PV junction box potting agents, bonding & sealing

Technical manual

DUPONT

Fortasun™

Solar Silicones

Introduction

This manual is intended to provide guidance on adhesive/sealant choice and proper application procedures for the DuPont™ Fortasun™, formerly Dow Corning® brand, photovoltaic (PV) materials used in junction box potting, bonding and sealing applications. This manual will aid in developing a basic quality assurance program around the use of adhesives/sealants in solar PV applications that require durability and reliability. The recommendations made in this manual are based on more than four decades of experience.

Leading the way in material solutions

Enough energy comes from the sun in one hour to power the global population for a year! The potential of solar energy is almost limitless as a completely renewable energy source that is not dependent on any fuel for its production. As the PV industry assumes an increasingly important role in meeting the world's energy needs, DuPont is committed to help PV producers grow and succeed.

DuPont is proud to add a new brand to its flagship Tedlar® and Solamet® product lines, introducing DuPont™ Fortasun™ solar silicones.

Built on decades of experience from Dow Corning, our silicone based product line featuring sealants, adhesives and potting agents deliver the exceptional performance and proven reliability expected from DuPont Photovoltaic Solutions. These products have been used in PV applications for 30 years, now you will find them under a new brand name: Fortasun™.

Fortasun™ PV junction box bonding solutions

This section is intended to provide guidance on proper application procedures for the DuPont™ Fortasun™ PV junction box potting agents. This manual will aid in developing a basic quality assurance program around the use of potting agents in solar PV applications that require durability and reliability. Since PV junction boxes vary in design and requirements, this manual cannot be considered a comprehensive guide for every situation.

Fortasun™ PV junction box potting agents are solventless silicone materials designed for potting of solar panel junction boxes. DuPont offers a variety of potting agents in two different cure systems: addition or condensation. These products may be used in different applications, and some are better suited for specific applications over others.

Fortasun™ PV junction box potting agents are available in heat-curing and room-temperature-curing versions. They are supplied as two-part systems consisting of a base and a curing agent for 10:1 mix ratio systems or in two parts (A and B) for 1:1 mix ratio systems. Most of these materials are low viscosity and flow readily around the intricate parts inside the junction box. When properly cured, they form coatings that provide protection from moisture, dirt, shock, vibration and other harsh environmental factors. All are resistant to solar radiation and high temperature. For more information about the products, please consult the product datasheets.

Fortasun™ PV potting agents - addition cure
Addition cure potting agents are supplied in two parts (A and B) that are mixed, usually in a 1:1 ratio. The materials are compatible with automated dispensing equipment. Solventless thick-section cure may be achieved quickly at room temperature or by heating, with minimal shrinkage. There are no volatiles or byproducts produced during the cure of this product.

Fortasun™ PV potting agents - condensation cure
Condensation cure potting agents are materials with broader compatibility than addition cure potting agents for PV substrates and junction box materials. Solventless, thick-section cure is achieved in room temperature with low shrinkage and minimal cure byproducts. These potting agents are supplied in two parts that are mixed in a 10:1 ratio by weight (PV-7321), and in a 6:1 ratio by weight (PV-7326) and are compatible with automated dispensing equipment. Because of cure byproducts, these materials should not be immediately confined since the byproducts should be allowed to disperse to avoid reversion issues.

Fortasun™ PV potting agents are specifically tested for solar applications by verifying performance after standard solar aging conditions. Contact your DuPont representative to discuss your specific needs.

Product Quality

DuPont performs quality assurance testing in our manufacturing facilities in accordance with rigid ISO 9001 standards. This section is intended to provide the end-user with simple screening tests to verify that the material, as received, has not been abused or damaged in transit and is properly maintained until use. The following procedure outlines a series of steps to ensure that the quality of Fortasun™ two-part potting agents will perform adequately.

LAR (lot acceptance requirements tests)
Each batch of material undergoes LAR testing and the results are available on a certificate of analysis (COA).

Recipient (customer) quality verification test
For each batch received, the customer should inspect the package for damage and the label should be checked for product name and "use by" date. When ready to be used, open the drum or pail to verify that there are no contaminants or color changes evident on the product surface. There should be no dirt specks or bubbles. *With materials that are known to separate, there will be a small silicone oil layer on the surface of the material. This pail or drum should be remixed and de-aired before using.*

Shelf life and storage conditions
Silicone potting agents must be stored at the proper temperatures. Check specific products for exact storage information. An expiration date is clearly marked on the product packaging. Potting agents should only be used if they are within the expiration date shown on the package. The product should be kept in its original, unopened packages until it is to be used. Potting agents should be stored indoors in a dry environment. Most of the products are lot-matched. For practical purposes it is best to use the oldest container of material first.

Separate parts must be homogeneous
Prior to placing material into the dispensing equipment, both parts - A and B or the base and the curing agent - should be visually inspected to check for separation. This is usually not a problem, but in the case of materials that have been stored for several months prior to use in production, settling may lead to a clear or oily layer on the top of the material. These materials have not gone bad, but must be remixed by agitation or rolling. If possible, do not incorporate excessive air during the mixing of the individual parts. Medium and high viscosity filled materials are more likely to show separation and should be mixed prior to use. Low viscosity catalyst and materials do not generally require mixing but should be checked in all cases before use. It is recommended to mix the materials one to three days before the pail or drum needs to be changed to allow the material to de-air. In some cases, this static de-airing will not be sufficient to remove the bubbles, and a vacuum de-airing is recommended.

Proper mixing
It is important to accurately measure the two parts according to the ratio given in the product data sheet. A thorough mix is required. Fortasun™ potting agent parts often come in different colors. When properly mixed, the material should appear homogeneous. If the mixing is incomplete there will be problems such as soft or uncured materials. Because mixing can introduce air into the material, it is best practice to use a vacuum chamber to de-air the mixture before application. A vacuum of about 28 inches Hg (948 mbar) is recommended. It is important not to apply vacuum to the mixture so long that the material begins to cure and becomes difficult to pour from the mix container.

General considerations
Quality control is one of the most important elements of a successful process and is the primary responsibility of the applicator. DuPont may assist you in the development of a comprehensive quality control program.

During production, it is good practice to periodically monitor potting agent performance. For example, test a sample at the beginning of each shift or periodically during each day's production. These tests are good practice because they can catch a quality issue prior to a large quantity of units being manufactured. Issues such as under curing or bubbling can sometimes be attributed to the potting agent. However, such issues could also be a result of a change in substrates, an introduction of contamination, or a variety of other factors that occur as a result of process changes.

Substrate preparation procedures

Material preparation
The successful application of potting materials involves the preparation of the material itself as well as the substrate. The cure speed and adhesion to the desired substrate should be monitored. The following procedures will help ensure good potting agent performance. Since Fortasun™ PV potting agents are applied in many different environments and situations, these procedures are not intended to be a complete and comprehensive quality assurance program. Following are the basic steps required for proper potting agent preparation and installation:

1. **Inspect** substrates and materials prior to use. The substrates should be in good condition.

2. **Clean** substrates as further explained in the section that follows. Surfaces must always be clean, dry, dust-free and frost-free. Moisture or contaminants on the surface may have an adverse effect on product adhesion to a substrate.

