

## Guidelines for working with and fabricating 3form Varia

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The completion and installation of applications produced from 3form Varia, an engineered thermoplastic panel product produced with ecoresin™, may involve secondary fabrication operations including cutting, drilling or bonding. This publication covers the properties and characteristics of Varia that need to be taken into account if secondary operations are to be performed successfully.

### Storage Instructions

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Varia should be stored at room temperature in a dry environment that is not exposed to direct sunlight or heat. Varia panels should be stored horizontally (flat), as delivered, to prevent warpage. Due to possibilities for expansion or contraction, allow material to come to room temperature prior to fabricating.

### Cutting and Drilling Techniques

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Varia can be fabricated with most tools used for machining plastics, wood or metal. Tool speeds should be such that the Varia panels do not melt from frictional heat. The highest speed at which overheating of the tool or sheet does not occur will give the best results.

It is important to keep cutting tools sharp at all times. Hard, wear-resistant tools with greater cutting clearances than those used for cutting metal are suggested. High-speed or carbide-tipped tools are efficient for long runs and provide accuracy and uniformity of finish. Bring the blade to full speed before starting the cut. Secure the sheet to minimize vibration. Since engineered resins are poor heat conductors, the heat generated by machining operations must be absorbed by the tool or carried away by a coolant. (A jet of air directed on the cutting edge will aid in cooling the tool and removing chips.) Another method of reducing heat is by making several passes while cutting or trimming the part rather than trimming “deep” through the part.

#### DO

- Leave the original masking on the sheet during cutting operations.
- Practice on pieces of scrap before cutting parts.
- Use recommended saw blades.
- Use sharp, clean blades and bits.
- Use slow, consistent feed rate.
- Hold sheet firmly while cutting to minimize vibration; use just enough clamp pressure to prevent vibration.
- Use compressed air to minimize heat buildup, especially for sheets more than 3/16 in (4.76 mm) thick.
- Feed against the rotation of the blade or tool.
- Wear proper safety equipment.

#### DO NOT

- Cut or drill with a dull blade, cutter or bit.
- Apply excessive clamping pressure.
- Use a blade with side-set teeth.
- Scribe-break product sheet.

#### SAW CUTTING

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Any of the following saw types, commonly used for wood or metal, should be satisfactory for cutting Varia sheets: circular saws, band saws, saber saws, jigsaws, hacksaws, or handsaws. However, some saw designs are better suited than others for sawing Varia because they produce smoother or faster cuts. Table saws and band saws usually produce the best surfaces, and they can be used in most sawing operations.

Blade design plays an important part in successful sawing of Varia sheets. A skip tooth band saw blade is preferred because the wide gullet provides ample space for the plastic chips to be carried out of the kerf (the cut made by the saw). For best results, the teeth should have zero rake and some set. For a curved cut, the blade should be narrower and have more set than for a straight cut. The blade must be kept sharp to prevent melting or chipping of the sheet, and the blade guide should be placed very near the cut to minimize vibration.

A circular saw is preferred to a band saw for straight cuts even though it tends to generate more heat. A circular saw should be operated at approximately 8,000 to 10,000 RPM and 10-20 feet per minute with carbide-tipped saw blades having 40 teeth and should have plenty of set or be hollow ground. A perforated saw blade will run cooler than a solid blade. It is essential that the spindle bearing be tight so that the saw will run true.

Remember: Be sure to hold or clamp the panel securely while sawing to prevent chattering which can cause cracking.

#### DRILLING

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Drills designed especially for plastics are widely available. It is suggested that the fabricator utilize such drills when drilling Varia. Standard twist drills for wood or metal can be used however they require slower speeds and feed rates to produce a clean, non-gummed hole. Optimum bit speed, feed rate, and applied pressure will depend on hole size and sheet thickness. Drill speeds up to 1,750 RPM are best

for smaller holes, while speeds as low as 350 RPM work well when drilling larger holes.

Twist drills used for plastics are suited to working Varia —they should have two flutes, a point with an included angle of 60 to 90 degrees, and a lip clearance of 12 to 18 degrees.

Wide, highly polished flutes are desirable since they expel the chips with low friction and thus tend to avoid overheating and consequent gumming. Drills with substantial clearance on the cutting edge of the flutes make smoother holes than those with less clearance. Drills should be backed out often to free chips, especially when drilling deep holes. Peripheral speeds of twist drills for plastics ordinarily range from 100 to 200 ft. (30.5 to 61 m) per minute. The rate of drill feed into the plastic sheet generally varies from 0.010 to 0.025 in (0.254 to 0.635 mm) per revolution.

