3M™ Solar Acrylic Foam Tapes for Solar Panel Attachment
Railbonding Application Guide

Overview

3M Solar Acrylic Foam Tape (SAFT) can provide durable attachment solutions for mounting solar panels to rails that are attached to a supporting structure, as shown in Figure 1. 3M SAFTs can also be used to attach solar panels using rails or frames to their supporting structures.

Figure 1. Dual-Glass PV Solar Panels mounted with 3M SAFT.

Fact: 3M SAFTs have been used to attach solar panel rails since 2009, with over 15 million meters of tape currently in the field.

About 3M Solar Acrylic Foam Tapes

The technology behind 3M Solar Acrylic Foam Tapes has been used around the world since 1980 to replace liquid adhesives and mechanical fasteners in permanent bonding and sealing applications. These applications range from the assembly of electronic hand held devices and many outdoor applications which include automotive body side moldings, commercial signage, architectural cladding and window glazing on skyscrapers.

3M SAFTs are made with acrylic foam, which is viscoelastic in nature. This gives the foam energy absorbing and stress relaxing properties which helps protect the bond. The acrylic chemistry provides outstanding outdoor durability. 3M SAFTs can be used to permanently bond and seal many substrates for increased productivity, high strength, long-term durability, and improved appearance.

Advantages and Benefits of Solar Acrylic Foam Tape for Railbonding

- Rails help reduce costs by reducing the amount of metal needed for frames.
- Modeling shows that rails distribute forces more effectively than either clips or frames. This minimizes the bending and localization of forces that can damage solar modules, as shown in Figures 2 and 3.
- Immediate handling strength.
- Uniform thickness provides consistent separation between bonded surfaces.
- Acrylic adhesive chemistry offers long-term outdoor durability.
- Viscoelastic response of foam accommodates differential thermal expansion/contraction between bonded surfaces.
- No messy liquids.
- Vibrational Damping.
- Helps prevent galvanic corrosion due to good electrical insulating properties.
- Modules using 3M SAFT have passed IEC, UL, and TUV testing.

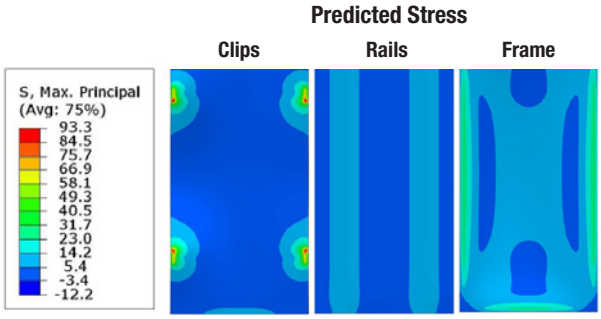


Figure 2. Stress (MPa) Distribution on a 3.2 mm Glass substrate with a 5400 Pa load. Fixed by different methods: a) clips, b) rails, and c) framed around the perimeter.

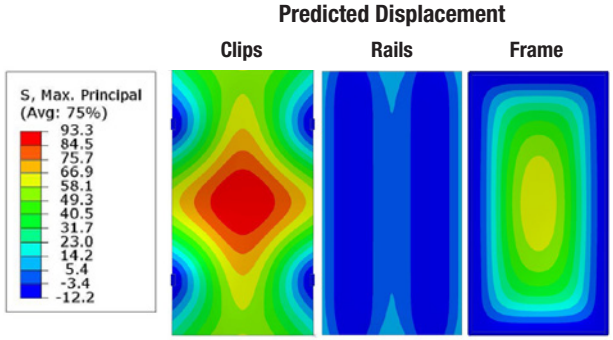


Figure 3. Displacement (mm) on a 3.2 mm Glass substrate with a 5400 Pa load. Fixed by different methods: a) clips, b) rails, and c) framed around the perimeter.

Recommended Products

Product	Thickness (mm)	UL	Color
2204	2.0	746C	White
2304	3.0	746C	White

Solar Acrylic Foam Tape Application

1) Cleaning and Surface Preparation

To obtain good performance with all 3M Solar Acrylic Foam Tapes, it is important to ensure that the surfaces are dry, free of condensed moisture, and any contaminates.