3. **Place** the unit. Care must be taken to not contaminate cleaned surfaces during any phase of production. Anyone handling the parts should use nitrile type gloves to avoid contamination from skin oils and to avoid poisoning the cure of the potting material caused by latex gloves. If contamination occurs, surfaces must be recleaned. **It may be necessary to apply primer or use plasma treatment on some plastics for good adhesion development during the use of these PV potting agents**.

4. **Apply** product. Avoid air entrapment.

5. **Inspect** the finished junction boxes. Determine whether the box has been properly filled. Determine whether the finished solar panels are stored in the proper conditions, and inspect whether the potting agent is curing properly. Ensure that all of the recommended quality control tests are being performed.

Substrate cleaning procedure
For best results, the junction boxes should be free of grease, oil and other surface contaminants or processing aids, such as plasticizers or mold release agents, before potting.

Common cleaners for substrate preparation include commercially available OS fluids, isopropyl alcohol, toluene or acetone. For most manufactured parts, a quick wipe of the surface is adequate to clean the junction box prior to potting. However, more detailed cleaning methods are outlined in the following paragraphs.

Prior to potting, the junction boxes should be kept in a clean area protected from dust and dirt. They should also be stored at room temperature to prevent moisture condensation or frost from forming on the plastic surfaces. They should not be stored at high temperatures since heat retained in the plastic may cause an undesired accelerated cure of the potting material.

Organic solvent usage
The proper use of solvents is an important part of the surface preparation for substrates. Solvents differ in their effectiveness in removing certain contaminants. Check with the substrate supplier for solvent compatibility.

The solvent used will depend on the type of dirt or oil to be removed and the substrate to be cleaned. Non-oily dirt and dust can usually be removed with a 50% solution of isopropyl alcohol (IPA) and water or pure (IPA). Oily dirt or films may require a degreasing solvent such as xylene, acetone or white spirit.

Please follow the solvent manufacturer's safe handling recommendations and local, state and national regulations regarding solvent usage.

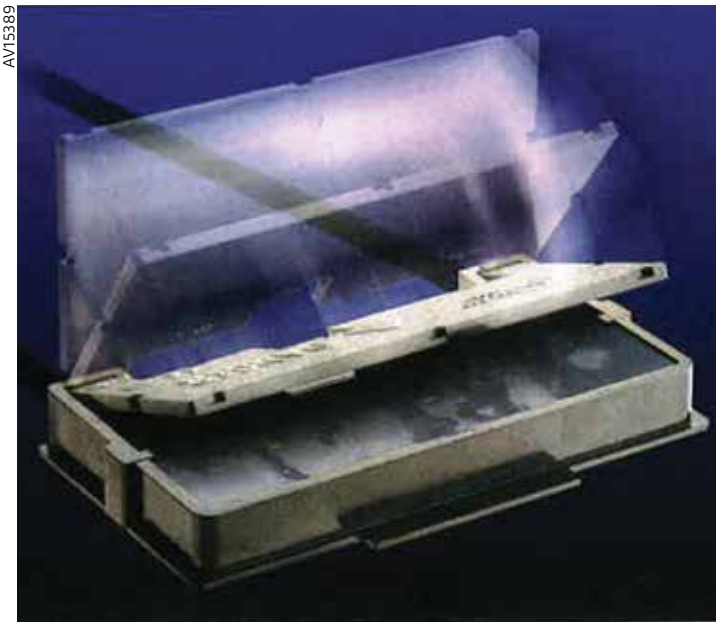
Product application procedures

Fortasun™ PV potting agents can be dispensed manually or by using one of the many different types of meter mix equipment available. Typically, the two components are of matched viscosity and are readily mixed with a static mixer.

The best mixing of these two-part products is achieved using commercially available automated dispensing machines. Most of these machines have tanks or reservoirs for each of the two parts and a static mixer arrangement where the two parts are injected simultaneously into a multi-element replaceable mixing nozzle. For materials that settle over time, the dispensing machines may be provided with agitation tanks. Also, for bubble-free application, it may be best to use a dispensing system that provides vacuum de-airing.

DuPont provides sample size cartridges of most of these products, that are designed to take advantage of the static mixing technology. However, each part (A and B) of these mix cartridges may need to be de-aired to avoid bubbles in the potting material. These samples are for initial screening of the potting materials and may not give results attainable from automated or semi-automated dispensers.

AV15389



Junction box filling recommendations
It is strongly suggested not to overfill junction boxes in order to prevent any detrimental effects of the normal swelling of the potting materials at high temperature. It is generally recommended that the fill be no more than 90%.

Manual mix and dispense
DuPont offers its potting agents in sample-friendly packages for easy evaluation. Most of the materials are two-part products with a 1:1 mix ratio. Samples are packaged into convenient trial cartridges most commonly referred to as dual packs. Dual packs are also referred to as 210 mL cartridges, side-by-side cartridges, mix packs or two-part sample kits. An available technical sheet contains the many details of proper cartridge use. The document (Form No. 06-1051*-01) can be found at photovoltaics.dupont.com. (Note, * represents an alpha character, which indicates the document version.)

Manual dispense units have separate chambers (or cartridges) for each component, which connect to a common static mixer tube. Applying pressure to the plungers on the chambers pushes the material through the static mixer. This can be done manually by squeezing a hand trigger with the use of a hand applicator, or it can be pneumatically powered. Static mixers are typically disposable one-time-use units and may need to be replaced or cleaned before long periods of disuse to avoid having the potting material cure in the mix tube.

When manually mixing and dispensing, a flat spatula or mixing tool should be used since it gives the ability to scrape the sides and bottom of the container. Solar potting agent parts (A and B or curing agent and base) typically come in different colors. Typically, the higher viscosity part is added to the container first (usually part B or the base), followed by part A or the curing agent. Products that are specific gravity matched can be added by either equal weights or equal volumes. A good practice when hand mixing is to first mix a small quantity in a paper or plastic cup to see how long the mixing process takes. Mix until the color of the mixture becomes homogeneous. This mix time and appearance becomes a guide for mixing larger quantities. If the mixing is incomplete there will be problems such as soft or uncured material. Because hand mixing introduces air into the material, it is best practice to use a small vacuum chamber to de-air the mixture for about one minute before application. A vacuum of about 28 inches Hg (948 mbar) is recommended. It is important not to apply vacuum to the mixture so long that the material begins to cure and becomes difficult to pour from the mix container.

Automated meter mix and dispense
Automated meter mix equipment is typically used for higher volume production processes. These systems consist of a separate feed reservoir and pump for each component. The systems are set to achieve the desired ratio of the two components. The materials are then fed through a dispense head attached to a static mixer, that is used to achieve a uniform mix. The dispense head is used to control the amount of material that is dispensed into the part. If the static mixer is shut down for long periods of time, the mixer tubes may need to be replaced as the potting materials may cure in the tubes. If there is air entrapment in the material, it may be necessary to de-air the material in the feed reservoirs. In some products, stirring in the separate reservoirs may also be needed to keep the filler distributed uniformly.