Remember: Holes for fasteners should not be drilled closer than 2x thickness of Varia panel. When drilling be sure to hold or clamp the part securely to prevent it from cracking or slipping and presenting a safety hazard to the operator.

### ROUTING

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Routing with sharp two-flute 1 1/8" diameter straight cutters produces very smooth edges. Routers are useful for trimming the edges of flat or formed parts, particularly when the part is too large or irregular in shape for a band saw. Portable, overarm, and under-the-table routers work equally well. Varia should be fed to the router slowly to avoid excessive frictional heating and shattering. The router or sheet, whichever is moving, must be guided with a suitable template. It is good practice to employ compressed air during the routing operation to cool the bit and aid in chip removal.

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It is important to keep cutting tools sharp at all times. Hard, wear-resistant tools with greater cutting clearances than those used for cutting metal are suggested. High-speed or carbide-tipped tools are efficient for long runs and provide accuracy and uniformity of finish. Bring the blade to full speed before starting the cut. Secure the sheet to minimize vibration. Since engineered resins are poor heat conductors, the heat generated by machining operations must be absorbed by the tool or carried away by a coolant. (A jet of air directed on the cutting edge will aid in cooling the tool and removing chips.) Another method of reducing heat is by making several passes while cutting or trimming the part rather than trimming "deep" through the part. Use up-cut tooling.

### REFINISHING

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It is possible for Varia to become damaged by scratching. Patent is the only Varia finish that may be fully repaired. (Use the flame polishing technique listed in the Edge Polishing section) While deep scratches can be fully repaired, the area of repair may not match the surface of the rest of the sheet.

Light scratches and scuffs on the sandstone surface finish can be repaired with a plastic polish. See directions below.

Use 3M Perfect-it Extra Cut Rubbing Compound (06060). Use with the 3M Superbuff™ III Buffing pad (05703). Apply a small amount of compound to the surface of panel before using the wool pad. Apply

medium pressure to remove the light scratches. When the scratches have been removed, use light pressure and work the residual compound back into the pad. Use a clean soft cloth to remove any remaining compound. Inspect the surface for scratches, and repeat above if necessary.

### TAPPING

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Conventional four-flute taps can be used for cutting internal threads in Varia when a close fit is required. Such taps, however, have a tendency to generate considerable heat during the tapping operation. A high-speed, two-flute tap should offer longer life and greater tapping speed than a conventional tap, as well as provide clearance for chip discharge. Flutes should be ground so that both edges cut simultaneously; otherwise the thread will not be uniform. Cutting edges should be 85 degrees from the centerline, giving a negative rake of 5 degrees on the front face of the lands so that the tap will not bind in the hole when it is backed out. It is desirable to have some relief on the sides of the thread.

When tapping it is not necessary to apply aggressive torque to the bolts. It is good practice to have a small air vent drilled into the tapped hole to minimize air pressure created in the tapped hole. Usually a tap depth of 1/2" (12 mm) is sufficient. Care must be taken especially when going 50% through the panel so as to not affect the lamination layer.

DO NOT use cyanoacrylate or solvent type thread locking materials with Varia. To more permanently secure hardware, use the recommended products from the 3form adhesives matrix.

### COLD BENDING

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Varia can be cold bent for simple bends and curved areas. The minimum cold bend radius is 100 times the thickness of the panel. For smaller panel dimensions, cold-bends close to the minimum radius may require significant force that may require that the panel to be heat formed.

### LINE BENDING

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Because of its low thermoforming temperature, Varia is easy to strip heat and line bend. Remove the protective masking from the area to be bent. For right angle bending, relieve 60-70% of the material using a 90 degree "V" cut. Using a line heat device, regulate the heat to a temperature that allows the Varia to reach 230-250°F. Thicker gauge requires a longer period of time to allow heat penetration. Place sheet over heat source at bend area. Allow heat to soften material; time depends on gauge, 1/8" typically requires 2 minutes. Remove from heat and make desired bend, place in wood or fabric-covered aluminum fixture to cool. Do not remove until sheet cools to room temperature.

- Always strip heat a sample piece first.
- Avoid drafty rooms which can cause uneven heating and cooling.
- Be sure to cover forming fixtures with soft fabric (felt) to avoid scratching Varia.
- Heat-Bending Varia that has not had sufficient heating time results in a highly-stressed, weakened material.
- Thicker gauges (over 0.125") may require heating on both sides.
- Always bend the sheet with the heated side forming the inside radius.

