SINTRA

JOHNSONPLASTICS PLUS

The Foamed PVC Family

SINTRA®

3A COMPOSITES

Fabrication Manual

3A Composites
May 2018

Foreword

Thank you for choosing a 3A Composites product for your graphic display applications.
We have compiled this Fabrication Manual based on our Fabrication Guide, which is divided into the following sections:

Mounting
Repositioning Vinyl
Direct Digital Printing
Direct Screen Printing
Painting
Knife Cutting
Saw Cutting
Routing
Die Cutting/ Punching
Embossing
Forming Curves
Appendix I: MSDS (Material Data Safety Sheet)
Appendix II: Specifications

This Fabrication Guide was created to incorporate the most common fabrication methods that are used with 3A Composites' line of graphics display products. Not all fabrication methods are compatible with each product, but this format was kept for consistency purposes. **The term "the substrate" is used throughout this guide and is meant to apply to all members of the substrate family unless noted otherwise.** Those fabrication methods that do not apply to a certain product are stated with a short explanation and a recommendation for an alternative product that fits that application method.

This manual also contains Appendix I which provides a Material Safety Data Sheet section. Appendix II includes an adhesives, fastening and storage guidelines section. Any unique product information will be contained in Appendix II. See Table of Contents. An Appendix III section lists products that can be used in conjunction with 3A Compositesproducts. 3A Composites is not responsible for the performance of any of these products when used independently or with any 3A Composites product.

The date of the last revision is shown on the bottom right hand corner of each page. Please make sure you have the most current version by going to GraphicDisplayUSA.com and selecting the document library.

If you have any further questions about our product or about how to use this manual, please feel free to contact us at 1-800-626-3365.

PLEASE NOTE:
TRIALING IS RECOMMENDED TO ENSURE SUITABILITY FOR THE PROPOSED APPLICATION AND FABRICATION BEFORE FULL-SCALE COMMERCIALIZATION.

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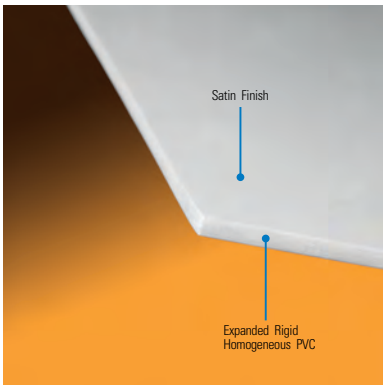
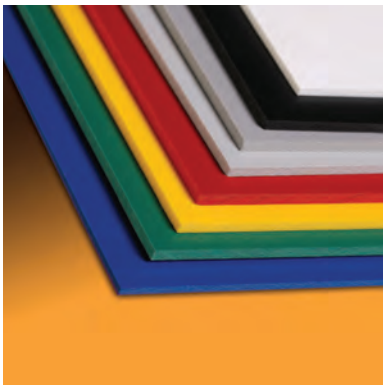
Introduction to Sintra

Sintra® is a lightweight yet rigid board of moderately expanded closed-cell polyvinyl chloride (PVC) extruded in a homogenous sheet with a low gloss matte finish.

Sintra® Bright White, our standard white, is ideal for direct printing signs, exhibits, point-of-purchase displays and kiosks, as well as for mounting. It is the graphic display board with the brightest, whitest surface available to produce eye-popping graphics in both direct screen printing and digital printing applications.

Durable Sintra® is easy to fabricate with wood or foam board techniques. It cuts cleanly, creating smooth edges; and, it can be direct printed and accept vinyl graphics. Sintra® fabricates easily without special tools and can be heat formed and laminated to other materials.





The Sintra® PVC board set of products feature a lightweight, rigid, smooth, flat and uniform surface. These characteristics make Sintra® suitable for a wide variety of application and fabrication methods. It can be mounted on or direct printed. It can be easily cut for dramatic lettering and dimension. Sintra® board products are available from 1mm all the way to as thick as 19mm. Consult the 3A Composites website for the most current products and sizes at **GraphicDisplayUSA.com.**

Why Choose Sintra?

The Foamed PVC Board Family

SINTRA® has been the industry's leading PVC for more than 20 years. It is comprised of moderately expanded closed-cell polyvinyl chloride (PVC) in a homogenous sheet with a low-gloss matte finish.

- Sintra® Bright White is now the brightest and whitest PVC board on the market
- The trusted brand leader by which all others are measured
- Lightweight yet rigid and durable
- Easily formed into just about any shape imaginable using wood and foam board fabrication techniques
- Heat formable and chemical resistant
- Superior dent and scratch resistance

Application & Fabrication Guides

APPLICATION GUIDE

	POP Display	Exhibits & Kiosks	Framing	Framing - Archival	Signage - Interior	Signage - Exterior	Signage - Structural
e-pvc™	●	●	■	■	●	●	
Sintra®	●	●	■	■	●	●	

Trialing is recommended to ensure suitability for the proposed application before full-scale commercialization

- ○ Short-term application life
- ● Medium-term application life
- ■ Long-term application life
- □ Applications such as workzone signage, canopies, pylons, and column covers

FABRICATION GUIDE

	Mounting	Repositioning Vinyl	Digital Printing	Screen Printing	Painting	Knife Cutting	Saw Cutting	Routing	Die Cutting/Punching	Embossing	Forming Curves
e-pvc™	◇[1]	◇	◇	◇	◇	◇[2]	◇	◇	◇[3]		◇
Sintra®	◇[1]	◇	◇	◇	◇	◇[2]	◇	◇	◇[3]		◇

Trialing is recommended to ensure suitability for the proposed application before full-scale commercialization

1. Cold mounting techniques only
2. 1-3mm may be cut with a knife or blade
3. May be die cut in gauges up to 5mm or 3/16"

Section I: Mounting

General Notes

Mounting, laminating and bonding are terms that are often times interchanged. For this document mounting is defined as the attachment of the graphic to the substrate. Lamination is the application of a covering (film or liquid) over the mounted item to either protect the graphic or provide a certain appearance i.e. matte or glossy finish. Bonding also conveys affixing one thing to another. This can involve a graphic to a substrate or one substrate to another. This document uses the term "mounting" to convey affixing as opposed to bonding. A paper, foil, plastic or fabric graphic can be mounted to the substrate.

With regard to adhesive, mounting consideration should follow the adhesive manufacturer's instructions. In general, determine the minimum amount of adhesive lay down to attain the desired adhesion level. It is advisable to leave the boards for a period of time to setup. Consult the adhesive manufacturer's instructions to see what specific times are recommended. Please refer to Appendix I for additional adhesive information.

Archival Mounting (Conservation Framing)

- The substrate is not suitable for Archival Mounting.
- Conservation or archival mounting requires the selection of materials that are pH neutral to use in conjunction with the substrate and the artwork. This includes matting material, hinges, and adhesives. Matboards, particularly those in contact with the art, should meet the Library of Congress specifications. Art must never be mounted in contact with the glass. If long-term preservation is the goal, only UV protection glass should be used. Finally, it is a good practice to seal the back of the frame with a dust cover or barrier paper.
- The substrate in both .700 specific gravity and .500 specific gravity are "acid free"/pH neutral — where the pH is slightly above 7.0.

Methods for Mounting

There are a variety of methods (adhesive, pressure, etc.) for mounting a graphic to a substrate. For this document, mounting will be broken into two groupings; hot or cold mounting, with discussion on the various methods of applying pressure.

- Hot mounting provides a heat source to activate the adhesive. Typically, this is accomplished with a heat source associated with either a vacuum press or a roller press.
- Cold mounting typically utilizes a spray or pressure-sensitive film or coating in combination with a roller press.

Printed papers, foils, and fabrics can all be mounted to the substrate provided that the proper types of adhesives are selected. Mounting can be accomplished on most standard equipment capable of applying adhesive and laminating sheets or roll stock to rigid boards.

Surface Preparation

Surface should be cleaned and free of any surface contaminates (i.e. oils, dust particles, etc.) prior to commencing.

The substrate should be cleaned with isopropyl alcohol, using a non-colored cloth for best results. It is important not to use thinners or soaps as they may leave a film residue which can affect adhesion. Additionally, cleaners containing silicone can interfere with adhesion and are not recommended.

Any surface scratches on the substrate will have a tendency to telegraph through the graphic. In order to remove small scratches or dents, rapidly fan a heat gun over the affected area. Care must be taken not to leave the hot air in one place for too long, as the surface can be deformed.

Section I: Mounting

Other Considerations

- Care should be taken when using laminate films on only one side of the mounted graphic. Moisture pickup will be sealed on one side while the other side in not protected from moisture pickup. Bowing may occur because of moisture imbalance.
- Additionally, care should be taken when mounting only one side with spray adhesives. As the mount cures out, tensile forces within the adhesive may cause the substrate to bow. It may be necessary to apply a counter-mount of comparable strength on the backside.
- Finally, one must use the minimum amount of tension when mounting with film or pressure sensitive adhesives as too much tension will cause the substrate to bow; too little will cause the graphic to wrinkle.

Hot Mounting - General Notes

The substrate is not recommended for this fabrication method. Please see the fabrication guide on page 7 for choosing the best recommended product.

Cold Mounting - General Notes

Getting Good Adhesion

- To cold mount pressure-sensitive adhesives, you need sufficient pressure. You also must make sure that proper spacers are used. Because effective mounting depends on equal force exerted across the entire width of the substrate being mounted, the top roll must move down evenly left and right. Even contact between the top and the bottom mounting rolls is essential.
- Adequate pressure helps squeeze out air from between the adhesive, the substrate and the print.
- The mount obtained after 3 hours will generally allow for processing. Maximum mount is usually obtained within 24 hours after mounting.
- To test adhesion, flex the finished mount. It should not come loose in the center.
- Moisture can become trapped between layers of porous material (such as paper) and cause blisters. The level of moisture in the atmosphere should be reduced before press work. Prints may even have to be pre-dried.
- When tacking prints to the substrate, some shops will hang a number of tacked pieces in an upside-down position until they are ready to pass them through. As a precaution, it is advisable not to hold them any longer than 10 minutes or the prints may absorb moisture, change in dimension and cause bubbles and wrinkles.
- Please contact the film manufacturer for recommendations concerning the use of their respective laminating material in conjunction with the substrate as film choice is the most important consideration.
- It is advisable to use a film with a high "green tack" strength. When using pressure sensitive films, the substrate should be at room temperature to achieve optimal results.

