Table of Contents

Introduction

This "How To" Manual has been developed to assist fabricators to work with Sintra® material 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 both the U.S. 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 Sintra material 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. ALCAN 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 Alcan 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 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 Sintra material.

MSDS for Sintra Material are available through our customer service department, call (800) 626-3365.

A UL RECOGNIZED COMPONENT

Section I: How to Form, Finish and Fabricate

Painting

The painting of Sintra® material is easily accomplished with paints known to have compatibility with rigid PVC.

Selection of a paint system for each use should be guided by the following:

a. Cost effectiveness.
b. Ease of application.
c. Safety and Environmental — odor, solvent systems, toxicity, etc.
d. Convenience and speed — one part vs. two part, one coat vs. multiple coats.
e. Solvent and/or chemical resistance.
f. Outdoor weatherability.

I. Types of paints known compatible with Sintra material

A. Vinyls
B. Acrylic Lacquers
C. Two part polyurethanes

With Sintra material, water-based latex systems and oil-based enamels generally do not have the good adherence properties of solvent based systems. Although, the use of primers can improve the adherence of non-solvent based systems, the adherence is usually minimal.

II. Surface Preparation

A. The surface to be painted must remain dry, clean, and grease free.
B. Any surface scratches on Sintra will have a tendency to telegraph through the paint. 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 disformed.
C. It is highly recommended that the surface be cleaned with a rag moistened with isopropyl alcohol prior to painting.

III. Adhesion Test

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

IV. Application

A. Paints can usually be applied with a brush or roller, although conventional air spray equipment will provide a more consistent appearance.
B. Consult paint manufacturer's literature for recommended application technique and thinning requirements.

V. Drying

Sintra material is a thermoplastic material. It should not be dried at temperatures in excess of 150° Fahrenheit. For drying and cure times, consult paint manufacturer's literature.

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

VI. Edge Treatment

When Sintra 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 surface of the sheet after painting.

A. Filling exposed cells (10-19 mm)
Spot putty or glazing compound used in the auto body industry works very well.
1. Fill edge cells with spot putty using a stiff, flat blade. Fill the cells, do not build up the edge.
2. When dry, usually 3-4 minutes, sand lightly to remove blade marks and any build up of putty.

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

C. Edge Banding
For thicker Sintra Material panels, 1 mm or 2 mm Sintra Material can be adhered to the edge using a PVC solvent.

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

E. Heat Form
1. V-Rout near edge of panel, approx. 90% penetration
2. Heat Bend
3. Solvent Bond

1)

2)

The tables of paints and primers on the following pages have been evaluated by Alcan Composites USA Inc. listed manufacturers or customers, as being compatible with Sintra Material. The products listed are by no means intended to be inclusive.

TABLE I

PAINTS	TYPE	GLOSS	ADVANTAGES	DISADVANTAGES
Matthews Map	2 part acrylic polyurethane.	Will match gloss required.	Has 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.	Has good outdoor weatherability with Grip-Flex clear top coat: 10-AFT 02-200. Needs no primer. Good thermoformability	Must use top coat for optimum performance.
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 Series, Carbit Paint Co.	Acrylic polyurethane.	Satin and gloss.	Good adhesion.	Slow drying. Experience necessary in spraying technique to get good finish. Irritating vapors.

TABLE II

PRIMERS	TYPE	ADVANTAGES	DISADVANTAGES
Consumers Paint Factory 1 Shot Vinyl Primer #5004.	Water soluble.	Improves the adherence of enamel.	
Ronan Paint Corp. Prime-All.	Water Borne.	Improves the adherence of enamel.	
Masterchem Industries Kilz.	Solvent Based.	Improves the adherence of enamel	

TABLE III

U.V. PROTECTION	TYPE	ADVANTAGES	DISADVANTAGES
Matthews Paint Corp. Map Clear.	2-part acrylic polyurethane.	No primer required. Has excellent outdoor weatherability.	Irritating vapors. Spraying provides most consistent finish.

Screen Printing

With Sintra material, the process of Screen Printing is easily accomplished. The surface of Sintra Material has a closed cell matte finish that makes mistakes easily wipe off with the appropriate thinner. The use of Vinyl and Vinyl/acrylic, solvent based inks are very compatible with Sintra material.