### HEAT FORMING

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Some thermoforming techniques can be used to force Varia, once heated, into the shape of a mold by mechanical means. For the most part, Varia is not vacuum formable (please contact 3form if an application required vacuum forming).

Use only uncoated product for thermoforming. Textured sheets can be formed, but the texture may not remain uniform across tight bends. Tooling can range from low-cost plaster molds to expensive water-cooled steel molds, but felt covered medium density fiberboard is most common. Other materials including wood, gypsum, expanded foam and epoxy can also be used. Forming processes to be discussed include drape, matched-mold, and mechanical.

Depending on the product interlayer, the overall surface area of the sheet may not change during forming. Fabrics and organic interlayers will not allow the sheet to stretch.

Temperature for forming ranges from 190°F to 240°F (88°C to 116°C). When forming textured sheet, temperatures should not exceed 240 deg. F (116°C) to prevent deformation of the texture. Always test a sample piece before forming the final part.

Varia is commonly formed using drape forming techniques. Drape forming is achieved by allowing a heated panel to form to a male mold under gravity or applied pressure. The use of vacuum during cooling is recommended as it keeps the part tight to the mold. For large or very complex parts, it may be necessary to use matched molds. Matched molds, also known as male-female molds apply much greater pressure to the part during the cooling process.

#### DO

- Inspect sheet prior to molding to confirm that you have the correct product and to verify face and back of sheet.
- Keep molds and sheet very clean. Remove dust with a damp cloth or blow it off with pressurized air.
- Form sheet of Varia at lower temperatures 190°F to 240°F (88°C to 116°C) than those used for acrylic and polycarbonate.
- Allow parts to cool sufficiently before removing from mold.

#### DO NOT

- Use coated Varia sheet for forming.
- Heat texture sheet above 240°F (116°C).
- Lay larger formed parts face up while cooling.
- Nest formed parts during storage.

#### EDGE POLISHING

The edges of Varia may be flame polished to achieve a beautiful clear edge. To prepare for flame polishing, sand away all machine or saw marks using 150 grit sandpaper using a dual action orbital sander. Once the machine marks are removed sand with 400 grit sandpaper. Be careful not to concentrate the sander in one area for too long, as heat build-up may damage the Varia panel. Apply even pressure so that the edges of the sander do not dig into the panel.

To flame polish, use a butane torch. 3form recommends the use of the Master Micro-torch (1WG61) that can be purchased from Grainger®. Turn the flame to the lowest setting. Keep the flame 1-3" away from the edge to be polished. Use a quick sweeping motion and always keep the flame moving. If you hold the flame on one spot for too long burning, melting or bubbling may occur. Continue to sweep the flame across the surface until the material is polished. Practice on a scrap piece of material before working on finished Varia panels.

1. Sand away machine or saw blade marks from edge using coarse sandpaper
2. Sand edge using 400 grit or higher sand paper
3. Flame polish using butane torch

#### EDGE SEALING

Varia panels containing certain woven color, paper and organic interlayers must be sealed before being installed in an application that may be exposed to water. The entire edge of the product must be sealed as well as any holes that are cut into the material. The following guidelines must be followed to insure that your Varia panels remain beautiful. Alternatively, 3form fabrication may be specified to perform factory applied edge sealing if desired. For more information please download the Varia edge sealing procedures and guidelines technical white paper from [www.3-form.com](http://www.3-form.com).

#### STEP 1: CLEAN

Clean Edges by wiping with a cloth dampened with Isopropyl Alcohol

#### STEP 2: SEAL

Seal all exposed edges with Weld-On 58. This is a two part urethane adhesive that is dispensed from a gun in a 1:1 ratio. Weld-On 58 has a 2-3 minute working time.

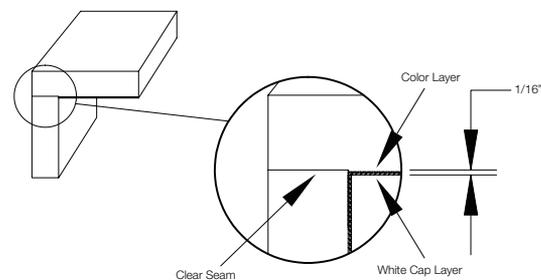
The adhesive should be laid down in a bead and smoothed down with your finger. Leave the adhesive alone for at least one hour before being touched again.