Demouning Bad Mounts

- Pressure-sensitive adhesives may be demounted if done within 5 minutes after mounting. The print will probably be ruined, but the substrate may be reused.
- Beyond 5 minutes, the adhesive has set and other methods will have to be used, such as a hot air gun or a hair dryer to peel off the laminate. The remaining adhesive may be taken off with isopropyl alcohol or mineral spirits.

Section I: Mounting

Cold Mounting - General Notes

Avoiding Wrinkles & Surface Blemishes

- Wrinkles can be caused by misalignment of adhesive roll, too much pressure, or unparallel rolls.
- Small bumps, particularly visible with Cibachrome or glossy prints, are caused by trapped dirt or hardened adhesive. Good housekeeping and an ionizing static eliminator on the press are important to minimize dirt pick-up. During mounting, the back of the print should be checked and wiped down before it is processed. If bumps are caused by hardened adhesive (cut open to check), use a fresh roll or sheet of transfer adhesive. To prevent strikethrough, one might also consider using a print made with thicker paper (.007+).
- Pressure roller applicators can compress the leading edge of the mounting substrate. In order to keep the leading edge from rounding as it goes through the roller, use a plastic lead or guide of the same thickness of the mounted substrate.

Clear Overlays

- Clear high-gloss overlays enhance color and protect against fading indoors and outdoors. To avoid blistering, do not use overlays, clear coatings, or sprays which contain solvents.

Cold Mounting Procedures

There are several techniques for cold mounting to the substrate:

Cold Mounting by Hand Using Transfer Adhesive

- Take a sheet of transfer adhesive (both sides covered by release paper) and fold back release paper on one side approximately 1/2" from one edge.
- Tack on edge of print to exposed adhesive.
- Lift the print slightly, remove the rest of the release paper and use a roller or squeegee to smooth the print onto the adhesive. The back of the print is now coated with an adhesive which is protected by release paper.
- Before mounting to the substrate, remove excess air between print and adhesive. This is done by turning the print over so that the release paper is up and smoothing out from the center with a squeegee.
- Now peel off approximately 1/2"–1" of release paper from upper edge and fold back.
- Tack on to the substrate, lining up edges.
- Using a hand roller or squeegee, closely follow the removal of the liner to eliminate bubbles caused by air entrapment. Work with a small surface at a time (approximately 12"). Continue this step until the mounting is complete.

Cold Mounting by Hand or Press Using Spray Adhesive

- Select a spray mounting adhesive that is safe to use with polystyrene and the artwork to be mounted; solvent based adhesives should be used with caution.
- Spray adhesive on the back of the piece to be mounted. Spray 6"– 8" away from the surface. A double coat is best, with the second coat applied in a cross direction to the first coat. For mounting most art materials, adhesive need only be applied to one surface, preferably the print. Avoid using excessive bonding adhesive
- Before mounting, allow adhesive to dry to the touch; the adhesive must be aggressively tacky. If there are blisters due to trapped solvent, allow slightly longer than 4 minutes of drying time.

Cold Mounting Procedures

Cold Mounting by Hand or Press Using Spray Adhesive (cont'd.)

- Carefully position piece on the substrate and smooth out if possible to eliminate any wrinkles and trapped solvent.
- If using a press, simply turn on the press to complete the mount.
- If mounting is done by hand, place a clean sheet of the substrate over the laminated piece and weigh down for 15 minutes to obtain the maximum bond. Depending upon the type of adhesive, allow 24 hours for maximum cure out before exposing the laminate to sudden temperature or humidity changes.

Cold Mounting by Roller Laminator With an Adhesive-backed Graphic

- Adjust the rollers to slightly compress the substrate to provide adequate pressure for mounting.
- Peel off a 1/2"–1" section of release paper from the upper edge of the preprinted adhesive backed paper.
- Tack on to the substrate, lining up edges.
- Feed tacked edge into nip of rollers keeping printed piece bent away from the substrate.
- As it passes through the rollers, strip away the release paper. (Make sure there are no wrinkles or trapped dirt.)

Cold Mounting Non-Porous Graphics

For non-porous material such as PVC, other plastics or metal, the following types of contact adhesive with solvent may be used.

- Neoprene, nitrile, polyurethane or other synthetic rubber types.
- Adhesive must be applied to both faces. Parallel beads of adhesive are often preferred because it allows evaporation of solvent providing faster cure.
- For mounting the substrate to flexible PVC sheets, only plasticizer-resistant types of adhesives should be used.

Cold Mounting Porous Graphics

For porous materials such as paper, textiles, fabrics or wood, the following adhesives may be used.

- Contact adhesive with solvent: Same systems as for non-porous materials.
- Construction mastic, structural silicone adhesives.
- Considerations such as expected temperature ranges (expansion/contraction), porous material, and size of substrate should be taken into careful consideration when deciding on a method of attachment.

Cold Mounting With Pressure Sensitive Tapes

Pressure sensitive tapes can be used for:

- Less demanding applications that are stress-free.
- Adhering parts during installation work.
- Holding parts while the primary adhesive is curing.

It is recommended to trial pressure sensitive tapes prior to use.

Section I: Mounting

A Note on Mounting Sintra to Sintra

- For edge mounting and joining parts made of Sintra material, use a PVC solvent such as THF, MEK, cyclohexanone solvent systems. Make sure the solvent is fresh – it can lose effectiveness with age.
- For mounting large areas: If using PVC solvent such as pipe cement, spread with a notched trowel and work rapidly. One can also use adhesives recommended for non-porous materials.

TROUBLESHOOTING WHEN USING COLD MOUNTING PRESSES		
Poor adhesion or bubbles:	a. Insufficient pressure	a. Increase mounting roll pressure if running without spacer shims. If using spacer shims, use next smaller size
	b. Stripping back more than 1" of release paper while tacking on print traps air	b. Never strip back more than 1" of release paper
	c. Premature contact between print and adhesive traps air	c. As it is fed through rolls, the print should be tilted or bent away from adhesive until it enters the nip
	d. The print contains moisture	d. Pre-dry print and/or keep humidity at a low level
Curl (bowing):	a. Too much web tension	a. Reduce unwind brake pressure
Wrinkles:	a. Misalignment of adhesive roll, causing web tension	a. Shift the material roll on the bar to release tension
	b. Top and bottom mounting rolls are not parallel	b. Stripping back more than 1" of release paper while tacking on print traps air
	c. Too much pressure	c. Reduce roll pressure
	d. Substrate material thickness relative to shim thickness is too great (should be no more than 1/32").	d. If correctly sized spacer shims are not available, zero the nip

Section II: Repositioning Vinyl

General Notes

Major market brands of vinyl films work well with the substrate. These vinyl films are, for the most part, flexible PVC films and are produced in various thicknesses, color shades, and gloss levels. They can also be un-pigmented to act as a U.V. inhibitor. These films have a layer of adhesive and a siliconized sheet of cover paper. These films generally have excellent adhesion to the substrate. Final selection of a particular vinyl film should be made after consultation with the manufacturer to ensure conformity for its application.

For thinner gauge substrates (1mm-2mm), the technique of "counter-balancing" should be considered. A vinyl sheet may be required on the back side of a vinyl covered substrate to prevent the possibility of bowing.

As a rule, take caution to avoid too much tension when applying vinyl, as excessive tension may lead to bowing of the substrate.

Surface Preparation

Surface should be cleaned and free of any surface contaminates (i.e. oils, dust particles, etc.) prior to commencing.

If surface has become soiled or scratched, it may be lightly hand sanded with a silicon carbide dry paper 180 grit or finer. Ensure that any remaining loose dust is completely removed from the substrate.

Any surface scratches on the substrate will have a tendency to telegraph through the graphic. In order to remove small scratches or dents, rapidly fan a heat gun over the affected area. Care must be taken not to leave the hot air in one place for too long, as the surface can be deformed.

Repositioning Vinyl

- Identify any misaligned or improperly adhered vinyl graphic.
- Using a sharp edge or razor blade held at a 45-degree angle to the substrate, begin to lift the vinyl, taking care to not scratch the substrate surface.
- After lifting enough of the vinyl surface in order to grab between the fingers, continue to peel back the graphic by hand, proceed with a proper speed so as to not tear or damage the vinyl graphic.
- Once completely removed, lay the vinyl graphic face-down smoothly on transfer paper.
- Reposition the vinyl graphic face-up in the proper location on the substrate and gently rub the transfer paper to re-adhere the vinyl graphic.
- Remove the transfer paper and gently press out any wrinkles or bubbles within the vinyl graphic by hand.

Section III: Direct Digital Printing

General Notes

Large format digital printing on flatbed printers has excellent application for the substrate. Although the substrate is available in a wide range of colors that all demonstrate excellent ink adhesion, the predominant substrate color is white when direct digital printing. However, colored variations of the substrate may provide vibrant color contrasts depending upon the availability of a white print head on the printer.

Surface Preparation

Surface should be cleaned and free of any surface contaminates (i.e. oils, dust particles, etc.) prior to commencing.

The substrate should be cleaned with isopropyl alcohol, using a non-colored cloth for best results. It is important not to use thinners or soaps as they may leave a film residue which can affect adhesion. Additionally, cleaners containing silicone can interfere with adhesion and are not recommended.

