Nova Polymers

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.

CUTTING AND DRILLING TECHNIQUES

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. In general, 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 a 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 sheet more than 3/16 in. 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.
- Remove safety guards from equipment.

SAWING

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 the 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 sets 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

Drills designed especially for plastics are available and it is suggested that the fabricator utilize such drills on *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 can work for 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: When drilling is sure to hold or clamp the part securely to prevent it from cracking or slipping and presenting a safety hazard to the operator.

ROUTING

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. Compressed air can be used during the routing operation to cool the bit and aid in chip removal.

TAPPING

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.

COLD BENDING AND STRIP HEATING

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 be heat formed.

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 head source at the bend area. Allow the heat to soften material; time depends on the gauge, 1/8” typically requires 2 minutes. Remove from heat and make the desired bend, place in wood or fabric-covered aluminum fixture to cool. Do not remove until the 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.

FASTENING AND ADHESION TECHNIQUES

MECHANICAL FASTENING

Varia can be fabricated into attractive joints with mechanical fasteners. Threaded metal inserts are preferred over the use of self-threading screws. Self-threading screws should not be used with *Varia* panels. Mechanical fastening is recommended for the 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.

MECHANICAL FASTENING GUIDELINES

DO

- 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 metal inserts if frequent assembly/reassembly is required.

DO NOT

- Over-tighten fasteners. Hand tightened fasteners are sufficient.
- Use self-tapping screws to hang large panels.

BONDING (WITH ADHESIVES & CEMENTS)

Varia can be fabricated into a variety of shapes and articles with adhesive bonds. We do not recommend using solvents for bonding or seaming *Varia* panels.

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 required waterproofing. Weld-On 55/58 is to be used when bonding *Varia* panels to other *Varia* panels, PETG, Polycarbonate, ABS, or Butyrate substrates. Weld-On 55 has a longer working time (6 min) than Weld-On 58 (3 min). Weld-On 42 is to be used when bonding *Varia* panels to Acrylic, Polyester, or PVC (Rigid or Foamed).

Weld-On 45 is to be used when bonding *Varia* panels to non-plastic substrates like concrete, fiberglass, metal, wood, or drywall. Please keep in mind that Weld-On 45 has a brownish color and an opaque backer should be specified for your *Varia*panel to hide the adhesive.

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

BONDING TECHNIQUES: VHB TAPE

Clear 3M™ VHB™ tape 4910 or 4905 can be used to adhere to *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, 90% of the ultimate strength will develop after 24 hours and full strength after 3 days. Ultimate bond strength can be achieved more quickly by exposure to higher temperatures (e.g. 150ºF for 1 hour). If the entire weight of the *Varia* panel is supported by the 3M VHB Tape, a minimum of 4 in2 of tape should be used for every pound of panel weight to be supported. 3M support is available for questions related to the use of 3M VHB Tape. Call 1-800-726-0126 and ask for technical service support especially when bonding *Varia* to other nonmetal substrates. Other support materials and data are also available online at www.3m.com/vhb.

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 the *Varia* surface to be bonded.
- Apply Tape to the first surface, apply firm pressure (more than 15psi) with a roller.
- Remove liner from the second side and apply to the second surface.
- Apply very firm pressure to the entire bond line.
- Wait 72 hours until the 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. GE 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 Product Technology Department at 1-800-726-0126.

DO

- Ensure all surfaces are clean and free of debris
- Use proper surface preparation on all surfaces to be sealed
- Use in designs and 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)
- The following table lists several solvents and adhesives that provide strong bonds when used in product sheeting fabrication operations.

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" from an air interface

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
Weld-On 45	2-Part Adhesive	*Varia* to wood, metal, concrete or drywall
Weld-On 10	2-Part Adhesive	*Varia* to wood, metal, concrete or drywall
3M™ VHB™ 4910 Clear Tape	2-Sided Structural 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 the surface with a 1:1 mixture of isopropyl alcohol (IPA) and water.
- Allow the surface to dry thoroughly before bonding.

- Ensure 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.

For more information, please visit www.3-form.com or call 800.726.0126