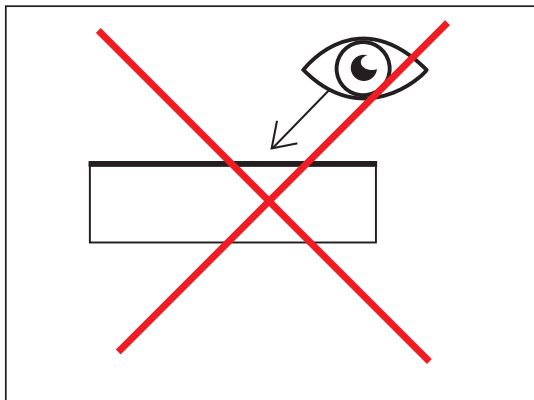


GUIDELINES FOR WORKING WITH AND FABRICATING 3FORM CHROMA

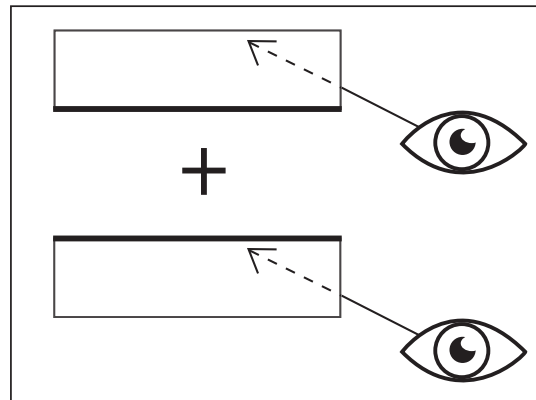
The completion and installation of applications produced from 3form Chroma[®] may involve secondary fabrication operations including cutting, drilling or bonding. This publication covers the properties and characteristics of Chroma that need to be taken into account if secondary operations are to be performed successfully.

IDENTIFYING COLORED SIDE

The colored side of Chroma will always be masked with a clear protective layer and a sticker. The renewable matte side will be masked with a paper protective coat. If the protective films have been removed, identify the colored side by looking into the edge of the panel. View the edge of the panel at an angle so that you are looking through the top face into a light source. Flip the panel over and repeat. The colored side will appear darker than the non-colored side. The non-colored side will appear colored due to the reflection of the light from the colored side. To identify a panel properly, always look at both sides.



Do not look through the front or rear face of Chroma.



Look through side of Chroma upwards toward a light source, then flip Chroma panel 180 degrees and view from side again.

Cutting and Drilling Techniques

Chroma can be fabricated with most tools used for machining plastics, wood or metal. Tool speeds should be such that the Chroma 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. Use upcut tooling.

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 (upcut ~250"/minute, 18,000 RPM).

Hold sheet firmly while cutting to minimize vibration; use just enough pressure to prevent vibration.

Use compressed air to minimize heat buildup, especially for sheet more than 3/16" (4.7 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.

Remove safety guards from equipment.

CUTTING

To cut 3form Chroma, use an overhead panel saw, beam type panel saw or a table saw. Saws should have minimal vibration and be powerful enough to make the cuts (3-10 hp).

Blade design plays an important part in successful sawing of Chroma sheets. A triple chip carbide tipped saw blade is recommended for cutting Chroma sheets. The optimum number of teeth per blade is also important. For 10" diameter blades, 60 and 80 tooth blades are recommended. For 12" and 14" diameter blades, 60, 80 and 100 tooth blades are optimum. Proper selection of the blade should be made by considering the surface feet per minute (SFM) of the blade in the saw. For Chroma, the SFM should be between 6000 and 14,000 ft/min (1830 and 4270 m/min). To determine the SFM of the blade, you can use this formula.

$$\text{SFM} = \text{Diameter (inches)} \times \text{RPM} \times 0.262$$

Typical feed rates for Chroma are 100" to 300" per minute. Saw blade dampeners can be used to reduce the saw blade vibration. This will result in improved saw cut quality of your Chroma panels. Up-cut with a rough bit, then use a slight helix upcut for the finish cut. High performance beam saws can cut Chroma up to 2" thick using an 8-10% feed rate. Chroma thicker than 2" can be cut using a CNC with a 1" diameter cutter having a 4" cutting edge.