Any surface scratches on the substrate will have a tendency to telegraph through the graphic. In order to remove small scratches or dents, rapidly fan a heat gun over the affected area. Care must be taken not to leave the hot air in one place for too long, as the surface can be deformed.

Suitable Inks

Actual ink type depends upon the printer make and model. Consult the printer owner's manual for recommendations. Trialing for ink compatibility is always recommended.

The substrate readily accepts all types of inks including:

- Aqueous
- Solvent-Based
- UV-curable

Elevated UV exposure can affect PVCs printed with UV ink, causing brittleness in the printed areas of the sheet.

Section IV: Direct Screen Printing

General Notes

Large format screen printing has excellent application for the substrate. The substrate is available in a wide range of colors that all demonstrate excellent ink adhesion.

Surface Preparation

Surface should be cleaned and free of any surface contaminates (i.e. oils, dust particles, etc.) prior to commencing.

The substrate should be cleaned with 70% isopropyl alcohol, using a non-colored cloth for best results. It is important not to use thinners or soaps as they may leave a film residue which can affect adhesion. Additionally, cleaners containing silicone can interfere with adhesion and are not recommended.

Any surface scratches on the substrate will have a tendency to telegraph through the graphic. In order to remove small scratches or dents, rapidly fan a heat gun over the affected area. Care must be taken not to leave the hot air in one place for too long, as the surface can be deformed.

Suitable Inks

When screen printing with the substrate, the following inks may be suitable:

- Solvent-Based
- Vinyl/Acrylic
- UV-curable

Screen Printing inks should be tested in a manner which duplicates your printing process before initiating production. It is advised that you contact the equipment and ink supplier to provide you with specific recommendations to achieve maximum results. It is strongly recommended to consult the appropriate ink manufacturer regarding any required ink additives such as catalyst for proper adhesion and exterior use.

Ink Curing

The ink, once applied, must be given proper time and treatment to completely adhere and cure.

Screen printing ink should air dry rather than be heat dried for the substrate as temperature in excess of 150°F may cause warping or bowing of the substrate.

Most UV Screen printing inks that are compatible with rigid PVC will work on the substrate. The most important factor to be considered when using UV systems is the amount of UV energy the printed substrate receives. The lowest amount of energy needed should be used to cure the UV ink. Elevated UV exposure can affect PVC's causing brittleness in the printed areas of the substrate. Low wattage bulbs should be used to keep the temperature below 150°F. The use of UV curing systems with variable speed conveyers are considered the best type to use with the substrate. UV inks should be cured for 24 hours for best printing ink adhesion.

Section V: Painting

General Notes

Painting is a suitable fabrication option for the substrate, whether for artistic expression or more commercial applications. On some projects that involve the substrate, a small quantity of "custom color" may be required that is often not practical to obtain from the factory and post painting is a viable option.

Surface Preparation

Surface should be cleaned and free of any surface contaminates (i.e. oils, dust particles, etc.) prior to commencing.

The substrate should be cleaned with 70% isopropyl alcohol, using a non-colored cloth for best results. It is important not to use thinners or soaps as they may leave a film residue which can affect adhesion. Additionally, cleaners containing silicone can interfere with adhesion and are not recommended.

Any surface scratches on the substrate will have a tendency to telegraph through the graphic. In order to remove small scratches or dents, rapidly fan a heat gun over the affected area. Care must be taken not to leave the hot air in one place for too long, as the surface can be deformed.

Suitable Paints

The substrate readily accepts the following paints:

- Acrylic Lacquers
- Two-part polyurethanes
- Vinyls
- Some water-based paints may also be suitable, depending upon the application.

The painting of the substrate is easily accomplished with paints known to have compatibility with rigid PVC.

Oil-based enamels generally do not have the good adherence properties of solvent based systems on the substrate. The use of primers may improve the adherence of non-solvent based systems, though the adherence is usually minimal.

Adhesion Test

The paint system chosen should always be tested for adequate adhesion. To test for adhesion, conduct the Cross Hatch Test after the paint has dried for at least 24 hours:

- Make 11 parallel cuts 1/16" apart with a razor blade knife. Make 11 similar cuts at 90 degrees to cross the first set.
- Across the scored area apply a strip of strong tape, such as #610 Scotch tape. Press firmly.
- Immediately remove the tape by pulling it back upon itself at 180 degrees in one rapid motion.
- There shall be no removal of the paint squares to obtain a good adhesion rating.

Section V: Painting

Application

Paints can usually be applied with a brush or roller, although conventional air spray equipment will provide a more consistent appearance.

Consult paint manufacturer's literature for recommended application technique and thinning requirements.

Drying

The substrate should not be dried at temperatures in excess of 150°F.

For drying and cure times, consult paint manufacturer's literature.

Due to the wide variety of paint products on the market, and the fact that some paints have been known to embrittle or bow the substrate, testing is recommended for the initial use of any coating system before commercialization.

Edge Treatment

When the substrate is cut to size during fabrication, edge cells are exposed. Although these cells do not allow paint or water to be absorbed any further than the first layer, the filling or chemical collapsing of these cells before painting can offer close to the same texture or appearance as the substrate surface after painting.

- Filling exposed cells (10-13 mm)
  - Spot putty or glazing compound used in the auto body industry works very well.
  - Fill edge cells with spot putty using a stiff, flat blade. Fill the cells; do not build up the edge.
  - When dry, usually 3-4 minutes, sand lightly to remove blade marks and any build up of putty.

- Collapsing exposed cells (1-6 mm)
  - Use a PVC solvent such as, Methyl Ethyl Ketone (MEK) or Tetrahydrofuran (THF).
  - Sand the substrate edge to remove all saw or router marks.
  - Apply PVC solvent to sanded edge with acrylic glue applicator bottle. With protected finger, rub solvent onto edge of the substrate. The more you apply and rub, the more cells you collapse.

- Edge Banding
  - For thicker substrate gauges, 1mm or 2mm Sintra material can be adhered to the edge using a PVC solvent.

Aluminum or plastic edge extrusions ("U" Channels, T-Moldings)

Section V: Painting

Table I - Advantages/Disadvantages of Paint Types

Paints	Type	Gloss	Advantages	Disadvantages
Matthews Map	2 part acrylic polyurethane	Will match gloss required	Excellent outdoor weatherability. Resists solvents, hard coating, no primer required. 16 standard colors.	2 part system. Slow drying. Experience necessary in spraying technique to get good finish. Irritating vapors.
Spraylat Lacryl 20 Series	Automotive quality acrylic lacquer	High	Single component. Good adhesion. Custom colors only. Weather resistant.	Translucent. Best used on white Sintra only. Not a hard finish like Map. Flammable.
Wyandotte Grip-Guard	2 component acrylic polyurethane. Use with 10 AHK 31050 primer	Will match gloss required	Good solvent resistance. Good weathering. Needs no top coat	2 part system. Slow drying. Experience necessary in spraying technique to get good finish. Irritating vapors.
Wyandotte Grip-Flex	1 part thermoplastic acrylic	To match gloss, use Grip-Flex clear top coat	Good outdoor weatherability with Grip-Flex clear top coat: 10-AFT 02-200	Must use top coat for optimum performance. Needs no primer. Good thermoformability.
Wyandotte Meta-Flex	1 part thermoplastic acrylic	Will match gloss required	Use clear top coat for best weathering. Hard coating. Needs no primer.	Must use top coat for optimum performance
Sherwin Williams Polane	2 part aliphatic polyurethane	Will match gloss required	Good adhesion and weatherability	2 part system. Slow drying. Experience necessary in spraying technique to get good finish. Irritating vapors.
Hydrocoat Finishing Products, Inc.	Water based: Vinyls, lacquers, and polyurethanes	Use top coat for high gloss	Good adhesion and compatibility. Water clean-up	Surface must be grease and dirt free
Carbithane 11 and 12	Acrylic polyurethane	Satin and Series, Carbit Paint Co.	Good adhesion	Slow drying. Experience necessary in spraying technique to get good finish. Irritating vapors.

Section V: Painting

Table II - Advantages/Disadvantages of Primer Types

Primers	Type	Advantages	Disadvantages
Consumers Paint Factory 1 Shot Vinyl Primer #5004	Water Soluble	Improves adherence of enamel	
Ronan Paint Corp. Prime-All	Water Borne	Improves adherence of enamel	
Masterchem Industries Kilz.	Solvent Based. Exterior or Premium	Improves adherence of enamel	

Table III - Advantages/Disadvantages of U.V. Protection Types

U.V. Protection	Type	Advantages	Disadvantages
Matthews Paint Corp. Map Clear	2 part acrylic polyurethane	No primer required. Excellent outdoor weatherability	Irritating vapors. Spraying provides most consistent finish

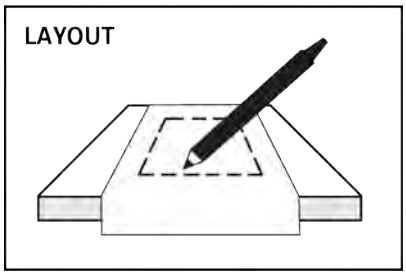
Section VI: Cutting

General Notes

There are many different methods in which "cutting" can be accomplished. This guide focuses on five primary cutting methods:

- Knife Cutting
- Shearing
- Saw Cutting
- Routing
- Die Cutting/Punching

When necessary, laying out a pattern on the surface of the substrate is best achieved with a soft pencil.



Knife Cutting

The substrate in thicknesses from 1mm to 3mm can be fabricated with this method.

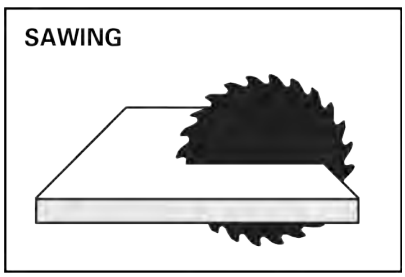
The substrate can be cut by hand with mat knives, utility knives, and razor blades. Mat cutters make smooth, excellent cuts, either right-angled or beveled. Cardboard and glass cutters also work well. The key to getting a smooth, clean cut is to use a very sharp thin blade held at as low an angle as possible to the board, which reduces friction. If a straightedge is being used as a guide, it may be practical to make the cut in more than one pass.