Pay special attention to the corners of the panel. It is important to ensure the entire corner is sealed. This is the most likely location to leave a void in the sealant

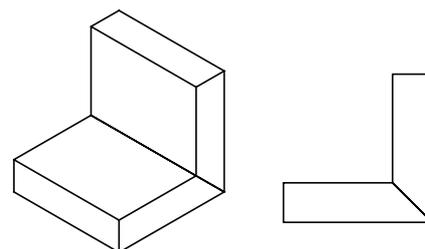
Correct and complete application is extremely important as any part of the panel not sealed can cause the entire panel to wick. A gap the size of a pinhole may allow water to seep into the interlayer.

#### STEP 3: POST SEAL

A second sealing step can be performed with the application of silicone to the Weld-On 58 coated edges. It should be noted that silicone by itself may



**LIGHT SEAM**



**MITER UV GLUE SEAM**

not completely seal the Varia panels. A pre-seal of Weld-On 58 is recommended prior to silicone application.

After the Weld-on has been allowed to cure for 72 hours, apply a layer of Momentive Performance Materials SiGlaze II SCSSCSSCS 2801 silicone to all edges that the Weld-On was applied. This silicone provides an excellent seal against moisture and also protects the Weld-On from damage. The silicone will continue to cure for 7 days, but can be handled after 24 hours.

## Joinery

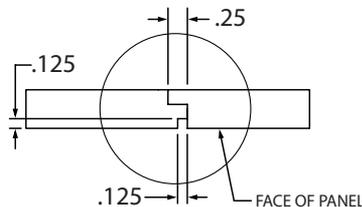
### ADHESIVE SEAMS

Light Seam - For 90 degree joints.

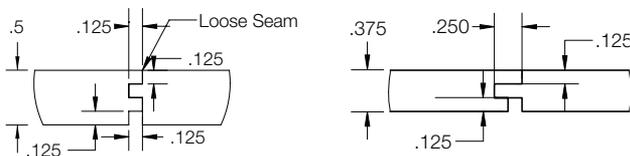
Miter UV Glue Seam - Very strong seam for most corner conditions.

### LOOSE SEAMS

Loose seams are not glued and are primarily used for panels that are backlit.



**HALF LAP QUIRK** - great accessibility for multiple panel installations. Use Align hardware.



**TONGUE AND GROOVE QUIRK** - best aesthetic loose seam however accessibility is limited on larger installations.

Use on panels 3/8" and thicker.

Line Bend - This is not an adhesive seam. The material is scored, heated, then bent into a 90 degree angle.

Tongue and Groove Seam - Not typically recommended as a glued seam. Air bubbles will be visible.

## Fastening and Adhesion Techniques

### MECHANICAL FASTENING

Varia can be fabricated attractively with mechanical fasteners. Mechanical fastening using through-holes is recommended. Self-threading screws should not be used with Varia panels. Mechanical fastening is recommended for assembly of larger articles.

Screws and rivets provide permanent assembly. Standard nuts, bolts, and machine screws are used in many instances; in addition, special screws and rivets specifically designed for use with plastics are suited for use on Varia. Springs, clips, and nuts are low cost, rapid, mechanical fasteners. Hinges, knobs and catches are some other popular devices used in mechanical assemblies with Varia panels.

3form offers a wide variety of mechanical fasteners designed to work well with Varia panels. Hardware solutions can be reviewed on our website, [www.3-form.com](http://www.3-form.com) or contact 801-649-2670 for more information.

### MECHANICAL FASTENING GUIDELINES

#### DO

- Use 3form Hardware for best results
- Use screws designed specifically for plastics.
- Drill holes slightly oversized to allow for thermal expansion and contraction.
- Insure drilled holes have smooth edges.
- Use washers for better load distribution.
- Use light to moderate clamping pressure

#### DO NOT

- Over-tighten fasteners. Hand tightened fastners are sufficient.
- Use self-tapping screws to hang large panels.
- Use Cyanoacrylate or solvent type thread locking materials.

### BONDING (WITH ADHESIVES & CEMENTS)

Varia can be fabricated and assembled into a variety of applications and articles with adhesive bonds. We do not recommend using solvents, or cyanoacrylates (superglue) for bonding or seaming Varia panels. The use of solvents will permanently damage Varia panels by causing solvent induced crazing or stress whitening.

