TI 144 **Vers. 2.0 e**

HelioSeal® PVS 101

Recommendations for processing / Product Training

Content

The Technical Information TI 144 is about edge seal application and processing instructions for HelioSeal® PVS 101.

1. Preface

The information provided in this technical information is provided for reference and guidance only and is in no way a guarantee of process capability or performance. Due to differences in equipment, materials and module layouts all processes must be optimized and are in the responsibility of the end user.

Since performance of the edge sealant is dependent on cleanliness, packaging system design, assembly technique, and care used during assembly the actual lay-up and lamination processes must be highly controlled and are in the responsibility of the module manufacturer. This includes any determination of suitability for use and service life estimates.

INFO | Contact your **KÖMMERLING** representative for help in designing a PV packaging system for optimal performance.

2. Recommendations for processing

2.1 PV Packaging Steps

- Be sure that all surfaces are clean and free of any dust, grease, oil, deletion dust, fingerprints or other soil or contaminants.
- Apply HelioSeal® PVS 101 to edge of glass being sure to leave sufficient clearance between the edge seal and the edge of the glass for expansion during lamination.
- Place the PV cells, ribbons and busbars in place as appropriate.
- Cut encapsulant to the proper size leaving sufficient gap between the edge seal and the encapsulant to allow for the expansion of the PVS 101 and volume changes of the encapsulant during lamination.

- Place encapsulant inside the bead or tape of HelioSeal® PVS 101 that has been applied to the glass front or back sheet depending on your design.
- Align and set the second sheet of glass or other backsheet material without pressure onto the assembly produced above.
- Laminate according to the recipe provided by the encapsulant supplier. The layup and lamination process should be completed within an hour.
- Inspect the seal for any discontinuities or other defects in the bond line. Adjust the cleaning procedure, edge seal dimensions or lamination conditions to correct any defects.
- Allow completed modules to cure for one week prior to beginning any environmental, output, certification or service life testing. Wet insulation testing may proceed as soon as the module has cooled down after the lamination process.

INFO

All front sheet and back sheet materials must be free of chips, cracks, dents, barrier film tears or other defects in the edge seal area. All components that come into contact with the edge seal must be clean and dry.

Dust from abrasive edge deletion must be completely removed. Laser edge deletion is recommended due to the lack of dust or residues and the pristine condition after the deletion process.

2.2 Design Considerations

- The width of the edge seal after lamination will be determined by PV cell sensitivity and desired service life.
- The thickness of the edge seal after lamination will depend on the internal components and the stress caused by any differential thermal expansion of the front sheet and backsheet.
- Even lamination is important as variations in the thickness between the frontsheet and backsheet will place excess stress on both the encapsulant and the edge seal.
- HelioSeal® PVS 101 should be as nearly flush to the edge as possible to prevent freeze/thaw damage during the module lifecycle.
- The buss bar or lead exit method should be considered early in the design phase of the module as it may have a direct bearing on overall packaging design and edge sealant requirements.
- HelioSeal® PVS 101 tape should not be stretched during the application process.
- The design configuration at the corners may have an effect on the lamination process.
  - When using HelioSeal® PVS 101 in tape form overlapping the edge seal at the corners must be done carefully so as to not trap air between the layers but may be necessary due to the tolerances of typical tape application equipment.
  - When HelioSeal® PVS 101 is dispensed as a hot melt the corner design can be overlapped or continuous based on the automation equipment design. Check with your dispensing equipment supplier for details.
- HelioSeal® PVS 101 should be compressed by approx. 20 % depending on a variety of module details during the lamination process to ensure good bonding and complete wet out. Stippled or

patterned glass may require more compression than flat glass to help evacuate any air that may become trapped in the pattern.

- Minimum application temperature for HelioSeal® PVS 101 in tape form is 21ºC.
- Application of HelioSeal® PVS 101 as a hot melt should be done at temperatures between 110ºC and 140ºC). Check with your dispensing equipment supplier for details.
- The open time for HelioSeal® PVS 101 in tape form is up to 8 hours at 23°C/50% r.H. No more material should be removed from the original packaging than will be used in an 8 hour period.
- Contact your Kömmerling representative during packaging design for consultation and recommendations.

2.3 Edge Sealant Sizing

It is recommended that HelioSeal® PVS 101 be compressed approx. 20% during the lamination process to ensure adequate wet out and adhesion. Please note that the degree of compression will vary with encapsulant type/thickness and lamination parameters.