The use of Water Based Screen Printing Inks has also had some success with Sintra material. Ink manufacturer directions must be followed for good adhesion.

Surface Preparation of Sintra material for Screen Printing is similar to those of painting.

A. The surface to be Screen Printed must remain dry, clean, and grease free.
B. Any surface scratches on the Sintra will have a tendency to telegraph through the ink. 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 disformed.
C. It is highly recommended that the surface be cleaned with a rag moistened with isopropyl alcohol prior to painting.

TABLE IV — SCREEN PRINTING INKS

INK SUPPLIER	SOLVENT INKS	UV INKS
Naz-Dar (913) 422-1888	9700 70000 GV PP System 2	1600 1700 3200 3600
Sericol (913) 342-4060	Plastijet XG Polyplast Gloss Vinyl Techmark VYL	Fascure FC Fascure ULT Polydyne Duracal Plastical UX Uviform 3D UVRP Uvantage POP

The above mentioned screen printing inks should be tested in a manner which duplicates your printing process before initiating production.

It is strongly recommended to consult the appropriate ink manufacturer regarding any required ink additives such as catalyst for proper adhesion and exterior usage.

Screen Printing ink should air dry rather than be heat dried. Temperatures in excess of 150° Fahrenheit may cause warping or bowing of Sintra material.

Most U.V. Screen Printing Inks that are compatible with rigid PVC will work on Sintra material. The most important factor to be considered when using U.V. systems is the curing oven. Low wattage bulbs should be used to keep the temperature below 150° Fahrenheit. The use of U.V. curing systems, which have variable speed conveyers are considered the best type to use with Sintra material.

Section I: How to Form, Finish and Fabricate

Adhesive Decals and Vinyl Graphics

Sintra material works very well with the major brands of vinyl films on the market. These vinyl films are for the most part flexible PVC films. They are produced in various thicknesses, color shades, and gloss degrees. They can also be unpigmented to act as a U.V. inhibitor. These films have a layer of adhesive and a siliconized cover paper. For the most part these films have excellent adhesion to Sintra material.

Surface preparation is a must for good adhesion.

A. At all times the surface must be dry, clean and grease free.
B. Moisten a clean rag with isopropyl alcohol and wipe the surface of Sintra material. It is important not to use thinners or soaps as they may leave a film residue on the Sintra. This residue can affect the adhesion.

Final selection of a particular vinyl graphic should be made after consultation with manufacturers to ensure conformity for its application.

Adhesive Bonding of Sintra Material

General Information

Sintra material can readily be bonded to itself or other materials. Commercially available adhesives that are suitable for bonding rigid PVC materials can be used for this purpose.

There are several considerations on which the choice of an adhesive depends:

a) the material to be bonded with Sintra
b) strength required—structural vs. non-structural
c) temperature range expected
d) expansion/contraction
e) ease of application methods, curing times
f) cost effectiveness
g) environmental and safety considerations—flammability, fumes, odors, etc.

Surface Preparation

In order to attain the optimum bond, the Sintra material surfaces to be bonded must be suitably prepared.

A. Both surfaces to be joined must be clean, dry and degreased. To get good adhesion with dispersion adhesives, pressure-sensitive tapes, self-adhesive letters and two-component polyurethane adhesives, pretreat the Sintra material surface with isopropyl alcohol.

   The pretreatment procedure consists of:

   1. Soaking a non-colored cloth in isopropyl alcohol and wiping the surface to be bonded. Once the surface has dried, one can proceed with adhesives application.

B. To ensure the best possible bond, both surfaces must be flush to each other.

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.

The following suggestions serve as general guidelines.

A. Bonding Sintra Material to Sintra Material

1. For edge bonding 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 storage.
2. For bonding large areas: If using PVC solvent such as pipe cement, spread with notched trowel and work rapidly. One can also use adhesives recommended for non-porous materials.

B. Bonding Sintra Material to Non-Porous Solid Material
For non-porous material such as PVC, other plastics or metal, the following types of adhesives may be used.

1. Contact adhesive with solvent:
   a. Neoprene, nitrile, polyurethane or other synthetic rubber types.
   b. Adhesive must be applied to both faces. Parallel beads of adhesive are often preferred because it allows evaporation of solvent providing faster cure.
   c. For bonding Sintra material to flexible PVC sheets, only plasticizer-resistant types of adhesives should be used.