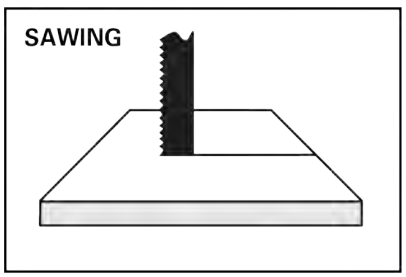
Shearing

Shearing with a guillotine shear is generally not recommended since the material is subjected to strong compression during the shearing process. This may result in an unsatisfactory cutting edge.

Saw Cutting

Cutting the substrate may utilize the following techniques: Sheets can be cut with hand, circular or saber saws. Wood-cutting saws can also be used. Fine-tooth hack-saws are not suitable since the finer tooth spacing creates excessive friction and produces an undesirable finish. For best results, in all cases, use saw blades that are identified as triple chip tooth configuration or "plastic cutting."





Problemshooting with Sawing

Should rough edges result, it may be from one or more of the following reasons:

- Dull cutting tool.
- Inadequate support of the work piece.
- Saws not adjusted closely to work, get weave of the blade.
- Vibration of the cutting tool.
- High friction temperature on the cutting surface.

Section VI: Cutting

Saw Cutting

Milling

- The substrate can be machined on the usual types of milling machines: universal, horizontal and vertical. To avoid indenting the surface when clamping, place flat pieces of wood or plastic between the work and the clamps.
- Tool geometry and working conditions are summarized in the chart below.

Edge Finishing

- Smooth edges can be achieved with a file, plane or sander. Conventional tools and methods for working wood or plastics can be utilized. Edges can be polished with solvent. More information on this topic is in the painting section.

Surface Finishing

- Short bursts of hot air from a heat gun can be used to remove small surface scratches and small dents.
- Surface finishing with cutting tools is possible. Grinding or polishing is not recommended since this may damage the surface and expose cut cells.

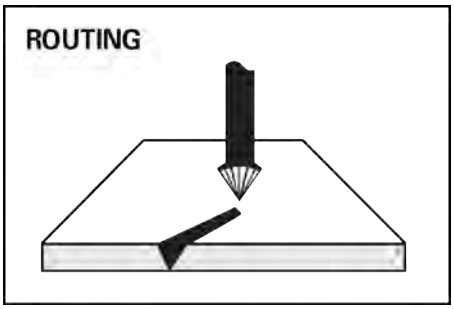
Specifications & Working Conditions Chart For Cutting

Cutting Methods	Applications; Advantages/ Disadvantages	Recommended Blade/Bit Geometry	Recommended Working Conditions	Recommended Blade/Bit
Circular Saws	Used for making cuts on radial arm or panel saws. Can stack up sheets if more than one piece is required at same length. Edge finishing may be needed since open cells are exposed by cut	Angled or curved teeth with alternative chamfer cutting nippers or set. Must be carbide-tipped. Well-rounded spaces between teeth. Rake angle: 5°-10°. Free angle: 10°-20°. Distance between teeth 3/16"-1/2".	Cutting speed: up to 10,000 FPM. Feed: up to 100 FPM.	1. No-melt Plasti-Kerf. 2. Triple-chip Carbide blade. 3. Many veneer type blades.
Bands Saws	Used for making curved cuts. Get very smooth edge—very little additional edge finishing required.	No rake, 8 teeth per inch. Hard edge type.	3,000 SFM	Do-All straight knife of "V" tooth blade
Saber Saws	Portable. Good for cutting curves, bevels, and intricate patterns. Not good for straight cut.	10-15 teeth per inch. Hard edge type.		2-pack blade package from Central Plastics Distributors. Use their green blade for Sintra material.
Milling		Rake angle: 5°-20°. Free angle: 10°-25°.	Cutting speed: 3,000-3,300 FPM. Feed rate: 8"-20"/min.	

Section VI: Cutting

Routing

Stationary or hand routers can be used for slotting, beveling, rabbeting, rounding edges and trimming. Best cutting results are obtained with carbide-tipped router bits. Routing, as a preparation for folding and heat bending, requires special shaped router bits. This information is included in "Heat Bending." Specifications and working conditions are listed in the chart below.



Specifications & Working Conditions Chart For Routing

Method	Applications; Advantages/ Disadvantages	Recommended Blade/Bit Geometry	Recommended Working Conditions	Recommend-ed Blade/Bit
Routing	Used particularly for making slots prior to heat bending. Can be stationary or portable, depending on type of operation desired.	High-speed carbide router bits. Various cutter head configurations.	Cutting speed: 3,000 FPM. Feed rate: 10"/min	Most high-speed carbide bits, `available at hard-ware stores

Die Cutting / Punching

Die cutting and/or Punching is a method for the rapid production of flat shapes or cutouts. Typical applications would include the die cutting of:

- Letters and shapes.
- Openings in a sheet used as part of an assembly
- Puzzle pieces

Die cutting and punching processes are similar in that they both can provide a curved shape by cutting through a substrate. Die cutting, however, uses one steel rule die that comes in contact with a flat platen, whereas, a punch has two designed shapes, a male and a female that cut the shape when pressed together.

Die cutting is typically used with lighter weight paper or foam type materials, where punches are used for heavier materials.

Prior to die cutting, the substrate can be painted or screen printed. After die cutting, the pieces may have additional fabrication including: heat bending, fastening, gluing, routering or machining

Section VI: Cutting

Die Cutting / Punching

A Note on Punching

- The substrate does not require "punching" tools, as die cutting works very well up to 5mm thicknesses; please refer to the previous section on die cutting.

Steel Rule Die Cutting Process

- The key elements to consider when die cutting are: the substrate, the press, the steel rules, and the ejection rubber. Each of these elements must be selected properly to yield satisfactory results.
- Although various methods such as using punches and "high-dies" are applicable to die cutting the substrate, cutting with steel rule dies (SRD) is the most common.
- SRD work basically the same way as a cookie cutter. They are made of a 1"-wide strip steel with one pre-sharpened edge. The cut strips are called "rules." The strip steel is typically made in a thickness range of .014"–.166". The strips are bent to the shape of the design's trim line and held in place in a block called a "die body."
- In order to facilitate ejection of the part, strips of a compressible material such as neoprene are glued along the perimeter and protrude above the cutting edge of the rule. The strips can also be glued to the top or bottom platen to hold the substrate in position.
- During die cutting, the SRD assembly is fixed under the top platen, and the substrate is placed on a steel bottom platen. Pressure is applied to force the rules of the SRD through the often preheated substrate
- The platens are then opened and the parts removed. In some cases, additional work such as finishing the cut edge might be required.

Substrate Considerations

Temperature of the sheet:

- Because the substrate is a thermoplastic material, it becomes more brittle with decreasing temperatures. With the sheet temperature below 75°F, the rule makes a clean cut about two-thirds of the way through and then fractures the last third of the cut.
- To get the best cut, it is advisable to preheat the material to 100°–130°F. The use of a press which contains hot platens can reduce the fracturing.

Thickness of the sheet:

- The quality of the die cut part is reduced as a thicker-gauge substrate is used. Beyond 5 mm, there is a greater chance of deformation, a rougher-cut surface or fracturing.
- It is possible to cut pieces thicker than 5 mm, providing the rule has the correct gauge (point) and bevel, the substrate is warm enough (100°–130°F), the right back-up plate is used and, most importantly, the cutting edge is kept sharp at all times. With thicker parts (5 mm+), it may be necessary to post-finish the cut edge.
- With a sheet thickness less than 5 mm, it is possible to form curves with radii less than 1/8". With thicker gauges, the minimum radius must be increased.

Section VI: Cutting

Die Cutting / Punching

Press Considerations

The substrate is typically die cut on flat bed presses, which can be either a "moving platen" type or a "clam shell" type. Either type may be utilized without affecting the quality of the die cut.

The key press consideration is proper "make ready", or preparing the press bed (anvil) to assure that the steel rule cuts evenly through the substrate without dulling the steel rules.

Typically, the substrate is cut on a "hard anvil." Make ready for this type of die cutting utilizes carbon paper. The press is lowered to the point where the steel rule just touches the anvil. The places where the rule fails to touch the anvil are built up with one-mil thick shim-tape. This process is repeated until a complete imprint of the steel rule is apparent.

Make ready is very important because the platen of the press does not necessarily close evenly. This can be caused by misalignment, uneven cutting loads or by deflection of the platen. As a rule of thumb, a four-post press will deflect one mil per foot. Steel rules that have been dulled by improper make ready will cut poorly, have increased cutting loads and can contribute to cracking problems.

Back-Up Plate

- One problem with steel plates is that the die might not completely penetrate the substrate which can result in fracturing at the base of the cut. An alternative to a steel plate would be to use additional substrate or chipboard as a back-up. This would allow the die to penetrate beyond the thickness of the substrate so that a cleaner cut could be obtained.

Steel Rule Considerations

Steel rules are flat strips of steel with a very uniform height. One edge of the steel rule is honed to yield a cutting surface. The key properties of cutting rules are hardness, flexibility, bevel type, thickness, uniformity of height and edge preparation

1. STEEL RULES THAT APPLY TO THIS SUBSTRATE ARE LISTED BELOW:

Cutting Rules

- Cutting rules are the most common when die cutting the substrate. These rules are used to cut the edge. Cutting rules are either center bevel or side bevel, which indicates where the cutting edge is located.
- Center bevel rules result in equal forces being placed on both sides of the piece to be cut and are used when both the inside and the outside of a cut needs to be saved, e.g., as in a puzzle. This distribution of forces can be important when attempting to minimize cracking
- Side bevel rules have one side that is essentially flat and the opposite side is sloped or beveled. The flat side should be placed toward the substrate that will be kept, with the bevel facing the scrap piece. This results in additional compressive force being placed on the scrap side. Cracking tends to be directed in this direction.