Properly maintain dispensing equipment
It is essential that the user establish a quality program that will ensure that the dispensing equipment is functioning properly. Because there are many different manufacturers of dispensing equipment, maintenance requirements will differ. Requirements common to all equipment manufacturers include:

- Potting agent must be dispensed free from exposure to air. Air incorporated into the potting material may have an effect on the adhesion and performance of the product. Air trapped during the change of potting agent containers must be completely bled out or flushed out of the system prior to use.
- If using a pressure pot to feed the material into a machine, use the lowest pressure possible, and relieve the pressure when the equipment is not running. Excess gas pressure in the head space over the material may cause gas to dissolve into the material, and it will escape as bubbles when the material is dispensed.
- Inspect and maintain components of the dispensing equipment on a regular basis. Air can be incorporated into the product if the pump is defective or gaskets have hardened or are damaged. When using high pressure pumping equipment with a follower plate system, check the follower plate to ensure that it is moving smoothly and will not be blocked by a damaged drum or pail or by a damaged or brittle gasket. Proper maintenance and cleaning of the mixer helps to ensure properly mixed product. Filters and gaskets should be inspected regularly and replaced as necessary.
- Ensure that there is no contamination of product components. Potting agent must not come in contact with machinery oils from the equipment. Pumps must be checked for tightness and oil should not be used on the internal parts. All gaskets must be compatible with the potting materials and any cleaning solvents.
- Regularly maintain gaskets. Some gaskets, especially those in direct contact to the potting agent components, could become brittle or will show a volume increase after prolonged exposure. Deteriorated gaskets must be replaced immediately. Please request gaskets and other components from your equipment supplier. The equipment supplier should also provide a schedule for regular replacement of gaskets. Please contact DuPont if you need specific recommendations.
- If dispense equipment provides for agitation and/or vacuum de-gassing, this additional equipment must be checked according to the manufacturer's recommendations.

Personal protective equipment
Refer to the individual product Material Safety Data Sheets for proper selection of personal protective equipment.

Repairability
In the manufacture of solar modules, salvage or rework of damaged or defective units is sometimes required. It may be necessary to remove Fortasun™ PV potting agents to allow repairs. This can be assisted by cutting away the defective areas or, in extreme cases, by using digestive stripping. In addition, if a small component within the potting material needs to be replaced, a soldering iron may be applied directly through the potting material to remove the component. After work has been completed, the repaired area should be cleaned with forced air or a brush, dried and patched with additional potting agent. Most of the materials are self adhering, and the repaired area should not be different visually or in quality from the original potting application.

Compatability of materials

Junction box
Polycarbonates and polymer blends such as polyphenylene oxide (PPO) and polyphenylene ether (PPE) are typically used to manufacture junction boxes. Each of these types of boxes is versatile, resistant to acids and possesses high dimensional stability and dielectric strength, as well as low moisture absorption. The potting materials may develop adhesion to these materials over time, but as always, the user should verify this through its own testing. In some cases, such as with polycarbonate, unprimed adhesion is rare, so a primer or surface treatment may be recommended by a DuPont representative. Some additional information on these materials is as follows:

- Polycarbonates are a particular group of thermoplastic polymers. This material is a versatile, tough plastic used for a variety of applications. Polycarbonate is lightweight and also features high temperature and impact resistance.
- PPO is a thermoplastic polyether with excellent electrical properties. It is unusually resistant to acids and bases and possesses high dimensional stability as well as low moisture absorption. PPO also has high mechanical and dielectric strength.
- Polymer blends such as PPO and PPE are used with polystyrene injunction box plastic blends. This is one of the most common plastic materials.

An important issue with any of these materials is the design of the junction box itself. While many junction boxes are a single molded piece, many are assembled in molded pieces with sonic welding of separate pieces to the plastic. This separate piece welding does not usually create a hermetic seal. This issue is of particular concern for the UL and IEC wet leakage tests. Care should be taken in the application of sealant and potting materials to be sure this leakage issue is addressed before placing the junction boxes into service.

Backsheets
The encapsulation and backsheet of the solar panel are important to the long life of a PV module. The backsheet is normally a laminated film composite that protects the internal components of the solar module. Two types of common composite backsheets are listed below. The junction box is sealed to these backsheet materials, and the potting material may come in contact with them depending on the junction box design. In many cases, the potting material will develop some adhesion to these backsheet materials over time, but if a manufacturer is relying on this adhesion, the manufacturer should conduct its own tests.

Tedlar®
Tedlar® polyvinylflouride (PVF) is a chemically inert film that remains flexible even with varied temperatures. Tedlar® also has excellent non-stick properties and offers long-term protection against environmental elements. Strong and durable, Tedlar® is also a good moisture barrier and offers excellent electrical insulation.

Polyester
Polyester materials are also used for solar module backsheets. Polyester offers excellent electrical insulation and mechanical properties. It is cut-through and tear-resistant, easy to handle and has good dimensional stability.

Other materials
As technology develops, other backsheet materials are coming onto the solar market. For example, some polyesters with thin aluminum or SiOx barriers have been introduced.

DuPont test lab capabilities

DuPont offers a wide variety of test capabilities to help ensure that the potting agent you choose for your application will perform as your design requires. Below is a description of the most common tests performed.

Adhesion testing
Adhesion testing may be done through the use of a tensile tester so that adhesive forces and failure modes can be analyzed. For soft materials, a simple peel test is used to verify cohesive failure. This means that the structure of the potting material will fail before the adhesion to the substrate. To the contrary, adhesive failure means that the adhesion to the substrate is weaker than the mechanical strength of the potting agent. A cohesive failure typically demonstrates the good adhesion to the substrate. Substrates should be tested with the proper product to validate adhesion. DuPont will evaluate the adhesion of its products to materials representative of those being used with a modified ASTM C794 peel adhesion test.

In some cases, such as with the use of highly engineered plastics like polycarbonates, it may be necessary to use primers or other surface treatments, to gain good adhesion with the potting material. Primers or surface treatments such as corona or plasma, may be needed. Other techniques may also be available, and these should be checked with a DuPont representative.

Material compatibility
There are a wide variety of cure mechanisms in the various families of silicone products, and some of these will be affected by certain substrates and other chemistries. It is important to check compatibility of all the elements of the junction box including wire, solders, solder fluxes, metals and the exterior sealant applied to adhere the junction box to the back of the solar panel.

Cure poisoning
Cure poisoning may be a problem with addition cured materials as cure poisoning is caused by the contamination of platinum catalysts with trace quantities of certain types of chemicals, typically at the surface. These chemicals interfere with the cure reaction and thus prevent conversion of material to a solid.

Extremely small quantities of contaminants may be sufficient to produce this effect.

Fortunately, only a small number of material types can cause cure poisoning. However, once a contaminant attaches to the platinum, any negative effects on the cure are permanent.

Certain materials, chemicals, curing agents and plasticizers can poison the cure of addition cure pottants. Some materials which can inhibit cure are:

- Organotin and other organometallic compounds
- Silicone rubber containing organotin catalyst
- Sulfur, polysulfones or other sulfur-containing materials
    - Latex and natural rubber
- Junction box cables made with these materials
- Amines, urethanes or amine-containing materials
- Unsaturated hydrocarbon plasticizers
- Some solder flux residues

If a substrate or material is suspected to be causing poisoning of cure, it is recommended that a small-scale compatibility test be done. A portion of the part containing the suspect material is placed in a clean dish . The dish is then processed by the desired cure method . A control dish without the part can be compared to the dish with the suspect part. The presence of liquid or uncured

product at the interface between the questionable substrate and the cured gel indicates incompatibility and poisoning of cure. These same considerations apply to other tools used in the processing of the materials. Equipment such as stirrers, funnels and mixing containers will sometimes pick up and retain residual contaminants. They should be scrupulously cleaned before being used with addition cure materials. One of the most common sources of cure poisoning is the use of latex gloves at or near the potting material.

