

Technical Report

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Subject: HelioBond® PVA 900HM Reliability
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Executive Summary

This document focuses on the current standards for photovoltaic modules, roofing materials, and adhesives with the intention of providing the correlation between the testing performed and field proven performance of materials and equipment that have been in continuous use for 20+ years. The testing shows that the performance of the PVA 900HM meets or exceeds those required for all of the other components in the system. In particular the adhesive far exceeds the requirements of the roofing materials to which it will be bonded.

Testing of PVA 900HM as Compared to Similar Industry Standards

General Test Parameter Notes

All test methods used are industry accepted methods from accredited organizations such as ASTM, FM, and UL/IEC. These test methods are the current industry standards for photovoltaic modules and roofing materials and are used to ensure the long term durability of roofing materials that have and continue to supply 20+ year service lives.

Some sample exposure conditions were chosen in consultation with the shingle manufacturer to answer specific questions regarding the direct attachment of PV modules to their asphalt shingles.

UL/IEC PV Tests for Module Certification

For a module to be certified by UL for use the module must pass a series of tests including tests after exposure to the following environments per UL and IEC standards. To ensure that the adhesive is as robust as the module the PVA 900HM was tested to these same standards. The aging requirements are listed below.

- 24 Hour room temperature control
- 1000 Hours at 85°C/85% relative humidity
- 200 Thermal Cycles: -40°C to 85°C
- 10 Humidity Freeze Cycles: -40°C to 85°C at 85% relative humidity

Testing for UL Relative Thermal Index Rating

Underwriters Laboratories requires that any polymeric material used in an electrical device such as a PV module be proven to withstand the temperatures under which it will operate for an indefinite lifetime. The standard for this testing is UL746C. The testing consists of long term aging at elevated temperature well above that expected during its normal operation. The results of this testing is used to compare the performance to materials that have extended field exposure. The PVA 900HM was placed in an oven for 3725 Hours at 125°C. Under UL protocols this is equivalent to a 95°C thermal rating and is typical of other materials used to construct the PV module.

Technical Report

Roofing Industry Test Standards

As compared to industry standard methods the test parameters chosen for assessing the PVA 900HM were well above the industry standards for current roofing materials. These materials have been in use for over 30 years with an excellent track record.

EPDM roof membrane - ASTM D4637 (116°C for 670 hours)

Asphalt shingles - ASTM D5147 (70°C for 90 days)

Roofing and waterproofing materials – ASTM D5869 (70°C for up to 180 days)

TPO membrane - ASTM D6878 (116°C for 224 days)

Roof membranes (Other than Asphalt) – FM4476 (137°C for 60 days)

ASTM D4637 Standard Specification for EPDM Sheet Used In Single-Ply Roof Membrane

8.15 Dark Oven Heat Exposure

Expose black sheet to dark oven heat at $116 \pm 2^\circ\text{C}$ [$240 \pm 4^\circ\text{F}$] for 670 ± 6.7 hours and non-black sheet for 166 ± 1.66 hours.

ASTM D5147 Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material

13. Heat Conditioning

13.1 This test method determines the effects of heat conditioning on polymer-modified bituminous sheets.

13.1.2 Condition specimens in a forced air oven at $70 \pm 3^\circ\text{C}$ [$158 \pm 5^\circ\text{F}$] for 90 ± 0.25 days in accordance with Practice D5869. Evaluate physical properties before and after conditioning.

D5869 Standard Practice for Dark Oven Heat Exposure of Roofing and Waterproofing Materials

8.1 Expose the specimens in a forced-ventilation oven at $70 \pm 3^\circ\text{C}$ ($158 \pm 5^\circ\text{F}$)

8.3 The duration of exposure of the specimens to the heat shall be selected by the user of this practice from the following options: (1) 35 ± 0.25 consecutive days; (2) 90 ± 0.25 consecutive days; or (3) 180 ± 0.25 consecutive days.

D6878 Standard Specification for Thermoplastic Polyolefin Based Sheet Roofing

7.9 Heat Aging—Test Method D573. Age sheet specimens for 5376 h (224 days or 32 weeks) at 116°C [240°F].
(Equivalent to a 91°C thermal rating)

ANSI/FM Approvals 4476-2014 American National Standard for Flexible Photovoltaic Modules

Appendix D: Determining the Heat Aging Effects of Flexible Photovoltaic Modules on Roof Coverings

Additional Shingle Manufacturer Requirements

During the project the team worked with several major asphalt shingle manufacturers who identified additional conditions above and beyond those in the industry standards noted above .

- 7 Days at 85°C
- 7 Days water immersion at 85°C , 72 Hours 70°C
- 20 Water immersion/freeze cycles

Technical Report

Discussion of Results

The adhesive strength values and results after exposure to the accelerated test conditions above are typical of other tests performed on other substrate/superstrate combinations. The results are comparable to results obtained by PVA 600BT which has been in use for 8 years attaching flexible PVs to low slope roof membranes and metal roof pans. In all cases the conditions chosen and the test results indicate the adhesive is more resistant to the effects of heat and water than the roofing materials to which it will be bonded.

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