C. Bonding Sintra Material to Porous Materials

For porous materials such as paper, textiles, fabrics or wood, the following adhesives may be used.
1. Contact adhesive with solvent: Same systems as for non-porous materials.
2. Construction mastic, structural silicone adhesives.

Considerations such as expected temperature ranges (expansion/contraction), substrate and size of Sintra material panels should be taken into careful consideration when deciding on a method of attachment.

D. Using Pressure Sensitive Tapes
Pressure sensitive tapes can be used for:

1. Less demanding applications that are stress-free.
2. To adhere parts during installation work.
3. To hold parts while the primary adhesive is curing.

The following pressure sensitive tapes have been found to be compatible with Sintra material:

3M Corporation: Y 4945, Y 9473

Norton Company: V 2043

Rexham Industrial Films: Rexham Fluorex A/PS

The table of adhesives on the following page has been evaluated by Alcan Composites, listed manufacturers or customers, as being compatible with Sintra Material. The products listed are in no means intended to be inclusive.

TABLE I — ADHESIVES

CODE: E — EXCELLENT
G — GOOD
F — FAIR

ADHESIVE	TYPE	ADVANTAGES	DISADVANTAGES	SINTRA MATERIAL	WOOD	ALUMINUM	MASONRY	GALVANIZED STEEL	DRY WALL	MOST OTHER PLASTICS	FABRICS	POLYSTYROFOAM	ACRYLIC	PAPER	GLASS
Tetrahydrofuran (THF) Dupont, Fisher Scientific. Schwartz Chemical Co.	PVC Solvent.	Water thin, best applied with acrylic glue applicator.	Very fast evaporation. Unpleasant vapors.	E											
Parabond P28 all purpose cement	Solvent based.	Softens surface allowing for stronger bond.	Flammable. Unpleasant vapors.	E						E			E		
IPS Weld on Adhesives 2007	Solvent based.	Softens surface allowing for stronger bond.	Flammable. Unpleasant vapors.	E						E					
Do-it or PVC Pipe Cement P.C.I.	PVC pipe cement (THF, MEK, cyclohexanone solvent systems).	Bond unaffected by water.	Solvents highly flammable. Unpleasant vapors. Recommend using masks.	E						E					
Liquid Nails LN 602	Synthetic rubber and resin solvent elastomers.	Excellent all-around adhesive.	Available at most hardware stores.	E	E	E	E	E		E					
Duro Quick Gel Manco	Super Glue (cyanoacrylate).	Quick bond. Good for joining small pieces.	Sets up too fast to use on large pieces.	E		G		G		F					
Bostik 4045 Bostik Corp.	Nitrile rubber ketone solvent.	Fast drying. Dries clear. Can be precoated and stored. Retracking with MEK.	Flammable.	E	G				G	G					
Fuller Max Bond Adhesive T.E.C. Corp.	Synthetic rubber base with petroleum distillates.	Bonds to several substrates.	Attacks the styrofoam slightly. (Let it flash off first).									E			
TACC 15-165	Synthetic rubber base.	Does not destroy the polystyrene.	Not a structural adhesive.		G							E			
Dow 795 Silicone Building Sealant	Silicone type.	Non-flammable. Easy to work with.	Slow curing (use double-faced tape for temporary bond). Not readily available in stores.	E	E	E	F	G	G						G
GE Silicone II Window and Door Sealant	Silicone type.	Non-flammable. Easy to work with. Available in many stores.	Slow curing.	G	G	G		G		G				G	
Scotch-Grip Plastic Adhesive No. 4475	Neoprene contact cement, ketone solvent.	Fast drying. Clear. Resists water and oils.	Flammable.	E							G				G
3M Spray Adhesive 90		Easy to apply. Quick to tack.	Flammable.											E	
National Casein PVC-E	Water soluble.	Non-flammable. Easy to apply.	Slow drying. Best for thick papers.		F				F			F		E	
Lord Adhesives 7542, 7545, 7660, 7610		Contact Manufacturer		G	G		G			G			G		

Section I: How to Form, Finish and Fabricate

Photomounting

Sintra material's surface and excellent adherence capacity make it one of the best materials available for photomounting. Whether you do small manual jobs or have a large, automated facility, here are some tips on photomounting/lamination that might be of help.