- Thickness – Initial edge sealant thickness should be approx. 20% greater than the initial encapsulant thickness. This may increase or decrease as lamination processes are optimized.
- Width – Initial edge sealant width is ultimately the responsibility of the end user and is generally a compromise between reliability and photovoltaic device specific criteria. An increase in width (spread) is typical in optimized lamination processes so this should be taken into account when specifying the initial profile.

2.4 Edge Sealant Placement

The placement of HelioSeal® PVS 101 should be optimized so that upon lamination the edge sealant is flush with the edge of the module while minimizing the amount of material “squeeze out.”

- As approx. 20% spread is typical in optimized lamination processes, insetting the edge sealant 0.1 to 0.2 times its initial width is the recommended starting point. For example, edge sealant with an initial width of 10 mm would be inset 1 – 2 mm from the edge of the module as the final width will be ~12 mm.
- Butt and miter joints should be avoided as they increase the risk for an inadequate seal. All joints should be overlapped a minimum approx. 25% of the tape width.

2.5 Encapsulant Sizing

INFO

To allow adequate expansion, compression and wet out of both encapsulant and edge sealant, there should be adequate spacing between the two. Please note that this spacing will vary with encapsulant type/thickness and lamination parameters.

- An initial encapsulant cut size that is approx. 2% smaller than the maximum allowable size is the recommended starting point. For example, for a 250 x 500 mm area (dimensions within the edge sealant) a 245 x 490 mm sheet of encapsulant would be centered within the module lay out. This results in an edge sealant to encapsulant gap of 2.5 mm and 5 mm on the long and short side of the module, respectively.

2.6 PVS 101 Tape and Bulk Considerations

The general process of development requires a number of prototypes and design trials before the final product is locked down. During these trials and any subsequent ramp up to full production the use of pre-extruded tape purchased directly from Kömmerling has the advantage of low capital investment and the ability to easily change production rates and adjust processes. This uncomplicated start up method comes with throughput restrictions and the need to employ additional labor.

INFO | As your volume increases there comes a point where a switch to bulk product and automated dispense and application equipment makes sense from many angles.

Following are the key benefits of using a pumpable bulk solution for PV modules:

- Reduced number of seams/knit lines. Tape application requires the material to knit during the lamination process. The use of pre-extruded tape results in a knit line at each corner. Bulk application can overcome this and the result is a single knit line which can be placed anywhere around the perimeter of the module.
- No need for precisely placed overlaps at the corners. Tape application requires precise placement of the tape at corners to ensure the balance of pressure and material fills the corner while minimizing excesses that will squeeze out and require trimming and laminator blanket cleaning. The choice of dispense equipment, motion control, program flexibility, and tip design can provide precise material placement and eliminate the variability inherent in tape applications.
- Flexibility to adjust dimensions based on internal architecture. Changes in dimension and material deposition can be made instantly by the module manufacturer during the production process. To make minor adjustments when using tape requires a new tape. With a bulk dispensed product these changes can be made through the control programming and varies the deposition as the tip traverses the perimeter. Changes in shape and size, like going from a corner to a back hole mounted J-box, can be accomplished effortlessly and with no change in tape dimension or tape applicator geometry.
- Reduced process changeovers reduce labor, inventory and process variability. Tape handling and application, even when using automated tape applicators, requires more labor for material handling and roll changes per shift and increases the potential for production shut downs and increased variability in module quality. This variability may not manifest itself for years and can have a very negative impact on installed array output. Bulk material requires only infrequent drum changes with no production stoppage.
- Dimensional controls by end user. Multiple designs can be run on existing lines and design changes are instantly accommodated by simply reprogramming the dispense and motion controls. No new tape sizes are needed and mechanical readjustments of tape application heads is necessary.
- Waste reduction. Bulk dispensed edge seal does not generate waste in the form of release liner, cores, desiccant packs or an excessive number of roll containers and other shipping materials.
- Reduction in process steps. Aside from the frequent roll changes the use of tape also demands four distinct steps to apply edge sealant to the module, one for each side assuming that corner

mounted J-boxes are not used. In that case even more steps and different dimension material is needed.

- Assuming that corner mounted J-boxes are not used. In that case even more steps and different dimension material is needed.
- No concern with atmospheric moisture exposure of tapes for desiccant capacity and reactivity. Once tape rolls are removed from the shipping container they are exposed to atmospheric moisture. Any exposure will start consumption of the desiccant and start the crosslinking reaction. If proper care is not used to reseal the shipping container the entire pail can be exposed. Since drums are changed infrequently this exposure is minimized and once under the platen it is again sealed against the effects of the atmosphere.
- Material cost reduction. In addition to the benefits listed above the material cost for using bulk is less than for tape paying for any additional capital expenses of an automated bulk system over an automated tape application system.

