Demonstrating Reliability of 3M Ultra-Barrier Film for Flexible PV Applications

3M Ultra-Barrier Solar Film

Revolutionary Product
- Over 45 U.S. patents and patent-pending applications on barrier constructions, materials, and processes
- Engineered for flexible Copper Indium Gallium Selenide (CIGS), Cadmium Telluride (CdTe) and Organic Photovoltaic (OPV) solar modules

Features
- Optical transmission >99% (average 400-1400nm)
- Water vapor transmission rate = 5x10⁻⁶ g/m²/day @ 23°C / 85%RH
- Excellent UV stability
- Flexible

Key Highlights
- UL Certified Component
- Partial discharge 1,000V

Manufacturing Highlights
- Full-scale product matches or exceeds performance of narrow-width product in 3M reliability and qualification testing
- NREL on Calcium testing as low as 5x10⁻⁶ g/m²/day at 45°C / 85%RH

Scale-up to Production

3M Ultra-Barrier Manufacturing
- New production line startup in 2012
- Located in the United States

Widths
- Currently producing at up to 1.2 meters
- Available in wider widths depending on market requirements

Manufacturing Process Capability
- Barrier coating thickness
- Mechanical strength
- Water vapor transmission rate
- Color
- Haze
- Signal is below detection limit
- Signal is below detection limit

Qualification Testing
- 3000hr damp heat (85°C / 85%RH)
- >1000 MJ/m² Total UV Dose*
- Humidity freeze
- Thermal shock
- Water submersion over the range 295-385nm

Film Responses
- Optical transmission
- Mechanical strength
- Water vapor transmission rate
- Color
- Haze

2nd Generation 3M Ultra-Barrier Film UBF-510

3M UBF-510 Key Highlights
- Improved adhesion to a broader range of encapsulant and edge seal materials
- Higher light transmission
- Lower Cost

Production Data

Reliability and Qualification Testing
- Multi-year study with indoor and outdoor exposures
- Accelerated indoor weathering chambers with varied irradiance, relative humidity and temperature levels
- Active modules and film-only specimens
- Multiple sizes, aspect ratios and film lots

Aggressive Conditions
- Test films to failure to speed development
- Multi-year study with indoor and outdoor exposures to modules-level performance
- Multi-year study with indoor and outdoor exposures to modules-level performance

Lifetime Prediction
- Combining measurements from film-only exposures to module-level performance
- Combining measurements from film-only exposures to module-level performance

Summary

3M Ultra-Barrier Solar Film
- Water vapor transmission rates as low as 5x10⁻⁶ g/m²/day at 45°C / 85%RH for production material
- Film performance for 1.2 meter wide film meets or exceeds narrow-width material in qualification testing
- 3M has extensive qualification and reliability test sequences to validate film performance
- 2nd Generation UBF-510 film with improved module performance to launch Q3 2013

3M Technology Advancing Every Company
3M Products Enhancing Every Home
3M Innovation Improving Every Life

*Total UV Dose (TUV) is the time integrated energy over the range 295-385nm

Over 45 U.S. patents and patent-pending applications on barrier constructions, materials, and processes. Engineered for flexible Copper Indium Gallium Selenide Solar Film, Cadmium Telluride (CdTe) and Organic Photovoltaic (OPV) solar modules. 3M is a trademark of 3M. Used under license. © 3M 2012. All rights reserved. Lower relative “fixed” module costs. Lower manufacturing costs – Fully automated roll-to-roll processing.