Advantages of Sintra Material

1. Sintra material's texture won't show through, in most cases.
2. Since Sintra material is a rigid material, finished mounts are stronger than mounts using card board or lighter foam-type substrates. Corners won't bend and mountings won't crease like other substrates. Therefore, Sintra can be shipped without damage if properly packaged.
3. After lamination, the mounted photo can be used as a component of a display. It may be routed, heat bent, drilled, screen printed and painted within the limitations of the photo.
4. Mounting is not limited to photos. Using the lamination process, Sintra is suitable for mounting resin coated (RC) photo papers, Cibachrome prints, posters, lithographs, blueprints, plastic-coated maps, rice paper, vellum, art papers, foils, tissues, newsprint and most paper.

Methods of Mounting/Laminating

Since Sintra material may warp at temperatures about 150° Fahrenheit, it cannot be dry or hot mounted. Cold mounting in cold roller laminators such as Warman-Greig, Greig or Sealeze presses, cold vacuum mounting in VacuSeal presses, or hand lamination all give excellent results.

General Recommendations

1. Getting Good Adhesion
   a. Clean the Sintra material with isopropyl alcohol to remove any grease, fingerprints, etc.
   b. To cold laminate pressure-sensitive adhesives, you need sufficient pressure, typically 25-40 psi. You also must make sure that proper spacers are used. Because good lamination depends on equal force exerted across the entire width of the material being laminated, the top roll must move down evenly left and right. Even contact between the top and the bottom laminating rolls is essential. To maintain even contact "zero the nip." Once the nip is zeroed, use spacer shims to preset the nip opening for a particular laminate.
   c. Adequate pressure helps squeeze out air from between the adhesive, the Sintra material and the print.
   d. The bond obtained after 3 hours will generally allow for processing. Maximum bond is usually obtained within 24 hours after lamination.
   e. To test adhesion, flex the finished mount. It should not come loose in the center.
   f. 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 predried. Sintra material does not have to be predried because it is not porous, moreover, heating Sintra material above 150° Fahrenheit may cause warping.

      When tacking prints to Sintra material, 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.

2. Delaminating Bad Mounts
   a. Pressure-sensitive adhesives may be delaminated if done within 5 minutes after lamination. The print will probably be ruined, but the Sintra material may be reused.

   b. 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.

3. Avoiding Wrinkles and Surface Blemishes
   a. Wrinkles can be caused by misalignment of adhesive roll, too much pressure, or unparallel rolls.

   b. 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 lamination, 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 strike-through, one might also consider using a print made with thicker paper (.007+).

4. 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.

Lamination Procedures

There are several techniques for cold lamination to Sintra material:

A) Cold lamination with presses using a separate transfer film
B) Cold lamination with a press using paper with an adhesive backing
C) Hand lamination using transfer adhesive
D) Hand lamination using spray adhesive

The procedure for each is as follows:

A. Cold Lamination with a Press, Using a Transfer Adhesive Film

Transfer adhesives such as Permacolor "PermaPrint IP 2000," or "PermaPrint IP 5000," by MACtac, or "Print Mount" or "Print Mount Ultra" by Seal Products, Inc.

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1. Apply transfer adhesive to either printed material or Sintra material:
   a. Pull off enough release paper from the top feed roll to do the lamination. Then pull the adhesive film from the feed roll (sticky side up) and over the lamination roll so that it tacks on to the piece to be precoated.
   b. Pass the film and the piece through the nip.
   c. Trim off excess adhesive film around the piece. It now has a coating of transfer adhesive on the back protected by a release paper.

2. Peel off a 1/2"–1" section of release paper from the upper edge of the piece and fold back.

3. Tack on the other material to be laminated (either an uncoated print to the precoated Sintra material or a precoated print to the uncoated Sintra material).

4. Feed tacked edge into nip rollers keeping printed piece bent away from Sintra material.

5. As it passed through the rollers, strip away the release paper. (Make sure there are no wrinkles or trapped dirt.)

B. Cold Lamination with a Press, Using an Adhesive-Backed Paper

1. Peel off a 1/2"–1" section of release paper from the upper edge of the preprinted adhesive backed paper.
2. Tack on to Sintra material, lining up edges.
3. Set rollers at 40 psi pressure.
4. Feed tacked edge into nip of rollers keeping printed piece bent away from Sintra material.
5. As it passes through the rollers, strip away the release paper. (Make sure there are no wrinkles or trapped dirt.)

