

Why Aluminum?

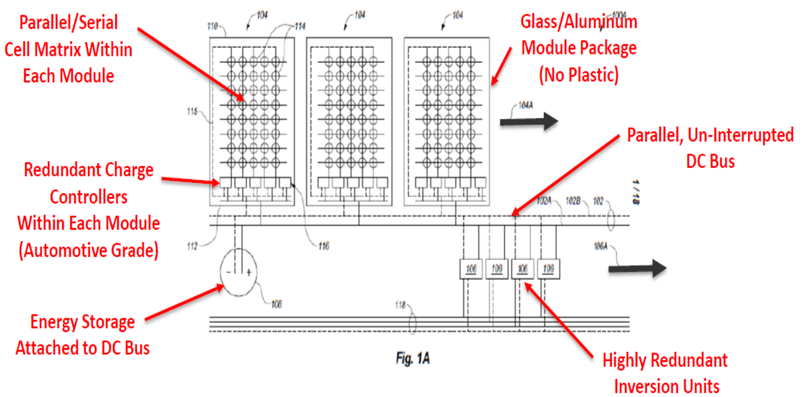
- Lowest material cost – 1/4th the cost of conventional backsheets
- Lightest weight vs. glass/glass (aluminum is 32x thinner than glass).
- Thermal Conductivity– Aluminum has 200x the thermal conductivity of glass or plastic.
- Anisotropic reflection pattern due to rolling texture – provides total internal reflection gain
- Fire – will not burn like conventional fluorinated backsheets

Challenges

- Conventional serial modules require ability to operate at 1000V (moving to 1500V) much too high for a metal backsheet

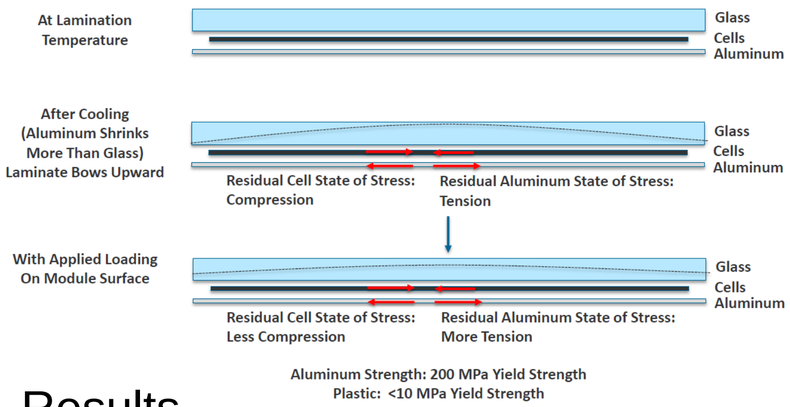
Module-System Design

Low Voltage serial-parallel cell interconnect configuration where backsheet is part of the electrical path and with embedded charge control electronics to provide ability to boost voltage from low voltage output to redundant inversion package that boosts voltage to grid interconnect voltages



Module Performance Benefits

Lower Nominal Operating Cell Temperature (NOCT), Extremely low module parasitic resistance –> Higher Power Output
Electrical encapsulation allows the "robustness" of avoiding current leakage from broken modules -> Fail Safe Durability
Residual compression imparted to cells, prevents cell cracking –> Enhanced Durability
Forces imparted by the aluminum backsheet keep the parallel strip tape interfaces in compression -> Enhanced Durability
Utilize w/ 3.2 mm glass for large 96 cell module and no back-brace -> Lower Cost, Lighter Weight
Glass can be shattered and module still has strength to resist snow and wind loads -> Fail Safe Durability
Hail Stone Certified to 45 mm/67 mph (compliance of module, higher energy absorption) –> Enhanced Durability
Low MVTR (moisture vapor transmission rate) -> Enhanced Reliability
Aluminum provides "getter" properties inside the module - Any water that does get in – reacts with the aluminum and not other components -> Enhanced Reliability



Results

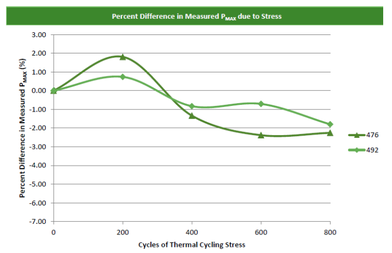
In upcoming release of Greentech Media PV Module quality scorecard from DNVGL PVEL PQP testing

tenK PV module achieved designation in Top Performing Group
· Thermal Cycling (-2.03%)
· Damp Heat (-2.62%)
· Humidity Freeze (-0.13%)
· Dynamic Load (-0.18%)

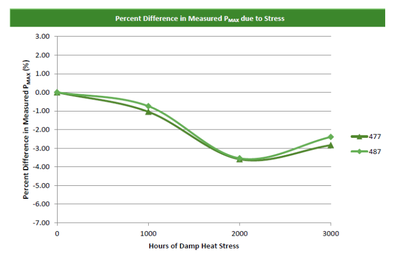
Achieved designation as Top Performer
· Humidity Freeze: 1 of 2 manufacturers degraded < 0.5%
· Dynamic Mechanical Load: 1 of 4 manufacturers degraded < 0.5%

Test Data

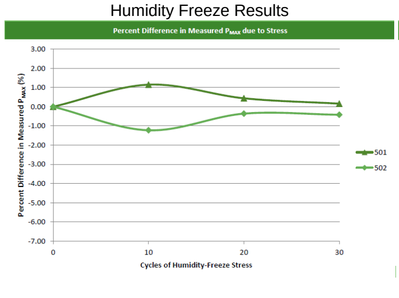
Thermal Cycling Results



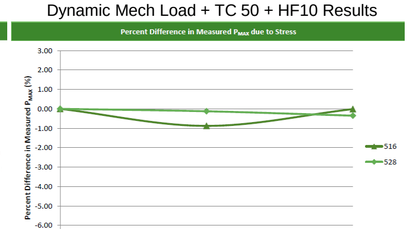
Damp Heat Results



Humidity Freeze Results

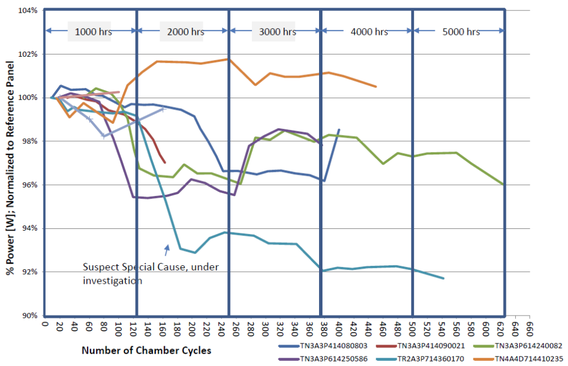


Dynamic Mech Load + TC 50 + HF10 Results



Ongoing Durability Test @ tenK

5 Hrs Extended Damp Heat (85/85) w/ Embedded 3 hr -40° C Freeze Cycle



Metal Spike Piercing Through Module:
Only experienced 1.3% Loss of AC System Power!