Die Cutting / Punching

Steel Rule Considerations (cont'd.)

2. EDGE PREPARATION:

Grinding

- Ground edge rules have micro-scratches on the cutting edge. This can result in a blade that has a reduced cutting force.
- The disadvantage of this type of rule is that it is difficult to maintain the uniform blade height.

Drawn Edges

- Drawn edge blades are made by drawing the blade through a die.
- This produces a uniform blade height and a smooth blade surface.

Although the knife has been hardened to 57-59 RC (Rockwell), after numerous die cuts, the cutting edge will become dull and may result in rough and/or incomplete cuts. Generally, it is not a good idea to resharpen the knives. Resharpening will often result in an uneven knife length. This in turn can cause uneven penetration or no penetration when the cut is made.

As the rule makes contact with the substrate, you may notice strong compression which can result in a deformation or rounding of the corner.

There is also a tendency to fracture the substrate about two-thirds of the way through the cut. With the same bevel, a thinner rule will produce a straighter, smoother cut and form sharper radius than a thick rule. The rule has to be thick enough, however, not to break when cutting thick substrate gauges, particularly if the temperature of the substrate is below 100°F. In general, the thinner the knife, the lower the substrate temperature required for making a cut.

As a guide for cutting substrate, we suggest that the following thickness (point) rules be used:

- For normal parts, 3 point (.042") or 4 point (.056").
- For intricate parts using a thin gauge (under 4 mm) substrate, 2 point (.028").
- For a very thick gauge (5 mm+), or if a wide cut separating adjoining pieces (some puzzles, etc.) is desired, 6 point (.084").

3. LENGTH OF BEVEL:

A long bevel will result in less deformation as the substrate is sheared. The length of the bevel is defined as the distance from the tip to the point where the honed (beveled) portion ends. The bevel should be 3/16"–1/4" in length.

Strippers / Ejectors

Ejection & Stripping Rubber

Ejection and stripping rubber is essential when cutting the substrate. It serves two purposes. The first purpose is to eject the part from the die after the press opens. The second purpose is to prevent cracking.

Section VII: Embossing

General Notes

The substrate is not recommended for this fabrication method. Please see the fabrication guide on page 7 for choosing the best recommended product.

Section VIII: Forming Curves

General Notes

The forming of curves can be accomplished with the substrate to provide a unique dimensional effect. Curves are typically formed by heat forming.

Heat Forming

One of the many advantages of the substrate is that it can easily be bent by using localized heating. It is possible to cut sheets to final dimensions and perform some machining operations prior to heat bending. Spray painting, screen printing, machining, gluing and fastening operations can be performed after heat bending.

When the above processing has been done, the part can be used in displays, signage, trade shows, or in many applications where a lightweight, curved substrate is desired. Other applications would include angles, channels and ducts.

Defining the Heat Bending Process

Most rigid thermoplastic materials become soft and pliable when heated. After cooling, these materials become rigid once more. This permits a variety of heat-forming techniques such as heat bending, vacuum forming and pressure forming.

Unlike vacuum forming, it is not possible to create an intricate shape with heat bending. However, unlike vacuum and pressure forming, the sheet gauge of the substrate experiences relatively little thinning-out during heat bending.

The steps in the heat bending process are:

- Heat the substrate in an area along the line where the bend is to be made. The width of the area is determined by the gauge of the sheet and the angle of the bend.
- After the sheet has attained the proper flexibility, bend to obtain the desired radius and angle.
- Hold the substrate in position to cool. Cooling may be accelerated by contact with cold metal, a moist rag, compressed air or fans.

Heating Parameters

The characteristics of the substrate, the thickness of the sheet, and the radius of the bend, will determine the method, time, temperature and width of the heated area.

Characteristics of the Substrate

As a moderately expanded rigid PVC, the substrate requires less time to heat than solid materials. For optimum bending, the temperature of the substrate should be in the range of 250°–300°F.

In general, the substrate should be allowed to "soak" (i.e., heated at a lower temperature for a longer period of time, instead of at a higher temperature for a shorter time).

Section VIII: Forming Curves

Heating Parameters

Types of Heaters

Direct contact heating bars can be used for 2mm - 6mm substrate thicknesses provided that the surface temperature of the bars is kept below 300°F. A higher temperature may melt the surface or leave an unsightly impression on the substrate.

The substrate should be set directly on the bar to get better contact. Continue heating until the substrate is pliable enough to bend.

To avoid direct contact heating, one may prefer to purchase or construct an IR heater recessed slightly below the surface of a table:

- Nichrome heater wires, Calrod heaters, or silicone blanket heaters work for this use.
- A rheostat must be used to adjust the intensity of the heat.
- For substrate thicknesses 3mm and thicker, the area to be bent should be heated from both sides by alternately flipping it back and forth over the heater until the sheet becomes pliable.

Effect of Thickness

As the thickness of the substrate increases, so does the total volume of the sheet to be heated. For this reason, different heating methods must be used for thicker substrates than for thinner-gauge material.

- Heating time and temperature: Increase heating time approximately 75% per each 1 mm increment in thickness. Keep the temperature setting constant.
- Application of heat: With 1mm and 2mm, heat the substrate on one side only—the side forming the inside of bend. Above 2 mm, heat either sides; or heat one side, flip over, and heat the reverse side.

Effect of Radius

The following heating widths are recommended:

- Very small radius = 2X the thickness of the substrate
- Average radius = 3X the thickness of the substrate
- Large radius = 4X the thickness of the substrate

To obtain very large radii, the following techniques can be used:

- Use Calrod heaters with reflectors to broaden heating area.
- Use hot air guns.
- Construct a heater to get a very wide heating area. Use a perforated steel sheet heated with gas. Drape over a waxed cardboard tube (sleek tube) to make bend.
- Silicone blanket heater used in conjunction with a rheostat to control heat.

To make very sharp bends.

Section VIII: Forming Curves

Heating Parameters

Effect of Radius

To make very sharp bends.

- Use a "V" groove 90 degree carbide router bit. Score the side of the sheet which forms the inside corners. Typically route about halfway through for a 90 degree corner with a slight radius.
    - Heat the routed area until the substrate will flex easily.
    - Bend the sheet and place in cooling guide.
    - Apply PVC solvent to seam to add strength to the corner.

1. V-rout near edge of panel, approximately 90% penetration

2. Heat Bend
3. Solvent Bond

Section VIII: Forming Curves

Bending & Cooling

Guides and Frames

A bending guide or frame can simply be a piece of wood or metal with the correct angle required for the part.

To facilitate cooling, both the guide and table can be constructed of metal.

Bending

When the proper flexibility is attained, quickly remove the substrate from the heater.

Position and bend the heated area over the guide. If only one side is heated, the heated side forms the inside of the bend.

Immobilize the part in the formed position until it has cooled.

To test whether or not the substrate has been sufficiently heated:

- While the material is still being heated, hold one end of the sheet and flex the other end.
- When it flexes easily, proceed with bending.

Cooling

Cooling is accomplished by ambient air or contact with a moist rag or cool metal. Fans or compressed air can also be used to facilitate the cooling process.

The cooling time increases with the thickness and size of the substrate.

Other Heat Bending Techniques

In addition to conventional heat bending, one could utilize a technique called drape forming. In this procedure, the whole substrate is first heated until pliable, then clamped to a mold and allowed to cool.

If more sophisticated parts are desired, use a vacuum forming process.

Cold Forming

The substrate is not recommended for this fabrication method.

Appendix I: MSDS

SECTION I - PRODUCT IDENTIFICATION

TRADENAME:
SINTRA®

SYNONYM:
Expanded PVC Sheet, Polyvinyl Chloride Sheet, Sintra® Standard Density, Sintra® Low Density

MANUFACTURER'S NAME & ADDRESS:
3A Composites USA, Inc.
08 W. 5th Street, P.O. Box 507
Benton, KY 42025
(270) 527-4200

EMERGENCY TELEPHONE:
Chemtrec - 1-800-424-9300
To be used only in the event of chemical emergencies involving a spill, leak, fire, and exposure accidents involving chemicals.

SECTION II - MATERIAL IDENTIFICATION AND INFORMATION

INGREDIENTS (Common Name)	PERCENT (%) (By wt.)[1]	OCCUPATIONAL EXP. LIMITS (TWA) ACGIH	(PEL)(OSHA)
Polyvinyl Chloride	70-85	10.0mg/m^3	15.0 mg/m^3 Total [(1)] 5.0 mg/m^3 Resp. [(1)]

This product is an "article" as defined in 29 CFR 1910.1200. It will not result in exposure to hazardous components under normal conditions of use.

SECTION III - PHYSICAL PROPERTIES

APPEARANCE AND ODOR: Odorless, plastic sheet
MELTING POINT: >350°F
SPECIFIC GRAVITY: .5 - 0.9 g/cm^3 range
SOLUBILITY: Insoluble in water

Appendix I: MSDS

SECTION IV - FIRE AND EXPLOSION DATA

AUTO IGNITION: N/A

FLASH POINT: (ASTM D-1929) >700°F

EXTINGUISHING MEDIA: CO_2, dry chemical, or water spray

SPECIAL FIRE FIGHTING PROCEDURE: Self-contained breathing apparatus should be worn

UNUSUAL FIRE & EXPLOSION HAZARDS: PVC will burn in the presence of supported combustion, and will emit hydrogen chloride gas, benzene, water, carbon monoxide, carbon dioxide, and smoke.