C. Hand Lamination Using a Transfer Adhesive

1. 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.
2. Tack on edge of print to exposed adhesive.
3. 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.
4. Before the lamination to Sintra material, 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.
5. Now peel off approximately 1/2"–1" of release paper from upper edge and fold back.
6. Tack on to Sintra material, lining up edges.
7. 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").
8. Continue procedure number 7 (above) until the lamination is complete.

D. Hand Lamination Using a Spray Adhesive

1. 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 bonding most art materials, adhesive need only be applied to one surface, preferably the print.
2. Before mounting, allow 2–4 minutes to dry—the adhesive must be aggressively tacky. If there are blisters due to trapped solvent, allow slightly longer than 4 minutes of drying time.
3. Position piece on Sintra material and smooth out to eliminate any wrinkles and trapped solvent.

4. Place a clean sheet of Sintra material over laminated piece and weigh down for 15 minutes to obtain the maximum bond. Allow 24 hours before exposing the laminate to sudden temperature or humidity changes.

TROUBLESHOOTING WHEN USING COLD LAMINATION PRESSES		
PROBLEM	**CAUSED BY**	**ACTION**
Poor adhesion or bubbles:	a. Insufficient pressure.	a. Increase lamination 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. Predry 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 lamination rolls are not parallel.	b. Make sure spacer shims are the same size, then zero the nip.
	c. Too much pressure.	c. Reduce roll pressure.
	d. Sintra 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.

Hot Air Welding

Sintra Material is a foamed PVC sheeting material and is therefore not well suited to hot air welding with a solid PVC welding rod. The effect of the heat required to melt the solid PVC welding rod has detrimental effect on the surface of the Sintra Material.

For this reason the preferred method of adhering Sintra Material to itself in corner applications is through the use of solvent based adhesives.

Section I: How to Form, Finish and Fabricate

Heat Bending

One of the many advantages of Sintra material 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, displays or in many applications where a lightweight, curved part 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 again become rigid. 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, relatively little thinning out of sheet gauge during heat bending is an advantage over vacuum and pressure forming.

The steps in the heat bending process are:

1. Heat the material 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.
2. After the sheet has attained the proper flexibility, it is bent to obtain the desired radius and angle.
3. The part is held in position to cool. Cooling may be accelerated by contact with cold metal, a moist rag, compressed air or fans.

I. Heating Parameters

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

A. Characteristics of Sintra Material

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

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

B. Types of Heaters

Direct contact heating bars can be used for 2 mm through 6 mm Sintra material providing the surface temperature of the bars is kept below 300° Fahrenheit. A higher temperature may melt the surface or leave an unsightly impression on the sheet.

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

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

1. Nichrome heater wires, Calrod heaters, or silicone blanket heaters work for this use.
2. A rheostat must be used to adjust the intensity of the heat.
3. For Sintra material, 3 mm 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.

C. Effect of Thickness

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

1. Heating time and temperature: Increase heating time approximately 75% per each 1 mm increment in thickness. Keep the temperature setting constant.

2. Application of heat: With 1 mm and 2 mm, heat sheet on one side only—the side forming the inside of bend. Above 2 mm, heat both sides; or heat one side, flip over, and heat reverse.

D. Effect of Radius

1. The following heating widths are recommended:

Very small radius .... 2 times the thickness of sheet
Average radius.......................... 3 times the thickness of sheet
Large radius.............................. 4 times the thickness of sheet

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

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

3. To make very sharp bends.

a. 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.
b. Heat the routed area until the sheet will flex easily.
c. Bend the sheet and place in cooling guide.
d. Apply PVC solvent to seam to add strength to the corner.

II. Bending/Cooling

A. 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.

B. Bending

When the proper flexibility is attained, quickly remove the sheet 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 sheet has been sufficiently heated:

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

C. 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 part.

III. Other Heat Bending Techniques

In addition to conventional heat bending, one could utilize a technique called drape forming. In this procedure, the whole sheet 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.

Section I: How to Form, Finish and Fabricate

Die Cutting

Die cutting of Sintra material is a method for the rapid production of flat shapes or cutouts.