Other possible cure poisoning may be caused by the use of an incompatible sealant to adhere the junction box to the back of the solar panel. It is possible that a sealant containing sulfide or amino adhesion promoters or various tin components, such as found in oxime sealants, may poison the cure of addition cure pottants. A simple test for this is to deposit a small ring of sealant on a piece of glass and pour a small amount of potting material within the ring. If after several hours of cure, there is a liquid area between the sealant and the potting, then the sealant is poisoning the pottant cure.

Contamination
One common source of contamination is mold release agents that may not be visible to the naked eye but are present at the surface of molded plastics. They are used to assist with the de-molding of complex plastic pieces such as a junction box. Less common is a buildup of dust or dirt contamination that will interfere with adhesion. This will probably be visible and if discovered should be followed with cleaning of the junction box.

Working time
Working time (or pot life) is the time required for the initial mixed viscosity to double at room temperature. For two-part products, the cure reaction begins when the parts are mixed. As the cure progresses, viscosity increases until the material becomes a soft gel. Cure conditions are shown in product data sheets. Full cure is defined by the T90 test, which is the time required for a material to reach 90% of its final properties. Gels will reach a no-flow state prior to full cure. Cure schedules should be verified in each new application.

Durability
Fortasun™ PV potting agents provide added protection to junction box diodes. Dissipating heat is critical to avoid over heating and to extend the lifetime of the diodes. In addition, the potting agents provide humidity protection and function as durable dielectric insulation over a wide range of temperatures.

Dielectric properties
Dielectric compounds and electrical insulation materials are used to form a barrier or isolator between electrical or electronic components. The system voltage potential between the conductor and conductive components will influence material selection based on the dielectric strength in order to prevent shorting. Dielectric strength information is provided on most of the potting materials' information sheets. In general, silicone materials are non-conducting and are good dielectrics.

Other tests
Customer specified tests may be available at Solar Application Centers. Contact a DuPont representative. These tests may include aging tests as defined in standards ULl 703, IEC61215 and IEC61646.

Potting agent functionality

Environmental protection
Fortasun™ PV potting agents function as barriers against environmental contaminants over wide temperature and humidity ranges.

Electrical insulation
As previously discussed, most silicones have excellent dielectric properties. Dielectric strength is normally reported in kilovolts per mm of thickness, but other electrical tests may be available on request.

Thermal conductivity
Potting materials have been successfully used to mitigate the effects of diode heating with conductivities as low as 0.15 W/mK. By contrast, the thermal conductivity of air in a non-potted junction box is 0.02 W/mK to 0.03W/mK.

Temperature stability
Silicones are generally known to be stable in the temperature range of -50°C to +180°C and thus well within the range of the UL and IEC specified age testing of solar panels from -40°C to 90°C.

Industry standards

UL 94 certification testing
Because the potential flammability of the junction box is a concern in the solar industry, all Fortasun™ PV potting agents are designed to obtain an acceptable rating defined by the UL 94 flammability testing standards.

Other UL testing
Due to the material property requirements of the UL 1703 test standard for solar panels, DuPont tests all of its potting agents according to the UL 746 standards. All materials undergo the short term tests as outlined in UL 746A. Many will also undergo the longer term testing as in UL 746B. Currently, all the potting materials are tested for UL 94 flammability ratings, HAI, HWI and CTI short term electrical tests.

Consult the UL website to see the testing result on the potting materials.

Fortasun™ PV junction box bonding solutions

This section is intended to provide guidance on material choice and proper application procedures for the Fortasun™ junction box adhesives/sealant for PV bonding applications. This manual will aid in developing a basic quality assurance program around the use of junction box adhesives/sealants in solar PV applications that require durability and reliability. Since PV junction boxes vary in design and requirement, this manual should not be considered a comprehensive guide for every situation.

DuPont offers a variety of products to meet your specific application needs - from the industry-proven conventional solutions to innovative, fast, higher efficiency product solutions. These products may be used in different applications and some are better suited for specific applications over others.

Fortasun™ PV adhesives/sealants are tested to meet PV industry standards and provide durable adhesion between junction box materials (including polycarbonate PPO) to backside construction of the PV panels (glass fluoropolymer laminates, such as Tedlar® laminates, polyester). Also, the adhesives/sealants are tested under long-term continuous outdoor conditions against moisture, environmental attack, mechanical and thermal shock, and vibration. Several products have been certified or are pending UL 94 and UL 746 A, B, C.

Fortasun™ PV junction box adhesives/sealants - one-part room temperature cure

One-part PV junction box adhesives/sealants have been used successfully for over 30 years. One-part materials come by reaction with water vapor from the ambient atmosphere . The cure reaction progresses deeper into the joint by diffusion of water vapor. Typical cure times range from 24 hours to 14 days depending on the joint depth. One-part materials are easy to apply manually or automatically. Equipment costs are lower for dispensing compared to two-part material. The adhesive/sealant cannot support load until cure is completed. The adhesive/sealants should not be exposed to environmental aging or submitted to a certification body until full cure, which takes at least seven days.

DuPont offers multiple PV adhesives/sealants that can meet your specific requirements. Please consult the Fortasun™ Photovoltaic Module Assembly Selection Guide - Form Number 06-1 016*-0l. (*Version update identified by alpha character.)

Fortasun™ PV junction box adhesives/sealants - two-part room temperature cure

Two-part silicone solution for PV junction box adhesives/sealants are supplied as two separate parts - base and catalyst. Appropriate pump equipment is required to meter and mix the component before dispensing. Two-part components typically cure within a few hours of dispensing, and a finished unit may be handled 30 minutes after assembly and installed within 48 hours **depending on your individual process and design**. The ability to rapidly complete production will reduce the need for large space requirements for work-in-process inventory. The adhesives/sealants should not be exposed to environmental aging or submitted to certification agency until full cure.

DuPont offers fast-cure and ultra fast-cure sealants to meet your specific application need. Please consult the Fortasun™ Photovoltaic Module Assembly Selection Guide —Form Number 06-1016*-01.

Product quality

DuPont performs extensive quality assurance testing in its manufacturing facilities in accordance with ISO 9001 standards. This section is intended to provide the end-user with simple screening tests to verify that the material, as received, has not been abused or damaged in transit and is properly maintained until use. The following procedure outlines a series of steps to ensure that the quality of Fortasun™ PV junction box adhesives/sealants will perform adequately.

LAR (lot acceptance requirements tests)

Each batch of material undergoes LAR testing and the results are available on a certificate of analysis (COA).

Recipient (customer) quality verification test

For each batch received, the customer should inspect the package for damage, and the label should be checked for product name and use by date. When ready to be used, open the drum or pail to verify that there are no contaminants or color changes evident on the product surface. There should be no dirt specks or bubbles.