Two-part adhesives are recommended when bonding Varia to dissimilar plastics and to bond Varia to itself. 3form specifies the use of Weld-On® adhesives made by IPS Corporation. Weld-On 55 and Weld-On 58 are effective when joints need to retain slight flexibility, may be subjected to changing thermal conditions, or require waterproofing. Weld-On 55/58 is to be used when bonding Varia panels to other Varia panels, to PETG, to Polycarbonate, to ABS, or to Butyrate substrates. Weld-On 55 has a longer working time (15-20 min) than Weld-On 58 (3-5 min). Devcon Plastic Welder II is to be used when bonding Varia panels to non-plastic substrates like concrete, fiberglass, metal, wood, or drywall. Please keep in mind that Devcon Plastic Welder has a milky yellow color. To hide the adhesive specify White Out for the Varia panel being ordered.

Although many adhesives are listed as translucent or colorless the bond will NOT be invisible.

When larger articles are to be joined or fastened, mechanical fastening is recommended.

### SURFACE PREPARATION

Ensure that all substrates are clean, dry and free of oils, dust or other surface contaminants. The amount of surface preparation directly influences the final bond strength of an adhesive.

- Wipe resin substrates with a 50/50 solution of Isopropyl Alcohol (IPA) and water
- (For Metals) Sandblast or abrade with 150 grit sand paper followed by a water wipe with a dry, lint-free cloth
- Wipe substrate again with IPA/water solution to remove loose particles

### DIRECTIONS FOR USE.

When working with a 35 mL or 50 mL adhesives cartridge, verify that

you have all of the materials in hand, dispensing gun, plunger (correct ratio), adhesive cartridge(s) and mixing tips. Hand mixing is not recommended and may result in unpredictable results.

Begin by loading the plunger into the dispensing gun. Hold the lever on the back of the gun up to install the plunger. Next slide the back plate off of the bottom of the adhesive cartridge and install into dispensing gun. Snap the cartridge holder in place. Finally remove the tip off of the cartridge and install a mixing tip by twisting into place.

Dispense and discard a small amount of adhesive to assure even ratio and free flow. Full bond strengths for all urethane and acrylic adhesives is 72 hours. See the 3form Adhesives Matrix available on [www.3-form.com](http://www.3-form.com) for specific working times and cure times.

When bonding the edges of Varia panels, first mask the face of the panels with masking tape closest to the edge to be bonded. Next apply the adhesive to the edge of the panel with an adhesive gun. Spread the adhesive evenly along the joint. Apply the adhesive to the second surface to be bonded. Finally, use a clean rag with isopropyl alcohol to clean any adhesive that dripped out of the joint. Apply light to moderate pressure to joint during curing process.

**BONDING TECHNIQUES: VHB TAPE**

Clear 3M™ VHB™ tape 4910 or 4905 can be used to adhere Varia to a variety of substrates while still achieving desirable aesthetics. 3M VHB tape can be used to attach Varia to sealed wood, sealed ceramics, metal, glass and some other plastics. VHB tape is UV stable and can be used in interior and exterior conditions as well as in the toughest environmental conditions. 3M VHB tape provides an excellent seal against moisture, however splices or seams in the tape may require additional sealing. The tape can tolerate some shear extension due to substrate movement from thermal expansion and contraction. Special surface preparation is needed before applying 3M VHB tape to a Varia panel. First both surfaces are to be cleaned with a 50:50 mixture of isopropyl alcohol and water. Next the Varia surface to be used should be primed using 3M Primer 94. (On the area to which the tape is to be applied requires primer). Follow the manufacturer's directions on how to safely handle and apply this primer. After the area has been primed and is dry, the tape can be applied to the first surface. Only handle the tape by the edges and apply firm pressure to the tape using a roller. Attach the second bonding substrate and apply pressure on the finished joint with a roller. Apply firm application pressure to the entire length of the taped area (at least 15 psi is necessary) to develop good adhesive contact and to improve the bond strength. Bond strength will increase over time with 90% of the ultimate strength developing after 24 hours and full strength after 3 days. Ultimate bond strength can be achieved more quickly by exposure to higher temperatures (e.g. 150°F for 1 hour). If the entire weight of the Varia panel is supported by the 3M VHB Tape, a minimum of 4 in<sup>2</sup> of tape should be used for every pound of panel weight to be supported. Call the 3form Technical Help desk at 877-649-2670 for help, especially when bonding Varia to other nonmetal substrates.