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 Chroma. Tip angles on standard drill bits are 118°- 130°, while tip angles to be used with Chroma should be 60°- 90°. Smaller tip angles will generate smaller chips and reduce melting. 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 well suited for Chroma —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 Chroma ordinarily range from 20 to 160 ft. (6 to 48.8 m) per minute. The rate of drill feed into the plastic sheet generally varies from 0.001 to 0.015 in (0.0254 to 0.381 mm) per revolution. It is best to place a piece of plywood or MDF underneath the Chroma panel being drilled. This prevents chipping on the bottom surface. Below is a chart that details recommended surface feet

per minute (SFM) and inches per revolution (IPR) for different bit sizes.

If panel gauge is less than 1", DO NOT DRILL closer than 2" from any edge

If panel gauge is between 1" and 2", DO NOT DRILL closer than 1.5" from any edge

Remember: 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.

BIT DIAMETER	SFM	IPR
1/16"	20-160	0.001
1/8"	20-160	0.002
1/4"	20-160	0.004
3/8"	20-160	0.006
1/2"	30- 90	0.008
3/4"	30- 90	0.01
1" and greater	30- 90	0.012- 0.015

MILLING

Chroma can be machined with standard high-speed milling cutters for metal, provided they have sharp edges and adequate clearance at the heel. Remove most of the material with the first pass and then run a final pass against the blade. Do not use climb cutting, as this will fracture the Chroma.

ROUTING

Routing with sharp two-flute 1 1/8" (28.5mm) 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. Chroma 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.

REFINISHING

3form Chroma is an ideal material choice for many applications such as table tops and counter tops. When being used in these and other applications, it is possible for the top surface (front finish) of the Chroma to become damaged by scratching. Chroma's unique renewable matte finish allows scratches to be easily repaired. This document explains how to renew a Chroma panel to its original beauty.

MATERIALS NEEDED

Random Dual Action Orbital Sander (5" or 11.5")
Sandpaper (3M 366L 80 micron)
Higher grit sand paper (grade 60-150 to remove heavy scratches)
Water Spray Bottle

STEP 1

If the scratches are deep (greater than 1/16" in depth) use a coarse sand paper to sand the damaged area of the panel. Make sure to sand in a large circular area at least 12" away from the scratch in every direction. If you only sand the affected area, it will cause an irregular surface that will be noticeable when you are finished. Continue sanding in circular patterns until the scratch/damage is completely removed.

STEP 2

Begin sanding the surface using an orbital speed (10,000-12,000 rpm) in small random circular movements. Continue sanding until the surface is free of the scratches that were caused by the coarse paper in the previous step. Clean the surface with a mixture of mild detergent and clean water using a clean, dry cotton cloth.

DO

Place sander flat on surface before applying power.
Maintain flatness during use.
Stop the tool as it is removed from the work surface.

DO NOT

Use linear movements.
Refinish the colored side (Back Finish) of Chroma.
Dig into the surface or use excessive pressures.
Concentrate the sander in one spot for prolonged time (this may generate excessive heat).

Fastening and Adhesion Techniques

MECHANICAL FASTENING

Chroma can be fabricated into attractive joints with mechanical fasteners. For mechanical fastening use threaded metal inserts. Self-threading screws should not be used with Chroma panels. Mechanical fastening is recommended for assembly of larger articles. Mechanical fastening is Required for Chroma produced with Applied Color technology. (more details below)

MECHANICAL FASTENING GUIDELINES

DO

Drill holes slightly oversized to allow for thermal expansion and contraction.
Insure drilled holes have smooth edges.
Use nylon 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.
Use Cyanoacrylate or solvent type thread locking materials (Loctite)

BONDING (WITH ADHESIVES)

As Chroma is typically used in applications that require structural performance. We do not recommend using solvents for bonding or seaming Chroma panels. Chroma Applied panels should never be used with adhesives of any kind. To secure or attach Chroma Applied panels, use mechanical fasteners.