INFO

PVS 101 is listed by UL in both bulk and tape forms under the same certification so the switch from tape to bulk is seamless. The product is marked with: ROYAL ADHESIVES & SEALANTS KÖMMERLING

Component - Photovoltaic Polymeric Materials E322031

ADCO PRODUCTS INC

4401 PAGE AVE, P O BOX 457, MICHIGAN CENTER MI 49254

PVS 101 (A) (B)(H)(I)(X)

Polyisobutylene (PIB), Dessicated, "HelioSeal", furnished as pumpable paste or extruded tape on liner

Color	Min Thk (mm)	Flame Class	HWI	HAI	RTI Elec	RTI Imp	RTI Str
BK	0.46	HB	0	1	105	-	105
	1.5	HB	0	1	105	-	105

Comparative Tracking Index (CTI): -

Inclined Plane Tracking (IPT): -

Dielectric Strength (kV/mm): 9

Volume Resistivity (10^X ohm-cm) : 15

High-Voltage Arc Tracking Rate (HVTR): -

High Volt, Low Current Arc Resis (D495): -

Dimensional Stability (%): -

(X) - Represents A, F or S to denote different viscosity levels

A - HB flame rating applies only when material is applied between two layers of glass having minimum thickness 2.25 mm

B - HAI rating applies only when glass having minimum 2.25 mm thickness is applied to one or both sides of material used in the minimum thickness specified

H - RTI ratings apply only when glass having minimum 2.29 mm thickness is applied to both sides of material used in the minimum thickness specified

I - Suitable for outdoor use with respect to exposure to Ultraviolet Light, Water Exposure and Immersion in accordance with UL 746C

ANSI/UL 94 small-scale test data does not pertain to building materials, furnishings and related contents. ANSI/UL 94 small-scale test data is intended solely for determining the flammability of plastic materials used in the components and parts of end-product devices and appliances, where the acceptability of the combination is determined by UL.

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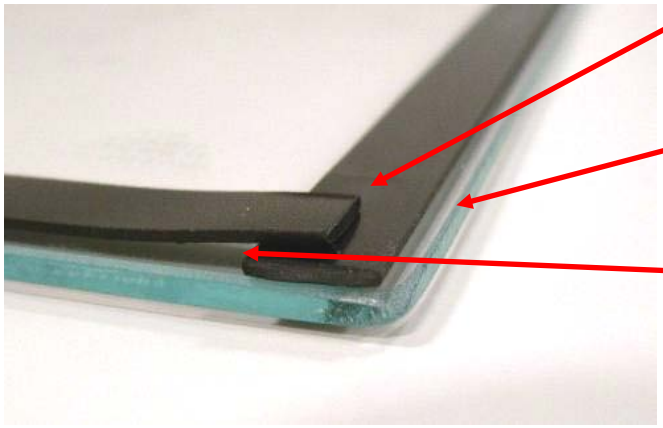
Last Revised: 2012-06-19

3. PVS 101 Application Details

In addition to choosing the best-in-class product for your module sealing needs, proper and consistent application methods are your best guarantee of long term reliability. As outlined above and as can be seen in the pictures showing corner detail great care must be used during module assembly. The following pictures show both good and bad placement of tape and bulk applied PVS 101.