Shelf life and storage conditions

The materials must be stored at the proper temperatures. Check specific products for exact storage information. A “use by” date is clearly marked on the product packaging. The materials should only be used if they are within the expiration date shown on the package. The product should be kept in its original, unopened packages until it is to be used. The material should be stored indoors in a dry environment. Most of the products are lot-matched. For practical purposes it is best to use the oldest container of material first.

Catalyst must be homogeneous
Prior to placing material on the dispensing equipment, the catalyst should be visually inspected and agitated in the pail to ensure homogeneity. Do not incorporate excessive air during mixing of the catalyst. It is recommended to mix the catalyst one to three days before the pail needs to be changed to allow the catalyst to de-air.

General considerations
During the production of solar panels, it is good practice to periodically monitor the performance of the adhesives/sealants. These tests can catch a potential quality issue prior to a large quantity of units being manufactured. Quality issues could be attributed to the material, and issues such as undercuring, insufficient adhesion or bubbling may be a result of a change in substrates or could represent an introduction of contamination or a variety of other factors that might occur as a result of process changes.

Substrate preparation procedures

Every bonding application requires a diligent and thorough procedure to ensure that substrates are properly cleaned prior to adhesive/sealant application. The following procedures should be followed for every bonding application. Further description of the cleaning is included in the subsequent section.

1. **Inspect** substrates and materials prior to use. The substrates (e.g., aluminum profiles) should be in good condition.

2. **Clean** substrates. Surfaces must always be clean, dry, dust-free and frost-free. Moisture or contaminants on the surface may have an adverse effect on adhesive/sealant adhesion to a substrate.

3. **Place** the unit. Care must be taken to not contaminate cleaned surfaces during any phase of production. Anyone handling the parts should be using gloves to avoid contamination from skin oils and to avoid poisoning the cure of the adhesive/sealant caused by latex gloves. If contamination occurs, surfaces must be re-cleaned. It may be necessary to apply primer or use plasma treatment on some substrates to develop good adhesion during the use of these adhesive/sealant materials.

4. **Apply** product. Avoid air entrapment

5. **Inspect** the junction boxes. Determine whether the boxes have been properly bonded. Determine whether the finished solar panels are stored in the proper conditions and inspect whether the adhesive/sealant is curing properly. Ensure that all of the recommended quality control tests are being performed.

Substrate cleaning procedure
The key to acceptable adhesive/sealant adhesion is a clean surface. Following are proven procedures to clean non-porous substrates.

Substrates such as glass, PPO and backsheets must be clean prior to application of material. One of the best cleaning methods is accomplished by the two-cloth cleaning method. The two-cloth cleaning method is described later in this section. Always confirm with the supplier of each substrate that the cleaning procedures and solvents are compatible with their materials.

Organic solvent usage
The proper use of solvents is an important part of the surface preparation requirements for substrates. Solvents differ in their effectiveness in removing certain contaminants. Check with the substrate supplier for solvent compatibility with their materials.

The solvent used will depend on the type of dirt or oil to be removed and the substrate to be cleaned. Non-oily dirt and dust can usually be removed with a 50% solution of isopropyl alcohol (IPA) and water or pure IPA. Oily dirt or films may require a degreasing solvent such as xylene, acetone or white spirit.

Please follow the solvent manufacturer's safe handling recommendations and local, state and national regulations regarding solvent usage.

Two-cloth cleaning method
The two-cloth cleaning method is one of many techniques to clean surfaces. The use of one cloth to clean a substrate is not as effective as two cloths and is not a recommended procedure. Clean, soft, absorbent lint-free cloths must be used. This method consists of cleaning the substrate with a solvent-saturated cloth followed by a drying wipe with a separate clean cloth. Following is the procedure described in greater detail.

1. Thoroughly clean all surfaces of loose debris.

2. Pour a small quantity of cleaning solvent into a working container. A clear plastic solvent-resistant squeeze bottle works best for this purpose. Do not apply solvent directly from the original container. Saturate clean cloth with solvent.

3. Wipe the joint surfaces with sufficient force to remove dirt and contaminants.

4. Immediately wipe dry the solvent-wet surface of the substrate with a separate clean, dry cloth. The second cloth must wipe the substrate before the solvent has evaporated.

5. Visually inspect the second cloth to determine if contaminants were effectively removed. If the second cloth remains dirty, repeat the "two-cloth cleaning method" until the second cloth remains clean. For each subsequent cleaning, rotate each cloth to a clean portion of the cloth. Do not clean with the dirty portion of the cloth. For best results, replace used and dirty cloths frequently.

Product application procedures

Properly maintain dispensing equipment
It is essential that the user establish a quality program that will ensure that the dispensing equipment is functioning properly. Because there are many different manufacturers of dispensing equipment, maintenance requirements will differ. Requirements common to all equipment manufacturers include:

- The materials must be processed in a closed system free from exposure to air. Air incorporated into the material may have a severe detrimental effect on adhesion and performance. Air trapped during the change of the material containers must be completely bled out or flushed out of the system prior to use.
- Regularly inspect and maintain components of the dispensing equipment. Air can be incorporated into the material if the pump is defective or gaskets have hardened or are damaged; this will allow air into the system. When using high pressure pumping equipment with a follower plate system, regularly check the follower plate to ensure that it is moving smoothly and will not be blocked by a damaged drum or pail or by a damaged or brittle gasket. Proper maintenance and cleaning of the mixers helps to ensure properly mixed material. Filters and gaskets should be regularly inspected and replaced as necessary.
- Ensure that there is no contamination of material components. Adhesives/sealants must not come in contact with machinery oils from the equipment. Pumps must be checked for tightness and oil should not be used on the follower plates. All gaskets must be compatible with the adhesives/sealants and any cleaning solvents.
- While cleaning machine parts and lines, ensure that the solvent does not contaminate the material. All gaskets must be compatible with the cleaning solvent.
- Regularly maintain gaskets. Some gaskets, especially those in direct contact with the material components, could become brittle or will show a volume increase after prolonged exposure. Deteriorated gaskets must be immediately replaced. Please request from your equipment supplier gaskets and other components that are compatible and recommended for use with Fortasun™ PV junction box adhesives/sealants. The equipment supplier should also provide a schedule for regular replacement of gaskets. Please contact DuPont if you need specific recommendations.
- If dispense equipment provides for agitation and/or vacuum de-gassing, this additional equipment must be checked according to the manufacturer's recommendations.

Maintain proper production facility temperature
Ambient temperature in the production facility must be between +10°C and +40°C. For best performance, maintain a temperature of between +18°C and +30°C. At colder temperatures, between +10°C and +18°C, cure rate and adhesion development will be slower. In higher temperatures, between +30°C and +40°C, working time will be shorter.

Processing
DuPont has successful, demonstrated experience working with production-scale junction box bonding solutions and has developed long successful contacts with equipment suppliers. DuPont will be pleased to make recommendations according to your specific needs and work with your preferred supplier. Please contact DuPont for more information.

Glue line design considerations
It is the responsibility of the manufacturer to determine the appropriate bead size, adhesive/sealant bite and thickness (glue line thickness) for their specific design and application based on performance properties listed on the specific material data sheet of the Fortasun™ PV junction box adhesives/sealants selected.