SECTION V - REACTIVITY DATA

STABILITY: Stable
INCOMPATABILITY: None Known
DECOMPOSITION PRODUCTS: Reference "Unusual Fire and Explosion Hazards", Section IV
CONDITIONS TO AVOID: None Known

SECTION VI - HEALTH HAZARD DATA

These products are not considered to be a health hazard in the form in which they are sold (sheet, panel). However, if these products are abraded, melted, welded, cut or processed in any manner that causes release of fumes or dusts, hazardous levels of fumes or dusts may be generated from these materials or constituents of these materials.

EFFECTS OF OVEREXPOSURE:

ACUTE: Physical irritation of the eyes may result from overexposure to high concentrations of dust or chips from certain fabricating operations.

CHRONIC: Studies have shown that workers exposed for long periods to high concentrations of respirable PVC dust may retain the dust in their lungs. There is no evidence of a toxic response associated with such PVC dust retention.

SPECIAL PRECAUTIONS: Avoid prolonged inhalation of high dust concentrations and ingestion of material. Wash hands before eating, drinking or smoking. Wear proper eye and respiratory protection when working in areas of high dust concentrations. Care should be taken during thermoforming operations. When temperatures exceed 350°F, decomposition of the material may occur.

EMERGENCY & FIRST AID PROCEDURES: If contact with eyes, wash immediately under water for at least 15 minutes. For inhalation exposure, remove to fresh air. Contact a physician.

Appendix I: MSDS

SECTION VII - STORAGE, HANDLING, AND DISPOSAL DATA

WASTE DISPOSAL: Care must be taken when using or disposing of material debris to prevent environmental contamination. Dispose of the debris in accordance with the Clean Air Act, the Clean Water Act, the Resource Conservation and Recovery Act and all state or local laws / regulations regarding disposal.

STORAGE AND HANDLING PRECAUTIONS: Store in a flat dry area. Exercise caution in all thermoforming procedures.

SECTION VIII - PERSONAL PROTECTION DATA

PRIMARY ROUTES OF ENTRY: Inhalation and ingestion

RESPIRATORY PROTECTION: An approved NIOSH/MSHA respirator must be used when engineering controls cannot be implemented to control dust concentrations. Reference OSHA 1910.134 for specific requirements.

VENTILATION: Local exhaust. Reference OSHA 1910.94f or specific requirements.

EYE: Eye protection must be worn when working in dust concentrations and during sawing or other operations which might cause flying debris. Reference OSHA 1910.133 for specific requirements.

PROTECTIVE GLOVE: Gloves should be used to prevent cuts or scrapes.

SECTION IX - REGULATORY

REACH: Pursuant to Title II article 7 of the regulation this product is exempt from registration and notification and is therefore compliant with the REACH regulation.

RoHS: Sintra® and e-pvcTM products are compliant with the RoHS standard.

IMPORTANT:
The information and data contained herein are believed to be accurate and have been compiled from sources believed to be accurate. All information contained herein is offered for your consideration, information, investigation, and verification. 3A COMPOSITES USA, INC. MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, CONCERNING THE ACCURACY OR COMPLETENESS OF THEI NFORMATION AND DATA HEREIN. THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE SPECIFICALLY EXCLUDED. 3A Composites USA, Inc. will not be responsible for claims relating to any parties' use of or reliance on information and data contained herein regardless of whether it is claimed that the information are inaccurate, incomplete, or otherwise misleading.

Appendix II: Specifications

Adhesives

Selection of Adhesives

The selection of the proper adhesive for a job depends on the materials to be joined, as well as the end use and other considerations mentioned earlier. Consulting with adhesive manufacturer and trialing adhesive method with all materials is key to success.

Fastening

Tips on Sign Installation With Post

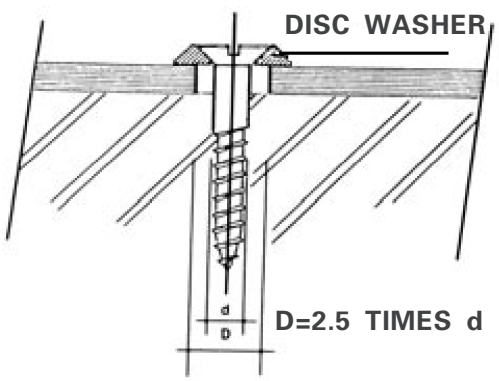
The following data has been compiled as a general guide for the mounting of Sintra material. Unusual designs falling outside the examples given may require certain modifications when considering Sintra material.

- Bolt holes should always be larger than the bolt shaft to allow for thermal expansion and contraction, thus eliminating the possible stress at bolt fixing points. The use of washers spread the compressive load when bolts/nuts are tightened. Never over-tighten — this will only weaken the connection.
- Split timber posts are the best to use because the Sintra Material is supported evenly on both sides. If steel or aluminum poles are used, nylon bolts and washers give the best results. In all cases, never skimp on the number of fixing points. Use at least three on the average-sized sign. They should be evenly spaced and away from the top and bottom edges.

Screwed Joints

For the attachment of Sintra material, basically all known through bolts can be used. For outdoor mounting, it is recommended that the bolt shank be passed through the Sintra material in prepared holes or suitably dimensioned slots that leave adequate clearance between the bolt shank and the Sintra material (Figure 2). The screws should only be tightened firmly enough to allow the sheet to expand and contract in all directions without warping or buckling. Tapping screws or screws with form-fitted passage of the shank through the sheet should be avoided, but are allowed for interior uses with predictably low temperature variations. The diameter of the hole or length of the slot should not be less than 2.5 times the shank diameter of the fastener. Disc washers should be used to cover the holes or to bridge the slots and they should be large enough to ensure adequate load distribution. Precise centering of the screws in holes and slots is essential to permit free movement of the sheet in all directions.

FIGURE 2



Appendix II: Specifications

Fastening

Riveted Joints

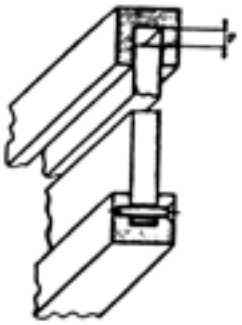
The measures that are used for screwed joints also apply to riveted joints. For this reason full rivets, whose shaft enlarges during the clenching operation so that the clearance to the hole diameter diminishes, are not suitable for outdoor mounting of Sintra material. Blind rivets (pop rivets) are suitable for fastening Sintra material to metal bases which are mounted by the drawing of aluminum or the steel mandrel.

For the United States surface temperature differences of 100°-180° Fahrenheit between extremes (winter -30° Fahrenheit, summer +150° Fahrenheit) must be assumed in exterior usage. Dark colored sheets heat up more than light colors, if exposed to direct sunlight.

Distances Between Fastening Points For Screw & Rivet Joints	
Sheet Size	Distance Between Fastening
2mm	6-8 inches
3mm	12-16 inches
4mm	20-28 inches
5mm	31-43 inches
6mm	47-70 inches

Frame Fastening of Flat Sintra Material Sheets

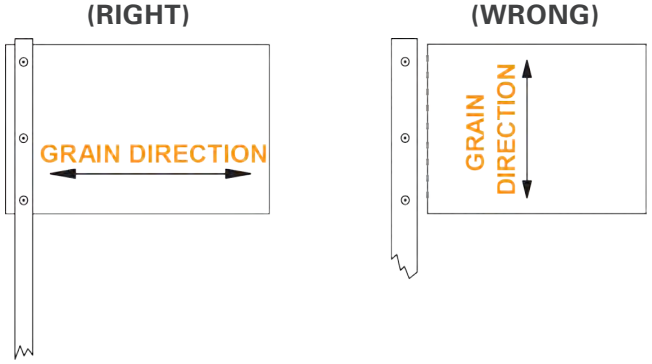
Besides the inherent rigidity of Sintra material sheets, which is dependent on thickness, all possible exterior stresses, e.g., wind pressure, etc., must be taken into consideration in frame fastening. Dimensional changes due to thermal expansion (or contraction) must be taken into consideration by leaving sufficient clearance between the sheet edge and the frame.



These are suspended attachment frames. Leave a space in the lower section, as well as in the side sections to allow for Sintra expansion. One pin in the middle of the rail can keep the Sintra centered in the frame.

Grain Direction

Sintra material is an extruded P.V.C. product and a directional grain is seen along the length of the sheet. Because Sintra material has a greater flexural strength along the extrusion direction, it is always advisable to cut signs so that the grain direction is horizontal to the post or pole fixings. This will allow Sintra material to "flex" with the wind pressure and ensure the best performance.



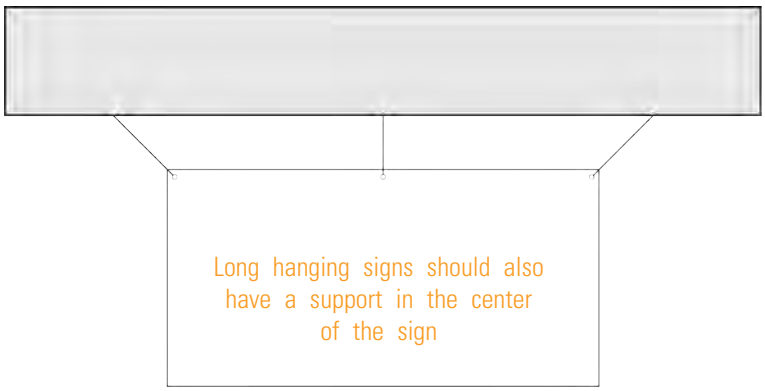
Appendix II: Specifications

Fastening

Hanging Signs

Sintra material may be successfully used as interior hanging signs. As Sintra material is an extruded sheet product, thin gauges or large hanging signs may require additional support. The addition of an aluminum or thick walled plastic "C" channel across the top, bottom, or around the perimeter may be needed to alleviate any tendencies to warp. When the additions of supporting channels are not an option, the following suggestion may also be used to help prevent bowing. Holes should be located 2-1/2 times material thickness from edge.