**DO**

- Seal porous materials like cement and wood before bonding.
- Keep tape away from debris and handle tape by the edges.
- Make sure both surfaces are clean and dry.
- Use a 50/50 isopropyl/water solution for metal and plastic surfaces.
- Apply 3M Primer 94™ on Varia surface to be bonded.

- Apply VHB Tape to first surface, apply firm pressure (more than 15psi) with a roller.
- Remove liner from second side and apply to second surface.
- Apply very firm pressure to entire bond line.
- Wait 72 hours until tape has reached full adhesion strength (1 day = 90% strength).

**APPLICATION TECHNIQUES: SILICONE SEALANTS**

Momentive Performance Materials SilGlaze II SCS2800 and Construction SCS1200 can be used to seal Varia in glazing applications. SilGlaze II is not a structural silicone and should not be used to create a bond that may experience any type of loading. For structural applications use Construction SCS 1200. SilGlaze II is a one part, neutral, fast curing silicone sealant. This can be used as a general-purpose weather and glazing sealant for Varia panels. SilGlaze II is not recommended for applications where the product will be in continuous contact with water. Further SilGlaze II sealant cannot be used on bare metal or surfaces that are susceptible to corrosion. This silicone sealant is formulated to adhere to glass, vinyl extrusions, fluoropolymers, acrylics, polyester paints, powder coated aluminum, and most other plastics. Momentive SS4004P (or tinted SS4004P) silicone primer can be used to enhance adhesion to substrates if desired.

To apply, the surface must be wiped free of debris then wiped with a cloth wetted with pure 100% isopropyl alcohol, then followed by wiping with a clean dry cloth. In a continuous operation apply the sealant horizontally in one direction and vertically from bottom to the top. Apply the sealant with positive pressure by pushing the bead ahead of the nozzle and making sure the entire cavity is filled. Tooling should force the sealant into contact with the sides of the joint or cavity, eliminating any voids. (Dry tooling is recommended.) Maximum cure depth from an air interface should not exceed 3/8". Excess sealant should be wiped away with a solvent (IPA) before curing. Additional technical support can be reached by contacting the 3form Technical Help Line at 877-649-2670.

**DO**

- Insure all surfaces are clean and free of debris.
- Use proper surface preparation on all surfaces to be sealed.
- Use in applications where the silicone has access to atmospheric moisture.
- Use a colored sealant when necessary (white, black, aluminum, blue white, bronze and beige are available).

**DO NOT**

- Use in underwater applications or applications where there is continuous contact with water.
- Use in food contact applications.
- Use on bare metals or surfaces that can corrode (i.e. mill aluminum, bare steel, etc.)
- Use in cavities or designs where the cure depth exceeds 3/8" (9.6 mm) from an air interface.

The following table lists several solvents and adhesives that provide strong bonds when used in product sheeting fabrication operations.

**ADHESIVES AND SEALANTS FOR PRODUCT FABRICATION**

PRODUCT NAME	DESCRIPTION	APPLICATION
Weld-On 55 or Weld-On 58	2-Part Urethane Adhesive	Varia to Varia, polycarbonate

PRODUCT NAME	DESCRIPTION	APPLICATION
Devcon Plastic Welder II	2-Part Acrylic Adhesive	Varia to wood, metal, concrete or drywall
3M VHB 4910 Clear Tape	2-Sided Tape	Varia to sealed wood, metal, glass or other plastics
Momentive SilGlaze II SCS2801	Clear Silicone Sealant	For sealing applications (glazing)
Momentive Construction SCS1201	Clear Structural Silicone	For structural silicone bonding

## DO

- Start with a flat surface.
- Insure sheet edges and surfaces are clean and free from contamination.
- Wipe surface with a 1:1 mixture of isopropyl alcohol (IPA) and water.
- Allow surface to dry thoroughly before bonding.
- Insure that surfaces to be bonded are smooth, mate well, and are accurately aligned.
- Mask both sides of each sheet near the edge during bonding operation.
- Use a jig or fixture to securely hold parts being bonded together while curing.
- Wipe extra adhesive away from the panel using a rag with IPA before it is fully cured.

## Cleaning Instructions

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3form Varia, like all thermoplastic resin materials, should be cleaned periodically. A regular, seasonal cleaning program will help to maintain the aesthetics and life of the material.

For detailed cleaning instructions, please see the 3form Varia Spec Sheet.

For more information, please visit [3-form.com](http://3-form.com) or call 877-649-2670.