Glue line bite
Glue line bites are determined by the required junction box pulling strength. Typically it can require 8 mm to 13 mm per junction box depending on the design. Too small of a glue line bite may cause insufficient bonding strength . Too small of a glue line bite can also compromise the adhesive/sealant's ability to protect connections during wet leakage testing. Too large of a glue line bite does not compromise the performance of the adhesive/sealant, but it may cause longer cure times and unfavorable economics.

Glue line thickness
Glue line thickness typically needs to measure more than 1 mm. Too little glue line thickness may cause inability to relieve thermal expansion between junction boxes and backside construction; and it may compromise the adhesive/sealant's ability to protect connections during wet leakage testing.

Glue line fillet
Glue line fillet is required to protect the connections from water ingression during wet leakage testing. The amount of adhesive/sealant is recommended and illustrated in Figure 1 on the following page.

Excessive fillet is not usually required. It slows curing of deep sections and is also economically unfavorable.

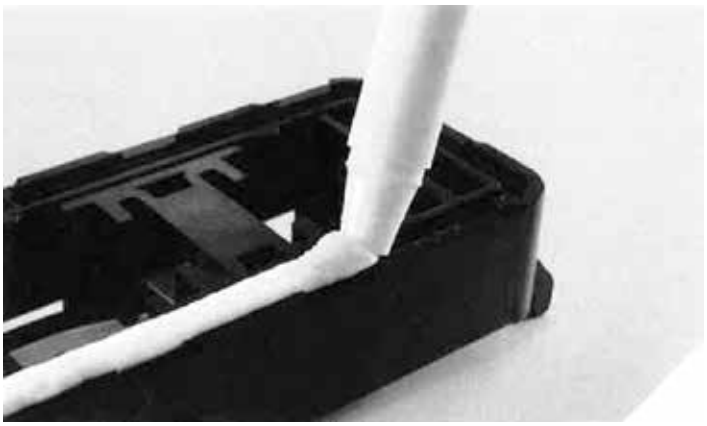


Figure 1 Amount of adhesive/sealant recommended

After the design process, critical attention should be given to the application process to verify a uniform, consistent bead is applied around the entire perimeter of the junction box with no skips, thin spots or shallow areas in order to prevent water ingress. If the application equipment is not robust enough to ensure a consistently applied minimal glue line profile in width and thickness per the design calculations, a factor of safety should be applied that increases the overall bead size so that minimum conditions are met at the worst case situations.

Care should be taken during the manufacturing process to ensure that glue line thickness is not reduced below the design requirements. Excessive adhesive/sealant compression during junction box placement can cause the glue line thickness to be reduced to a level in which movement may exceed the material's movement capacity. Some thickness is important so that the material performs as a sealant and not simply as an adhesive.

Avoid excessively high humidity
The PV junction box adhesives/sealants will cure faster and have a shorter working time in higher relative humidity environments. Excessively high humidity (>80%) could cause condensation on the substrate surface and adversely affect material adhesion. To minimize moisture damage to the individual material components, pails and drums must be kept airtight during storage and after being placed on the dispensing equipment. When using a pressure pot, the air inside the drum or pail must be filtered and dried (silica gel filters are recommended).

Cure Requirements
PV junction box adhesives/sealants cure by reaction with water vapor in the air. The cure reaction progress deeper into the joint by diffusion of water vapor. Typical cure times range from 24 hours to 14 days depending on the cure depth.

All PV junction box adhesives/sealants, whether one- or two-part, require exposure to atmospheric moisture to cure. In a closed container or concealed joint that is not exposed to atmospheric moisture, sealant cure will be slow to nonexistent. The material adhesion will only occur if the material is allowed to fully cure. Please ensure that the material joint is fully exposed to the environment.

Two-part dispensing equipment guidelines
When Fortasun™ PV junction box adhesives/sealants are properly applied, they will provide excellent long-term adhesion and durability.

Fortasun™ two-part PV junction box adhesives/sealants require correct mixing by the sealant user to achieve intended performance. State-of-the-art technology for the application of two-part sealants uses an appropriate pumping, metering and mixing machine with either a dynamic or static mixer.

There are several different suppliers for such equipment. The dispensing machines available in the market are all different in design; therefore, DuPont strongly recommends that the user follow the equipment supplier's guidelines regarding the proper use and maintenance of the dispensing equipment.

Compatibility of materials

Junction box
Polycarbonates and polymer blends such as polyphenylene oxide (PPO) and polyphenylene ether (PPE) are typically used to manufacture junction boxes. Each of these types of boxes is versatile, resistant to acids and possesses high dimensional stability and dielectric strength, as well as low moisture absorption. The adhesives/sealants may develop adhesion to these materials over time, but as always, the user should verify this through his or her own testing. In some cases such as polycarbonate, unprimed adhesion is rare, so a primer or plasma treatment may be recommended by a DuPont representative.

- Polycarbonates are a particular group of thermoplastic polymers. This material is a versatile, tough plastic used for a variety of applications. Polycarbonate is light weight and nearly unbreakable. It also features high temperature and impact resistance.
- PPO is a thermoplastic polyether with excellent electrical properties. It is unusually resistant to acids and bases and possesses high dimensional stability as well as low moisture absorption. PPO also has high mechanical and dielectric strength.
- Polymer blends such as PPO and PPE are used with polystyrene in junction box plastic blends. This is one of the most common plastic materials.

An important consideration with any of these materials is the design of the junction box itself. While many junction boxes are a single molded piece, many are assembled in molded pieces with sonic welding of separate pieces to the plastic. This separate piece welding does not usually create a hermetic seal and some junction boxes of this design will leak. That is, low viscosity potting materials may leak out of the junction box, and, conversely, moisture and water may leak into the junction box. This issue is particularly a concern for the UL and IEC wet leakage tests. Great care should be taken in the application of sealant and potting materials to be sure this leakage issue is addressed before placing the junction boxes into service.

Backsheets
The encapsulating system and the backsheet of the solar panel are the components most responsible for the long life of a PV module. The backsheet of the module is normally a laminated film composite, protecting the internal components of the solar module. Two types of common composite backsheets are listed below. The junction box is sealed to these backsheet materials and the materials may come in contact with the backsheet to a greater or lesser degree depending on the junction box design. In many cases, the adhesive/sealant will develop some adhesion to these backsheet materials over time, but if the manufacturer is relying on this adhesion, the manufacturer should conduct their own tests.

Tedlar®
Tedlar® polyvinylflouride (PVF) is a chemically inert film that remains flexible even with varied temperatures. Tedlar® also has excellent non-stick properties and offers long-term protection against environmental elements. Strong and durable, Tedlar® is also a good moisture barrier and offers excellent electrical insulation.

Polyester
Polyester materials are also used for solar module backsheets. Polyester offers excellent electrical insulation and mechanical properties. It is cut-through and tear resistant, easy to handle and has good dimensional stability.

Other materials
More and more backsheet materials are coming onto the solar market since some early materials were expensive and in some cases in short supply and others were proven to be ineffective. New materials, such as some polyesters with thin aluminum or SiOx barriers, are being introduced, and testing should be performed to determine compatibility.

DuPont test lab summary

DuPont offers a wide variety of test capabilities to help ensure the adhesives/sealants you choose for your application will perform as your design requires. Following is a description of the most common tests performed.