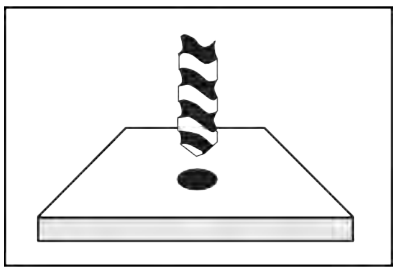
Point-to-point dimensions on the ceiling should be greater than point-to-point dimensions on Sintra material.



Drilling

Sintra material can be drilled with conventional, high helix, high speed steel or carbide-tipped metal bits. Quick removal of chips can be achieved by a process of high-revolution, slow-feed and occasional lifting of the drill bit. High pres- sure air can be used to evacuate the immediate area from chips. Smaller drills run at faster speeds than large drills.

Pressure should be released near the termination of through holes to prevent breakthrough. Cutting edges must be kept sharp to prevent poor surface finish and undersized holes.



Specifications, working conditions, and suggested drill bits are summarized in the chart below

Method	Applications; Advantages / Disadvantages	Recommended Blade Bit Geometry	Recommended Working Conditions	Recommended Blade/Bit
Drilling	For all holes up to 1" diameter. Larger holes can be cut with a hole saw.	Carbide-tipped, high helix preferred. Angle at tip: 100°-110°. Pitch angle: 30°.	Cutting speed: 150-1,000 FPM (defined as RPM x circumference of bit; smaller diameter runs faster). Feed rate: .001-.010 in./rev. (rate should be decreased as depth increases).	1. Do-All D-175B high helix. 2. Plasdrills.

Appendix II: Specifications

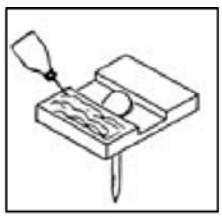
Fastening

Concealed Fastening on Brickwork of Cut-Out Advertising Letters & Figures Made Out Of Sintra Material

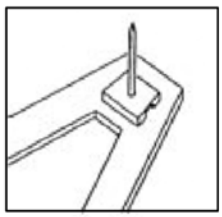
The system described here is a method of concealed fastening, not visible to the observing public. For the sake of aesthetics, a certain distance between the type print and the backing wall is often desired, whereby the system is ideally suited. The mounting is quick, easy and inexpensive.

The system consists of square mounting plates constructed out of Sintra material with an encased pin or special nail for brickwork.

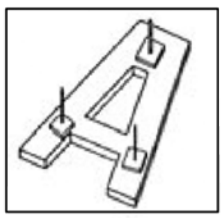
- Construct a mounting plate with Sintra Material as shown. Drill hole 2.5 times larger than shank of the pin, but smaller than the head of the pin. Apply THF solvent to upper side of mounting plate with an acrylic glue applicator bottle.



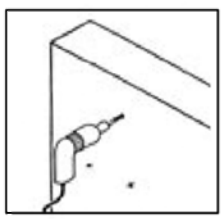
- The treated side of the mounting plate is pressed into position of the Sintra cut-out letter and pressed firmly. Run a bead of the THF solvent around the seams of the pad and the letter and let the capillary action drag the solvent into the seam.



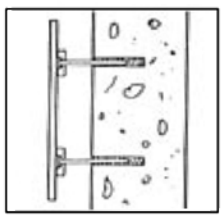
- Repeat step 2 for the desired number of fastening points according to the letter type and size.



- Mark the fastening points on the wall to be decorated. Holes, which are sufficient in diameter to hold the nail or pin, are drilled with an impact drill.



- The holes are filled with mortar, a curable plastic material or a prime filler. The letter with the attached metal pins is then pushed into the prepared holes, holding the desired distance from the wall.



Appendix II: Specifications

Fastening

Outdoor Use of Sintra Material

The effects of outdoor exposure on tensile, color, impact resistance and dimensional stability are as follows:

- Color Changes
  Field testing reported by many Sintra material customers shows acceptable color maintenance using white, black and gray material. Other colors are not recommended for long-term exterior usage.

  Colored Sintra materials are produced with organic pigments. Exterior light and some interior light fixtures emit light waves in the lower range of the light spectrum. These low range light waves may cause a fading of the Sintra material colors over time.

- Impact Resistance & Environmental Stress
  Effect of Temperature — With decreasing temperature, there is a tendency towards decreased impact resistance. For exterior cold weather applications with minimal framing (i.e. post signs), it is recommended to use 6mm Sintra or thicker.
  Effect of Chemicals — Certain solvents (such as cyclohexanone) present in inks can cause environmental stress, cracking, and poor impact resistance. For this reason, the solvent systems used to dilute Screen Printing inks must be carefully chosen.

Thermal Expansion

In the mounting or installation of Sintra material in outdoor applications or in rooms with very drastic temperature changes, the linear thermal expansion of the material has to be taken into consideration. As in all plastic materials, the sheets can warp, bulge, or inadmissible stress conditions can occur.
The linear thermal expansion of Sintra material is about the same magnitude as that of solid plastic materials, and is clearly larger than those of metals, wood and inorganic building materials like brickwork and concrete.

The dimensional change in each case depends on the expected difference between minimum and maximum temperature and the length and width of the sheet to be mounted. Appropriate values are shown in Figure 1.

FIGURE 1 - Expansion/Contraction (in.) VS. Temperature Change for Common Sheet Sizes

Total Temperature Change (°F)	48 Inches	60 Inches	96 Inches	120 Inches
20	.032	.040	.064	.079
0	.064	.079	.127	.158
60	.095	.119	.190	.238
80	.127	.158	.253	.317
100	.158	.198	.317	.396
120	.190	.238	.380	.475
140	.222	.277	.444	.554

Appendix II: Specifications

Fastening

Thermal Expansion - EXAMPLE

A printed sign board made of 6 mm strong, white Sintra material, measuring 39 in. x 98 in. is to be fastened to a wooden framework with screws of 0.196 in. shaft diameter. The sign is to be erected outdoors in a well protected and shaded place. What is the thermal expansion to be considered in mounting this sign board?

- Coefficient of linear expansion for Sintra material: 0.000033 in/in/° F
- Minimum Temperature (winter) - 5°F
- Maximum Temperature (summer) - 140°F
- Installation Temperature - 70°F

- Maximum winter temperature change (from installation): 70° - 5° = 65°
- Maximum summer temperature change (from installation): 140° - 70° = 70°

Calculate maximum expansion for the length of the panel

Total contraction during winter temperatures is calculated as follows:

- Maximum winter temperature change x coefficient of linear expansion x sheet length = 65° x 0.000033 in/in/°F x 98 in. = 0.210 in.

Total expansion during summer temperatures is calculated in the same manner:

- Maximum summer temperature change x coefficient of linear expansion x sheet length = 70° x 0.000033 in/in/°F x 98 in. = 0.226 in.

For further calculations, always use the larger number, in this case, 0.226 in.

Calculate maximum expansion/contrction for width of panel in the same manner

Total contraction during winter temperatures is calculated as follows:

- Maximum winter temperature change x coefficient of linear expansion x sheet length = 65° x 0.000033 in/in/°F x 39 in. = 0.08 in.

Total expansion during summer temperatures is calculated in the same manner:

- Maximum summer temperature change x coefficient of linear expansion x sheet length = 70° x 0.000033 in/in/°F x 39 in. = 0.09 in.

For further calculations, always use the larger number, in this case, 0.09 in.

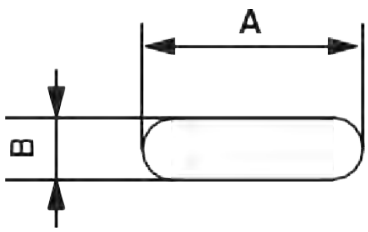
Holes:

Holes diameter = Expansion/contraction + bolt shank diameter
= 0.226" + 0.196" = 0.422"

Diameter of holes to be drilled into the Sintra material sheet is 7/16" (0.4375) or the closest larger size to 0.422 that is available.

Length = Expansion/contraction + bolt shank diameter
= 0.226" + 0.196" = 0.422" (7/16")

Width = Expansion/contraction + bolt shank diameter
= 0.09" + 0.196" = 0.286" (5/16")



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Thermoforming

Sintra is a slightly expanded thermoplastic sheet material which may be thermoformed by all conventional methods and techniques. Standard machines used for thermoforming work with Sintra material.

With regard to forming capability, extensibility, and detail definition, Sintra material has certain limitations. The air entrapped in the closed cells cannot be plasticized by the heat and can affect the molding and stretching of the sheet. Sintra is most suitable for large-faced and smoothly-contoured parts.

Draw ratios between 1:1 and 1:1.25 are readily attainable with Sintra. Larger ratios can be accomplished with auxiliary equipment such as plug assist or pressure assist forming. The radius and depth of draw is generally limited to the extent that the surface of the material can stretch.

Heating Cycle

Because Sintra is moderately expanded, it reacts differently than solid plastic materials and the working cycle is generally shorter. Small panel ceramic or quartz sandwich heaters are the most efficient type of heating. Care must be taken to not overheat the surfaces during the heating cycle in order to avoid degradation.

For more uniform temperature distribution, preheat Sintra material in a circulating air oven at 140° Fahrenheit.

Processing Temperatures

Mold and Set Temperature: 1
The Set temperature is the temperature at which the sheet hardens and can be safely removed from the mold. The closer the Mold temperature is to the Set temperature, the smaller the chance of encountering internal stress problems.

Lower Processing Limit: 2
This is the lowest temperature possible for the sheet before it is completely formed. Material formed at or below this temperature could have severely increased internal stresses that later can cause warpage, and lower impact strength.

Orienting Temperature: 3
Biaxially orienting the molecular structure of thermoplastic sheet approximately 275% to 300% at these temperatures and their cooling greatly enhances properties such as impact and tensile strength.

Normal Forming Temperature: 4
This is the temperature which the sheet should reach for proper forming conditions under normal circumstances. The normal forming temperature is determined by heating the sheet to the highest temperature at which it still has enough strength to be handled, yet below the degradation temperature.