Rails and glass (or backsheet) may have residual oils, dirt, debris, etc. which must be removed to achieve a good bond to the surface. Simply cleaning the surfaces with a 50:50 blend of IPA:water may be sufficient.

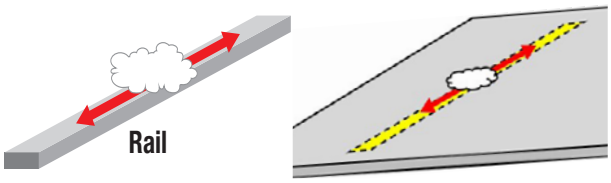


Figure 4. Clean the metal rail and the module surface where the tape will be attached.

Beyond the simple IPA:water cleaning, additional surface preparation may be required.

Heavy Oils: A degreaser or solvent-based cleaner may be required to remove heavy oil or grease from a surface and should be followed by cleaning with IPA:water.

Abrasion: Abrading a surface, followed by cleaning with IPA:water, can remove heavy dirt or oxidation and can increase surface area to improve adhesion.

Adhesion promoters: Applying an adhesion promoter on a surface can significantly improve adhesion to many materials (e.g., plastics, backsheets, etc.) as well as improve durability.

For metal rails, no additional surface treatment may be needed beyond cleaning, but, an adhesion promoter, such as AP111, can be helpful to build robustness. AP111 is a simple wipe-on, wipe-off application. Apply it to the surface using a damp tissue or cloth, then wipe the surface dry before applying the tape. In some cases, this may be all that is needed as a cleaning step.

On glass surfaces, 3M suggests the use of a silane adhesion promoter, such as AP115, to increase the moisture and high-humidity durability of the adhesive bond to glass. AP115 does not improve the initial strength of the bond, but can improve durability. For a period of time after applying tape to a silane-treated surface, the adhesion may appear to be slightly lower when compared to untreated glass, but it will be sufficient for immediate handling strength. A very durable bond will build as covalent bonds form.

To apply AP115, spray on the surface of the glass or moisten a clean towel or cloth and treat the glass in the bonding area. Wipe the glass surface with the AP115. Use a clean cloth to wipe off any remaining material. For the last wipe, move the cloth in one direction. If a hazy residue or streaking is still observed, wipe vigorously until it is completely dry and no film, streakiness or residue is visible.

For more details and assistance in glass surface preparation, see 3M Solar Acrylic Foam Tape Glass Bonding and Silane- Coupling Agents used to improve high humidity performance, August 2011 (www.3m.com/solar).

To achieve a durable bond between the glass and the primer, the primer must react sufficiently. The primer initially hydrogen bonds with the surface of the glass until the reaction occurs which will give a stronger covalent bond. Some typical variables that can impact the creation of a strong covalent bond include primer thickness (thinner is better), temperature, and time.

Performance With and Without AP115

Peel tests are not necessarily representative of the forces on a solar panel, but peel tests are used widely in the industry and can be used to show adhesion build as a function of time. Figure 5 shows a peel test comparison between treated and untreated glass for SAFT 2304. Initially, the treated surface shows slightly lower adhesion than the untreated surface, but the treated surface is stronger after a 72 hour dwell, and after a 72 hour water soak. Figure 6 shows a comparison of the adhesion build for SAFT2204 versus time for glass with and without AP115. In this case, the surface with AP115 shows stronger bond (cohesive failure) as the adhesion builds over time.

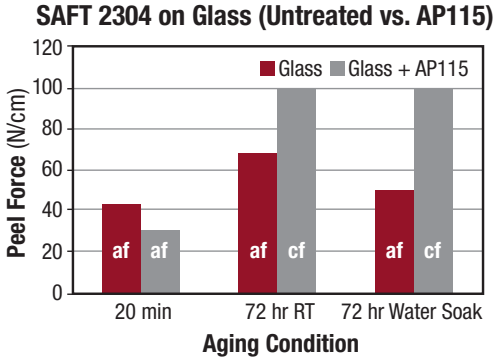


Figure 5. Solar Acrylic Foam Tape on glass. Comparison of untreated glass vs AP115 after 20 min, 72 hour, and a 72 hour water soak for a 90° peel test at 12 in/min.
Note: af = adhesive failure, **cf** = cohesive failure.