Skin-over time/elastomeric test
For one-part PV junction box adhesives/sealants, a skin-over and elastomeric test should be performed once per week and on every new lot of material used. The purpose of this test is to check the materials working time and to ensure the material cures fully. Any excessive variation in the skin-over time may indicate a material has been affected by environmental conditions or is potentially out of shelf life.

The test is performed as follows

1. Spread a bead of material into a 0.04-inch (1mm) thick film on a sheet pf polyethylene.

2. Every few minutes, touch the material film lightly with a clean tool of folded-over piece of polyethylene.

3. When the material does NOT adhere to the tool, the material is said to have skinned over. Note the time required to reach this point. If a skin has not formed within three hours, do not use this material and contact DuPont.

4. Allow the material to cure for 24 hours. After 24 hours, peel the material from the polyethylene sheet. Stretch the material slowly to verify complete cure. Release the stretch and check to see that it returns to approximately the original length. If the material has not cured, or the sample does not demonstrate typical elastic behavior, contact DuPont.

Peel adhesion test
The peel adhesion test is the most effective daily test to verify sealant adhesion to a substrate. This simple screening test should be used as the daily test to verify adhesion of sealant to a substrate. This test should be performed on all substrates to which the sealant is expected to have adhesion at the following intervals:

- After each pump start-up or after extended breaks
- After a change of the catalyst or base container
- For each new lot of substrate

Following is a description of the peel adhesion test:

1. Clean and prime the substrate as recommended by DuPont and exactly the way the production units will be prepared.

2. Place a piece of polyethylene sheet or bond breaker tape across the flat surface.

3. Apply a bead of sealant and tool it to form a strip approximately 20 cm long, 1.5 cm wide and 6 mm thick. At least 4 cm of the sealant should be applied over the polyethylene sheet or bond breaker tape.

4. It is best to embed a wire mesh halfway within the body of the sealant. For best results, solvent clean and prime the screen to ensure good adhesion to the wire mesh. If wire mesh is not available, reliable results can still be achieved.

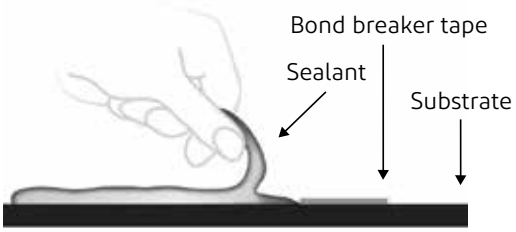
5. After sealant cure, grasp the 4 cm tab of sealant which overlays the polyethylene sheet. Pull the sealant at a 180° angle. Peel back only 1 to 2 cm of sealant leaving the remainder in place for additional testing.

6. If the sealant tears within itself and remains fully bonded to the substrate, this is called "cohesive failure." 100% cohesive failure is desirable since this indicates that the strength of adhesion is greater than the strength of cohesion.

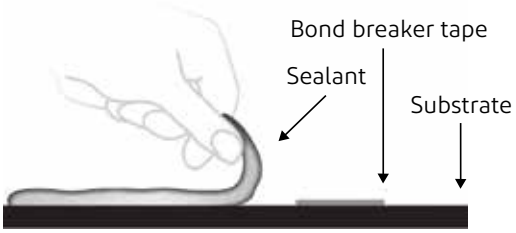
7. If the sealant releases from the substrate, the sample indicates 100% adhesive failure (or 0% cohesive failure). Since sealant adhesion develops over time, repeat the test after an additional 24 hours of cure. Continue until 100% cohesive failure is achieved. If adhesion does not develop as expected, contact DuPont.

For anodized aluminum and when 100% cohesive failure is recorded in dry conditions, place the initial peel test under water for 15 minutes at room temperature. Remove the sealant from the water and again start the peel testing procedure. 100% cohesive failure in wet conditions is required. If adhesion does not develop as expected, contact DuPont.

An improved approach is to use a mechanical peel tester to give quantitative peel strength, and if the peel strength is above the required minimum, the failure made is of less importance.



Peel adhesion test: cohesive failure



Peel adhesion test: adhesive failure

AV13884

Substrate suitability and adhesion

All Fortasun™ PV junction box adhesives/sealants are designed for adhesion to typical substrates, but all substrates should be tested before the proper product is chosen. DuPont will evaluate the adhesion of our products to materials representative of those being used on your job using a modified ASTM C794 peel adhesion test. Contact DuPont to arrange for this testing.

In some cases, such as with the use of highly engineered plastics such as polycarbonates, it may be necessary to use primers or other surface treatments to gain good adhesion with the adhesive/sealant. Primers such as Sylgard® Prime Coat and surface treatments such as corona or plasma may be needed. Other techniques may also be available, and these should be checked with a DuPont representative.

Material compatibility

There are a wide variety of cure mechanisms in the various families of silicone products and some of these will be affected by certain substrates and other chemistries. It is important to be sure all the elements within the junction box - including wires, solders, solder fluxes, metals, and the exterior adhesive/sealant applied to adhere the junction box to the back of the solar panel are checked for compatibility.

Cure rates

Cure time can be best approximated by fabricating several small samples that replicate the final product. These test specimens should be cured along with regular units. As time elapses, these samples are cut apart to determine the degree of cure as a function of time. Additionally, the samples can be used to check the adhesion of the adhesive/sealant to the substrates.

The cure rate of room temperature cure silicones is affected by temperature and humidity. This is especially true of one-part products that may only cure at the surface.

Quality assurance of material

Qualification and quality control

Comprehensive qualification and quality control programs are the most critical elements of a successful adhesive/sealant solution. DuPont provides procedures and recommendations that must be completely understood and followed by the material user. These procedures are proven to be effective and reliable.

DuPont performs extensive quality assurance testing in our manufacturing facilities in accordance with rigid ISO 9001 standards. This section is intended to provide the end-user with simple screening tests to verify that the material, as received, has not been abused or damaged in transit. The following chart outlines a series of tests to ensure that Fortasun™ PV Junction box adhesives/sealants will perform adequately.

Sealant production QC test	Frequency of test		
	After each pump start-up	After each container change	Diagnostic investigation
Glass test	Required[1]	Required[1]	Required
Butterfly test	Required[1]	Required[1]	Required
Snap time test	Required	Required	Required
Mixing ratio test	Not required	Not required	Required

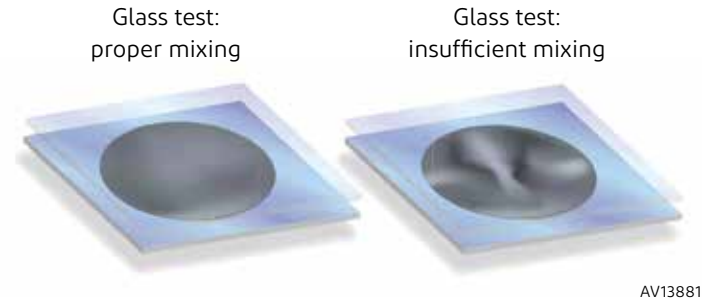
[1] Either the glass or butterfly test must be performed at the scheduled frequency. It is not required that both tests are performed.