Upper Limit: 5
The Upper Limit is the temperature at which the sheet begins to degrade or decompose. It is crucial to ensure that the sheet temperature stays below this temperature.

Thermoforming Processing Temperature Range

1		2		3		4		5	
Mold & Set Temperature		Lower Processing Limit		Orienting Temperature		Normal Forming (core) Temperature		Upper Processing Limit	
°F	°C	°F	°C	°F	°C	°F	°C	°F	°C
115	46	240	116	260	127	275	135	350	177

Appendix II: Specifications

Thermoforming

Simple Rules to Follow When Designing Molds

1. Make your part no bigger than absolutely necessary.
2. Make the ratio of part height to part minimum width as small as possible.
3. Make all outside radii and inside fillets as large as possible.
4. Allow as much draft on all parts as possible.
5. Always design to a reference point in the mold for trimming or hole placement.
6. Mold in details, such as ribbing or domed surface, for adding stiffness.
7. Design in details for positioning other components to be added.

Mold Construction

When deciding between Male or Female molds one should take into account the following points:

- Which side of the part needs the detail?
- Male molds are cheaper than female molds.
- Closer tolerances can be held on male molds.
- With female molds, the flange area wall thickness is the greatest while the bottom of the cavity is the thinnest. By using a male mold, this thickness variation is just the opposite.

Additional Thermoforming Tips

Sintra material, provided it is stored indoors or properly sheltered, need not be dried before forming. Unlike ABS and polycarbonates, Sintra material does not absorb any hydroscopic moisture.

Plug-assist forming, using normal equipment, is necessary for more complicated shapes. Because of the lower heat capacity of Sintra material, low conductivity materials must be used for the plug.

Molds must be designed to facilitate ready flow of material. Sharp edges and narrow recesses should be avoided. Radii should not be less than 1.5 to 2 times the original sheet thickness.

Double-sided (sandwich type) heating is strongly recommended, especially for thicker sheets, Sintra material of 3 mm gauge and thicker can be thermoformed only with a double-sided heating arrangement. When heated above 150° Fahrenheit, sheets shrink slightly in the extrusion direction. Provide for the firm clamping down of sheets or for controlled slip-in.

When thermoforming colored Sintra material, deep draws combined with sharp radii may cause stress whitening, as with most PVC materials.

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Storage Guidelines

Sintra is to be stored inside in a dry and clean area. Material must be stored horizontal.

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Certificate of Compliance

ONLINE CERTIFICATIONS DIRECTORY

UYMR2.E101623
Sign Accessories - Component

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Sign Accessories - Component

See General Information for Sign Accessories - Component

3A COMPOSITES USA INC E101623
208 W 5TH ST
PO BOX 507
BENTON, KY 42025-0507 USA

Click on a product designation to view it's ratings and conditions of use.
For enhanced search functionality, please visit: UL iQ™ for Sign Components.

Structural panels/siding, Model(s) Alucobond®, DIBOND®, Sintra Material

Marking: Company name and model designation.
Last Updated on 2015-09-04

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Appendix II: Specifications

SINTRA PRODUCT SPECIFICATIONS			
Product Specifications	**1mm**	**2mm**	**3mm**
Target Thickness	1mm	2mm	3mm
Gauge (+ or -)	-0.05mm, +0.25mm	+ / - 0.20mm	+ / - 0.20mm
Sheet Size Tolerances			
Width	0" + 1/8"	0" + 1/8"	0" + 1/8"
< 66" Length 66" - 96" >96"	0" + 1/4"	0" + 1/4"	0" + 1/4"
Diagonal	max 1/4"	max 1/4"	max 1/4"
Squareness (Straight Edges)	N/A	N/A	N/A
Warpage / Bow	N/A	N/A	N/A
Surface Energy (Dyne)	N/A	N/A	N/A
Color (E)	3 delta (Δ) E units for Bright White and 5 for all others	3 delta (Δ) E units for Bright White and 5 for all others	3 delta (Δ) E units for Bright White and 5 for all others
Opacity	N/A	N/A	N/A

DEFINITIONS

Target Thickness: The gauge that is to be focused on as optimum. The Gauge Range is then used to define the limits of the thickness that can be considered "in spec".

Gauge Range: The upper and lower limits in thickness that a product can be manufactured making it "in spec".

Example: Target of 250mils with a range of + or - 25 mils would be 225 mils to 275 mils.

Sheet Tolerances: We measure width, length and diagonal. Width is typically cross machine, length is typically machine direction and diagonal is the difference in the diagonals.

Squareness: The difference in the lengths of the machine direction sides.

Warpage/Bow: This is the measured by laying the sheet flat on a surface and measuring the amount of "smile" or "frown" in the center of the board in either the length or width. Should we have a problem described as "potato chip" this is a two direction warp, which is automatically "not in spec".

Surface Energy: This is measured using standard dyne solution pens.

Color (E): This is measured using a standard color meter.

Opacity: This is measured using a standard opacity meter.

Appendix II: Specifications

SINTRA PRODUCT SPECIFICATIONS			
Product Specifications	**4mm**	**5mm**	**6mm**
Target Thickness	4mm	5mm	6mm
Gauge (+ or -)	+ / - 0.30mm	+ / - 0.35mm	+ / - 0.32mm
Sheet Size Tolerances			
Width	0" + 1/8"	0" + 1/8"	0" + 1/8"
< 66″ Length 66″ - 96″ >96″	0" + 1/4"	0" + 1/4"	0" + 1/4"
Diagonal	max 1/4″	max 1/4″	max 1/4″
Squareness (Straight Edges)	N/A	N/A	N/A
Warpage / Bow	N/A	N/A	N/A
Surface Energy (Dyne)	N/A	N/A	N/A
Color (E)	3 delta (Δ) E units for Bright White and 5 for all others	3 delta (Δ) E units for Bright White and 5 for all others	3 delta (Δ) E units for Bright White and 5 for all others
Opacity	N/A	N/A	N/A

DEFINITIONS

Target Thickness: The gauge that is to be focused on as optimum. The Gauge Range is then used to define the limits of the thickness that can be considered "in spec".

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Squareness: The difference in the lengths of the machine direction sides.

Warpage/Bow: This is the measured by laying the sheet flat on a surface and measuring the amount of "smile" or "frown" in the center of the board in either the length or width. Should we have a problem described as "potato chip" this is a two direction warp, which is automatically "not in spec".

Surface Energy: This is measured using standard dyne solution pens.

Color (E): This is measured using a standard color meter.

Opacity: This is measured using a standard opacity meter.

Appendix II: Specifications

E-PVC PRODUCT SPECIFICATIONS				
Product Specifications	**3mm**	**6mm**	**10mm**	**12.7mm**
Target Thickness	3mm	6mm	10mm	12.7mm
Gauge (+ or -)	+ / - 0.20mm	+ / - 0.32mm	+ / - 0.60mm	+ / - 0.75mm
Sheet Size Tolerances				
Width	0" + 1/8"	0" + 1/8"	0" + 1/8"	0" + 1/8"
< 66" Length 66" - 96" >96"	0" + 1/4"	0" + 1/4"	0" + 1/4"	0" + 1/4"
Diagonal	max 1/4"	max 1/4"	max 1/4"	max 1/4"
Squareness (Straight Edges)	N/A	N/A	N/A	N/A
Warpage / Bow	N/A	N/A	N/A	N/A
Surface Energy (Dyne)	N/A	N/A	N/A	N/A
Color (E)	3 delta (Δ) E units for Bright White and 5 for all others	3 delta (Δ) E units for Bright White and 5 for all others	3 delta (Δ) E units for Bright White and 5 for all others	3 delta (Δ) E units for Bright White and 5 for all others
Opacity	N/A	N/A	N/A	N/A

DEFINITIONS

Target Thickness: The gauge that is to be focused on as optimum. The Gauge Range is then used to define the limits of the thickness that can be considered "in spec".

Gauge Range: The upper and lower limits in thickness that a product can be manufactured making it "in spec".
Example: Target of 250mils with a range of + or - 25 mils would be 225 mils to 275 mils.

Sheet Tolerances: We measure width, length and diagonal. Width is typically cross machine, length is typically machine direction and diagonal is the difference in the diagonals.

Squareness: The difference in the lengths of the machine direction sides.

Warpage/Bow: This is the measured by laying the sheet flat on a surface and measuring the amount of "smile" or "frown" in the center of the board in either the length or width. Should we have a problem described as "potato chip" this is a two direction warp, which is automatically "not in spec".

Surface Energy: This is measured using standard dyne solution pens.

Color (E): This is measured using a standard color meter.

Opacity: This is measured using a standard opacity meter.

Conclusion

This Fabrication Manual has been developed to assist fabricators to work with the substrate in the most efficient and effective manner. The tips and suggestions contained in this manual are the result of many years of combined experience by fabricators in the U.S., Canada, South America, Asia and Europe.

These fabrication suggestions and product specifications are based on information which is, in our opinion, reliable. However, since skill, judgment, and quality of equipment and tools are involved, and since conditions and methods of using the substrate are beyond our control, the suggestions contained in this manual are provided without guarantee. We recommend that prospective users determine the suitability of both the material and suggestions before adopting them on a commercial scale. 3A COMPOSITES USA, INC., DOES NOT MAKE ANY WARRANTIES, EXPRESS OR IMPLIED, INCLUDING MERCHANTABILITY AND FITNESS FOR PURPOSE, WITH RESPECT TO ANY SAID SUGGESTIONS AND PRODUCT DATA. In no event shall 3A Composites USA, Inc., have any liability in any way related to or arising out of said suggestions and product data for direct, special, consequential or any other damages of any kind regardless of whether such liability is based on breach of contract, negligence or other tort, or breach of any warranty, express or implied.

Also, normal safety and health precautions practiced in any fabricating environment should be used when fabricating the substrate.