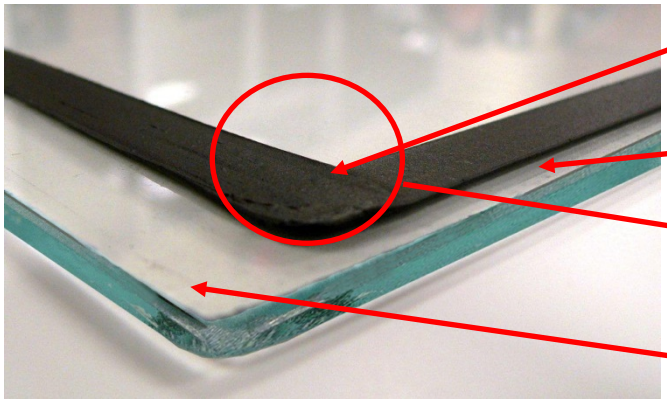
3.1 Corner and Placement Details

PVS 101 Tape Application

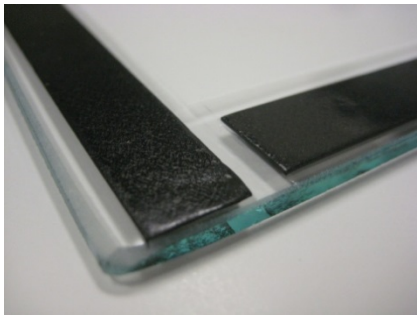
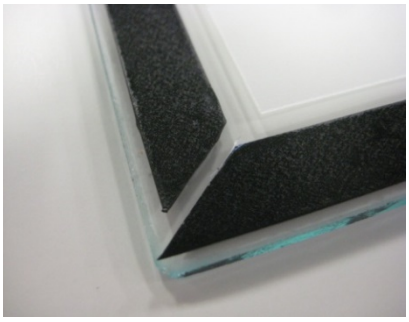
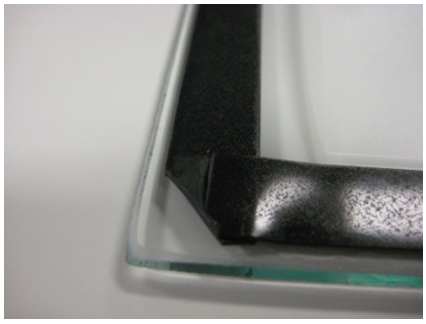


Optimized placement of tape and proper tape overlap will result in PVS 101 being pressed evenly into the corner filling it completely without any material being squeezed out of the module.

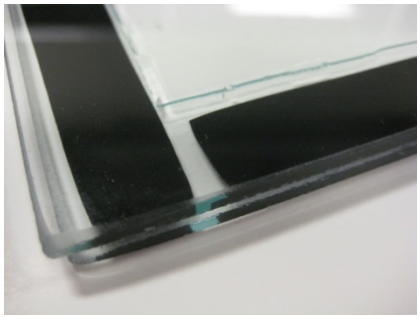
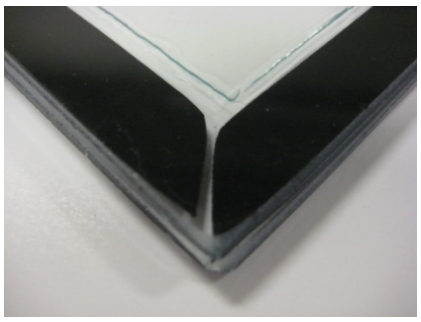
PVS 101 Bulk Dispensed



3.2 Examples of Improper Tape Overlaps in the Corner

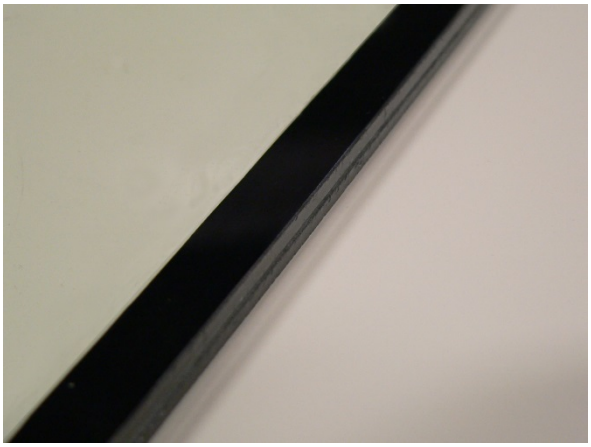




3.3 The Results after Lamination


3.4 Results Achieved with Proper Edge Seal and Encapsulant Spacing

Square corner without squeeze out, minimal internal rounding



Edge seal flush to the edge of the module without squeeze out

INFO

After lamination the interface between the edge seal and the front and back sheets should be free of any defects such as bubbles, dirt, occlusions, voids, or other defects. The encapsulant must not intrude into the edge seal area.

3.5 Lamination Process Parameters

While lamination cycles for most encapsulants are compatible with HelioSeal® PVS 101, excessively high temperatures and pressures can have undesirable results in terms of both excessive squeeze out and high residual stresses in the finished module. It is in the best interest of the end user to develop a lamination process that is as "gentle" as possible.

INFO

A gentle lamination process will; use less energy, have shorter cycle times, reduce tool maintenance costs, increase the process window and produce a module with lower residual stress.

When properly applied HelioSeal® PVS 101 will ensure the longest possible service life for your modules.

4. Additional Information

Your Kömmerling representative can provide you with additional application guidelines including a presentation entitled "Vacuum Lamination Process Development for Photovoltaic Modules" which describes in detail lamination processes using HelioSeal® PVS 101.

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