Adhesion of Encapsulating Films Used in PV Module Manufacturing

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Fluoropolymer-based films are preferred as frontsheets for thin film flexible PV modules as they provide:

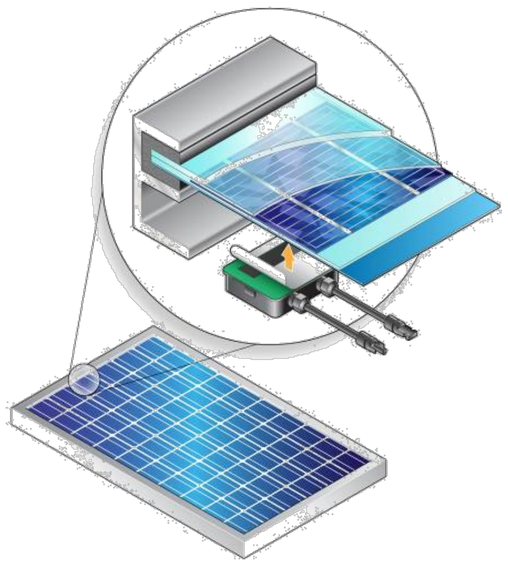
- **Excellent resistance to UV, temperature and chemicals for long term weather protection.**
- **Light weight for flexibility.**
- **High light transmission for optimal efficiency.**
- **Low surface energy to reduce soiling.**

The most common fluoropolymer used today as frontsheets in PV modules is ETFE. The ETFE film is typically bonded to the solar cell with an EVA encapsulant to form a front surface protective laminate.

Strong ETFE-EVA adhesion is a critical requirement to ensure long-term durability of PV modules. However, ETFE's low surface energy and inertness is a challenge to achieve sufficient EVA adhesion.

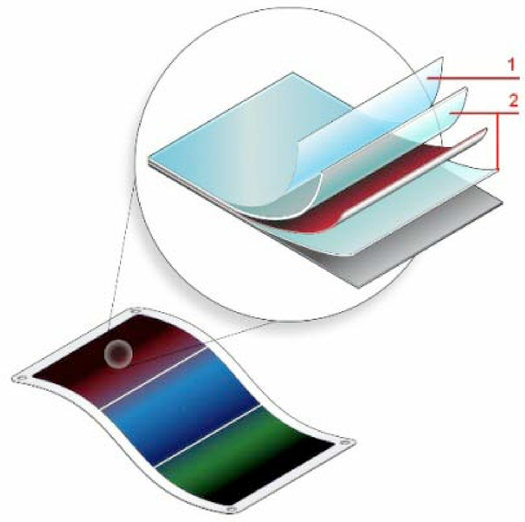
In this study, several surface treatment methods (Corona, Plasma and Saint-Gobain's C-treatment) were explored for their effectiveness in modifying the ETFE surface to achieve adequate adhesion to EVA.

ETFE treated with Corona and Plasma treatments were found to give significantly lower adhesion strength to EVA and are therefore unacceptable for PV applications . Saint Gobain proprietary treatment yielded higher adhesion strength.