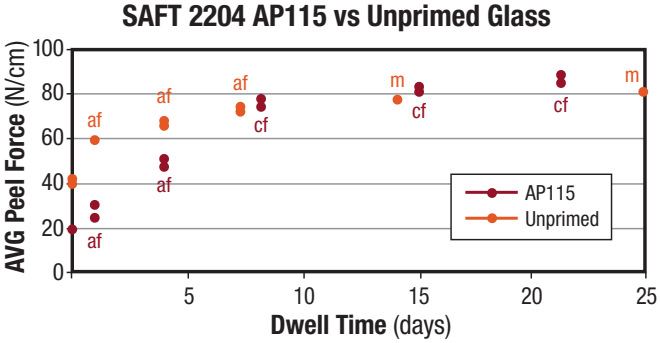


Figure 6. Adhesion build at room temperature of glass + AP115 primer vs untreated glass. Note: af = adhesive failure, cf = cohesive failure, and m = mixed failure mode.

2) Pressure

Apply the tape to a clean surface. Apply a pressure of at least 100 kPa (15 psi) at the bond line. Hand rollers or automated pressure applicators may be used for this step.

In the case of two rigid surfaces (e.g., glass and rail, or frame and support), higher pressures will be needed to achieve sufficient pressure at the bond line. Pressures up to 200-300 kPa (30-45 psi) may be needed to achieve a good bond between two rigid surfaces.

Tip: It is generally best to start at one end of the rail and then press the rail down starting from that point, as shown in Figure 7. This will help prevent air from being trapped between the surface and the tape.

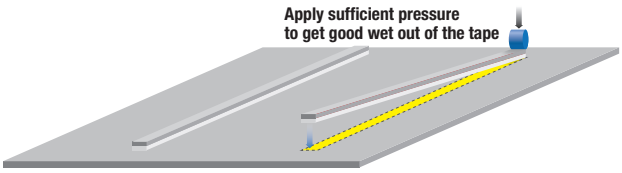


Figure 7. Pressurizing the bond from one end can help eliminate air entrapment.

Tip: For wider amount of tape, using two pieces of tape instead of one (e.g., two ½" wide strips vs one 1" wide strip) may help eliminate air entrapment and improve wet out to the surface, as shown in Figure 8.

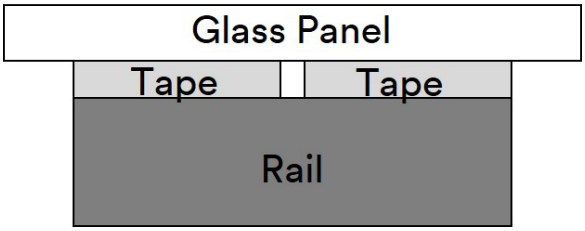


Figure 8. Using two pieces of tape can help eliminate air entrapment during application of the tape.

Tip: A plane sheet of glass can be used to test the application method, as shown in Figure 9. When the proper amount of pressure is applied to the tape it will evenly wet out against the glass. In the case where not enough pressure is used, small pockets of air may still be seen at the bond line, showing that the tape is not uniformly wet out to the surface.

Figure 9. A piece of glass showing good wet out of the tape vs poor wet out.

Tip: Applying tape to the edge of the rails will help to prevent contact between the corner of the rail and the glass panel when a load is applied to the solar panel by external forces (e.g., snow, wind, etc), as shown in Figure 10.

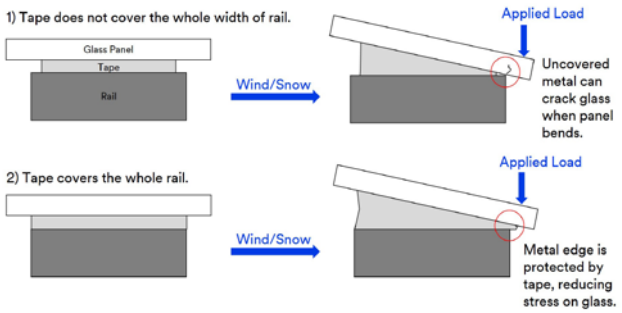


Figure 10. Apply tape to the edge of the rail to prevent stress on the glass panel under loading.