Generally, Chroma (with the exception of Applied Colors) bonding is achieved with a two-part adhesive. These adhesives bond well to most surfaces including plywood, metal and other plastics. 3form recommends the use of Devcon Clear Welder for Chroma seaming. Devcon Clear Welder is a 2-part acrylic adhesive that has a clear color and a 5-10 minute working time.

When bonding Chroma to a substrate or sub-top material 3form recommends the use of Momentive Performance Materials (formerly GE Silicones) SilGlaze II SCS 2801. It is recommended that any wood (plywood or MDF) sub-top be sealed with an acrylic, laquer or polyurethane sealer before bonding. The SilGlaze II should

be applied as dots on the subtop with each dot being 3/4" in diameter and each dot separated by 12". Apply Chroma panel and apply light pressure. Do NOT spread the adhesive, as silicones require air to cure. Do NOT clamp. Allow silicone to cure for 24 hours before handling.

The adhesive may be hidden by specifying White Cap to any Chroma panel. The White Cap may slightly alter the tone of the Chroma so please to request samples to determine if this is acceptable. Opaque layers do not permit backlighting, but edge lighting is possible. 3form recommends not clamping parts, but if pressure is necessary use light pressure (less than 10 lbs). DO NOT use cyanoacrylates (superglue) or solvent adhesives with 3form panels. Use Nylok blue patch for all thread locking applications.

Be sure to consult with the 3form Adhesives Matrix prior to bonding. [http://www.3-form.com/downloads/3form_adhesives_matrix.pdf]

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 Chroma to a variety of substrates while still achieving desirable aesthetics. *3M VHB* tape can be used to attach Chroma to sealed wood, sealed ceramics, metal, glass and some other plastics. *VHB* tape is UV stable and can be used for interior and exterior applications 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. Surface preparation is needed before applying *3M VHB* tape to a Chroma panel. First both surfaces are to be cleaned with water. Following cleaning allow surfaces to dry thoroughly. 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. 150°F for 1 hour). If the entire weight of the Chroma panel is supported by the *3M VHB* Tape, a minimum of 4 in² (25 cm²) of tape should be used for every 11lb (0.45 kg) of panel weight to be supported. *3M* support is available for questions related to the use of *3M VHB* Tape. Call 1-801-649-2670 and ask for technical service support especially when bonding Chroma 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 water wipe for metal and plastic surfaces.
- Apply Tape to first surface, apply firm pressure (more than 15 psi) with a roller.
- Remove liner from second side of tape 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 Chroma 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 Chroma 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" (9.5 mm). Excess sealant should be wiped away with isopropyl alcohol before curing. Additional technical support can be reached by contacting the 3form Technical Help Desk at 1-801-649-2670.

DO

- Insure 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).

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" (9.5 mm) from an air interface.

The following table lists several adhesives and bonding mediums that provide strong bonds with Chroma.

ADHESIVES AND SEALANTS FOR CHROMA FABRICATION

PRODUCT NAME	DESCRIPTION	APPLICATION
Devcon Clear Welder Plexus Acrybond P9157	2-Part Acrylic Adhesive	Chroma to Chroma
<i>Weld-On 55/58</i>	2-Part Urethane Adhesive	Chroma to sealed wood or painted surfaces.
3M™ VHB™ 4910 Clear Tape	2-Sided Structural Tape	Chroma to sealed wood, metal, glass, plastics
Momentive SilGlaze II SCS2801	Clear Silicone Sealant	For sealing edges (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 water.
- Allow surface to dry thoroughly before bonding.
- Insure that surfaces to be bonded are smooth, mate well, and are accurately aligned.
- Use a jig or fixture to securely hold parts being bonded together while curing.
- Wipe extra cement away from the panel using a rag before it is fully cured.