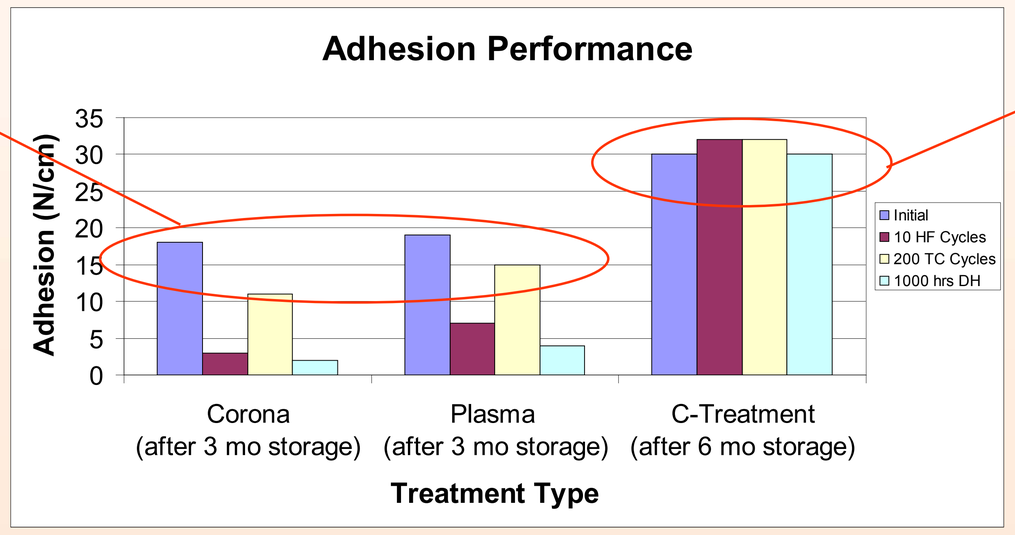


Surface Treatment Technologies

Corona	Plasma	C-Treatment Saint Gobain Proprietary
High Energy Filamentary Discharge	High Energy Glow Discharge	High Energy Treatment



Failure Mode: Peel (Adhesive Failure)

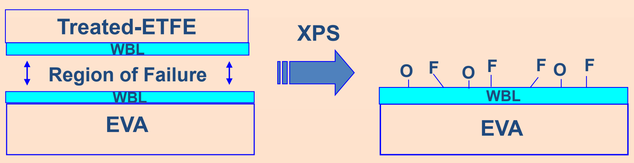


Failure Mode: Film Break (Cohesive Failure)

Lamination Condition: 145°C, 1300 mbar, total lamination time: 12.5 min Test Method: "T"-peel

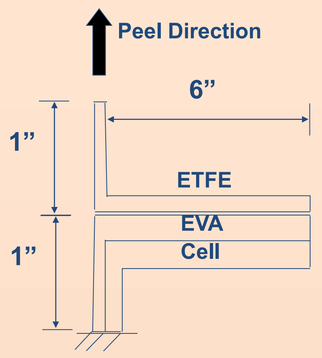
Comparison of Treatment Technologies

Postulated Failure: Weak Boundary Layer (WBL)



Samples	F (%)
EVA surface before lamination	0
EVA surface after peel	27

	Corona	Plasma	C-Treatment
Level of Polar Groups by X-Ray Photoelectron Spectroscopy (XPS)	7.6 %	4.6 %	9 %
Evidence of Weak Boundary Layer	**Yes**	**Yes**	**No**
Adhesion to EVA (After Aging)	X	X	√
Stability of Treatment (> 6 months)	X	X	√



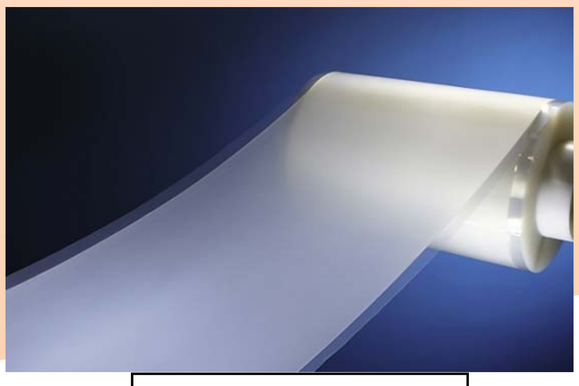
Lightswitch Complete

Advantages

- Production Efficiencies
  - Reduced Lay-up
  - Reduced Defects
- Lower cost
  - Less packaging
  - Less shipping

Pre-laminate of ETFE with EVA

Now available at widths up to 2 m



- Saint Gobain's C-treatment is more stable and long lasting compared to Corona and Plasma treatments.
- Adhesion performance of Lightswitch® ETFE to Lightswitch® EVA remains strong even after undergoing the accelerated aging tests required for PV applications.
- ETFE/EVA pre-lamination (Lightswitch Complete) simplifies processing, reduces defects as well as costs.

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This poster contains no confidential information.