After the rails have been attached to the module, the rails can be mounted on the support racking using adhesives or mechanical means, according to the system design as shown in Figure 11.

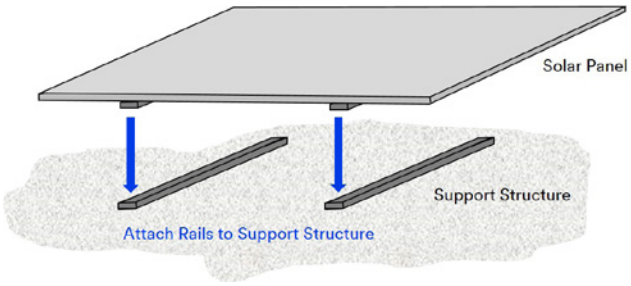


Figure 11. Attachement of modules with rails to substrates.

3) Temperature

Ideal application temperature range is 20°C to 50°C (68°F to 122°F). Pressure sensitive adhesives use viscous flow to achieve substrate contact area. The minimum suggested application temperature is 10°C (50°F).

4) Time

After application, the bond strength will increase as the adhesive flows onto the surface. This flow is faster at higher temperatures and slower at lower temperatures. Ultimate bond strength can be achieved more quickly by exposure of the bond to elevated temperatures, e.g. 66°C (155°F). This can provide better adhesive wet out onto the substrates.

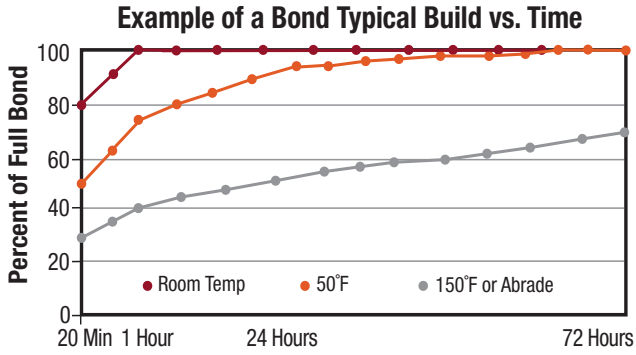


Figure 12. Example of a bond typical build vs time. How the bond strength builds will depend on the specific substrate and the tape used.

3M Tape Removal Systems

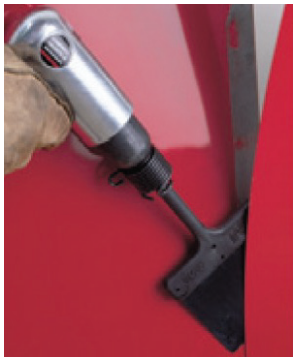
Occasionally, parts need to be taken apart and reworked. 3M has tools for a fast, effective job. Examples, shown below, are the 3M SMART Tool (Part # 08978) and the 3M Stripe Off Wheel (Part # 07499, 07498).

Easy-to-use for separating bonded parts and removing residue.

3M™ SAFT Tapes bond most surfaces permanently.

3M™ SMART Tool

Use by hand or in an air chisel to quickly separate such bonded assemblies as overlapped panels and stiffeners.



3M™ Stripe Off Wheel

Takes residue off faster and easier than solvents or adhesive cleaners. Resilient rounded edge follows contours and irregular surfaces and cleans without scratches or damage.

United States
3M Renewable Energy Solutions
800 755 2654

Germany
49 2131 144450

Denmark
45 43 480100

Spain
34 91 3216000

France
33 1 30316161

United Kingdom
44 1344 858000

Italy
39 02 70351

Singapore
65 6450 8888

China
86 21 62753535

Korea
82 2 3771 4043

India
91 80 22231414

Canada
800 364 3577

Brazil
0800 13 23 33

Mexico
52 55 52702250

Taiwan
886 933 896752

Japan
81 3 3709 8283

Malaysia
603 78062888

Other Areas
800 755 2654

For more information on our solar manufacturing product line, contact 3M Renewable Energy at 800-755-2654 or visit us at 3M.com/solar.

3M

Renewable Energy Solutions
8601 River Place Blvd.
Austin, TX 78726
1-800-755-2654
3M.com/solar

Please recycle. Printed in USA.

98-0151-1155-8