Glass test

The glass test is a procedure used to evaluate the mix of two-part silicone sealants. This test is performed each time a pump starts up and after either the catalyst or base container is changed. The purpose of this test is to determine whether the two-part dispensing equipment is adequately mixing the sealant base and catalyst.

When properly mixed, the finished sealant is either black or white, with no streaks. Improper mix can be the result of a damaged check valve, a clogged hose, a clogged mixer, etc. Regular equipment maintenance will help to ensure proper sealant mixing. Please consult with your dispensing equipment manufacturer for maintenance guidelines.

To perform the glass test, apply a bead of sealant to a clean, clear glass sample that is approximately 10 cm x 10 cm. Place another clean, clear glass sample on top of the silicone, pressing the two pieces of glass together. In the case of the black catalyst, the resulting sandwiched sealant should then be visually inspected for white streaks. The sealant should appear completely uniform and black. If results are negative, perform the test again after additional material is processed through the machine. It the results are negative again, equipment maintenance may be necessary. If additional assistance is required, please contact DuPont.



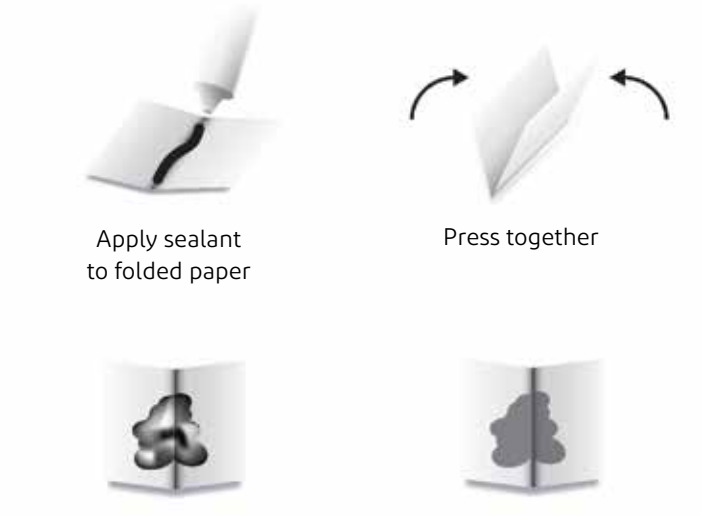
AV13881

Butterfly test

The butterfly test is a procedure that is similar to the glass test. This test is performed at each pump start-up and after either the catalyst or base container is changed. The purpose of this test is to determine whether the two-part dispensing equipment is adequately mixing the sealant base and catalyst.

Following is the procedure for performing a butterfly test:

1. Fold a sheet of stiff, white A4 (or 8.5" x 11") paper in half.
2. Apply a bead of sealant to the fold in the paper.
3. Press the sheet of paper together compressing the sealant into a thin film.
4. Pull the paper apart and visually inspect the sealant for indications of poor mix.



AV13879

Snap time test
Once proper mixing of the sealant is established by the glass test and/or butterfly test, a snap time test must be performed for two-part sealants. This test is performed each time a pump starts up and after either the catalyst or base container is changed. The snap time test helps to determine if the mix ratio is correct and whether the sealant is curing properly. Mixed sealant will handle like a one-part sealant until the chemical reaction between the base materials and catalyst begins to take place. The sealant will in a matter of minutes begin to "snap" and begin to show elastomeric or rubber properties.

Following is the procedure for the snap time test:

1. After proper mixing of the base and the catalyst, fill a small container with sealant.

2. Place a small stick or spatula into the sealant. Record the time (starting at the beginning of the mix). Every few minutes, pull the stick or spatula out of the sealant. Do not stir or agitate the sealant. As the sealant becomes more cured, it will become stringy. Once the sealant tears cohesively and snaps back when it is pulled, record the time.

This is the "snap time." The snap time will vary depending on temperature and humidity. Higher temperatures and higher humidity will cause the sealant to snap faster. Colder temperatures and lower humidity conditions will slow the snap time. Snap time will also vary from tester to tester depending on how the results are interpreted. Also, there will be variation from lot to lot of material and as the sealant ages. Highly unusual snap time values could be an indication of a problem with the pump. The most important determination from snap time is that the sealant does cure. If the sealant does not cure, then further investigation is required.

Stick inserted in cup | Before snap time | Snap time

AV13886

Mixing ratio test
The mixing ratio test is not a test required by DuPont as a daily test. This test is useful to determine whether the sealant is mixing at the recommended ratio. Most two-part silicone dispensing machines provide a set of valves that allow the mixing ratio to be checked. Following is a procedure to perform the mixing ratio test:

3. Pressure valves must be adjusted in such a way that the pressure is equalized for both parts.

4. Hold a disposable cup underneath each valve outlet on the pump. Open the valve for 10 seconds or at least three strokes of both the base and catalyst pumps.

5. Weigh the two cups, minus the weight of the cup itself.

It has been the experience of DuPont that this test is not reliable as a daily quality control test. It is a useful test if there are concerns about the mix of the sealant or the snap time. This test method is a very good diagnostic test and, along with the glass test or butterfly test and the snap time test, should be useful in the investigation of equipment problems.

General considerations
Quality control is one of the most important elements of a successful project and is the primary responsibility of the applicator. DuPont may assist you in the development of a comprehensive quality control program specifically for your organization. DuPont may also audit a production facility and make recommendations for improvement if necessary.

Industry Standards

UL 94 certification
Because the potential flammability of the junction box is a concern in the solar industry, all Fortasun™ PV junction box adhesives/sealants are designed to obtain an acceptable rating defined by the UL 94 flammability testing standards.

Other UL testing
As outlined above, all Fortasun™ PV junction box adhesives/sealants have or will undergo the standard UL746 electrical testing known as HWI (hot wire ignition), HAI (high current arc ignition) and CTI (comparative tracking index). Consult the UL website to see the testing result on the potting materials.

Important information

The information contained herein is offered in good faith based on DuPont research and is believed to be accurate. However, because conditions and methods of use of our sealants are beyond our control, this information shall not be used in substitution for customer's tests to ensure that Fortasun™ sealants are fully satisfactory for your specific applications. The Fortasun™ sole warranty is that sealant will meet its current sales specifications. Your exclusive remedy for breach of such warranty is limited to refund of purchase price or replacement of any sealant shown to be other than as warranted.

DuPont specifically disclaims any other express or implied warranty of fitness for a particular purpose or merchantability. Unless DuPont provides you with a specific, duly signed endorsement of fitness for use, DuPont disclaims liability for any incidental or consequential damages. Suggestions of use shall not be taken as inducements to infringe any patent.

40 years of driving our photovoltaic products forward.

For over 40 years, our material innovations have been among the leaders in the photovoltaics industry and helped our clients transform the power of the sun into power for us all.

Today, we offer a portfolio of solutions that deliver proven power and lasting value over the long term. Whatever your material needs, you can count on quality DuPont Photovoltaic Solutions to deliver the lifetime performance, efficiency and financial returns you require, day after day after day.

Learn more

DuPont has sales offices and manufacturing sites, as well as science and technology laboratories, around the globe. For more information, please visit photovoltaics.dupont.com.

@DuPont_Solar

DUPONT

Fortasun™

Solar Silicones

photovoltaics.dupont.com