Typical applications would include the die cutting of:

1. Letters and shapes.
2. Openings in a sheet used as part of an assembly.
3. Puzzle pieces.
4. 3D assemblies—die cutting part-way through to form hinges. Hinges can be reinforced by Mylar tape. The flat die-cut piece can be folded into a three-dimensional shape such as a picture frame or a display.

Prior to die cutting, Sintra material can be painted or screen printed. After die cutting, the pieces may be heat bent, fastened, glued, routed or machined.

Definition of Steel Rule Die Cutting

Although various methods such as using punches and "high-dies" are applicable to die cutting Sintra material, cutting with steel rule dies (SRD) is the most common.

Steel rule dies 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 "knives." The strip steel is typically made in a thickness range of .014"–.166". To specify thickness, the term "point" is used.

The strips are bent to the shape of the trim line and held in place by 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 Sintra material sheet in position.

During die cutting, the steel rule die (SRD) assembly is fixed under the top platen, and the Sintra material sheet is placed on a steel bottom platen. Pressure is applied to force the knives of the SRD through the (often preheated) Sintra material sheet.

The platens are then opened and the parts removed. In some cases, additional work such as finishing the cut edge might be required.

I. Recommended Parameters Affecting Die Cutting

The primary factors affecting the quality of the cut are temperature and thickness of Sintra, thickness of the SRD, type of bevel on the SRD, sharpness of the beveled edge, and the type of back-up plated used.

A. Temperature of the Sheet

Because Sintra material is a thermoplastic material, it becomes more brittle with decreasing temperatures. With the sheet temperature below 75° Fahrenheit, the die knife 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° Fahrenheit. The use of a press which contains hot platens can reduce the fracturing.

B. Thickness of the Sheet

The quality of the die-cut part is reduced as a thicker-gauge Sintra material 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 material is warm enough (100°–130° Fahrenheit), the right back-up plate is used and, most importantly, that 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 radii below 1/8". As you go thicker, the minimum radius must be increased.

C. Thickness of the SRD

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

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

As a guide for cutting Sintra material, we suggest that the following thickness (point) knives be used:

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

D. Selecting the Correct Bevel

The type and length of bevel on the SRD is critical and varies with the way the sheet is to be cut.

1. Length of Bevel

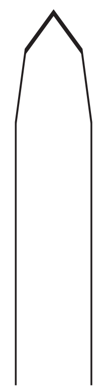
For Sintra Material, a long bevel will result in less deformation as the material is sheared. The length of the bevel is defined as the distance from the tip to the point where the honed (beveled) portion ends. For Sintra material, the bevel should be 3/16"–1/4" in length.

2. Type of Bevel

There are three types of bevels: A center bevel, and two types of side bevels—inside bevel and outside bevel.

A *center bevel* is "V" shaped, i.e., honed from both sides. For Sintra material, the center bevel should be a facet (double double) cut. This means that the "V" is formed by two obtuse angles coming to a point.

A center bevel is used when both the inside and the outside of a cut have to be saved, e.g., as in a puzzle. In this case, the cut is wedge-shaped so that the cut face on the periphery is sloping away from the inside and the cut on the inside piece is sloping away from the outside. The longer the bevel and the narrower the thickness (point) of the rule, the straighter the cut.



FACET-CUT

An *inside bevel* has the straight unhoned side of the rule on the outside of the cut and the beveled side on the inside of the cut. The rule of thumb is that the beveled side is always towards the scrap.

An *outside bevel* has the straight unhoned side on the inside of the cut and the beveled side on the outside. An outside bevel is used if the inside piece must be saved.

E. Sharpness of the Beveled Edge

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.

F. Back-Up Plate

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

II. Strippers

Strippers or ejectors are compressible materials set along the perimeter of the SRD to facilitate ejecting the part.

The stripper must be resilient enough to eject the part but not so hard as to leave dent marks in the sheet. The best stripper materials to use with Sintra material are moderately firm rubber types such as neoprene or silicone rubber. In order to be compressed and thus produce the rebounding action required for proper ejection, the strippers must be thick enough to project about 1/16" above the bevel of the SRD.

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) Temp.		Upper Limit	
°F	°C	°F	°C	°F	°C	°F	°C	°F	°C
115	46	240	116	260	127	275	135	350	177

Simples 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:

1. Which side of the part needs the detail?
2. Male molds are cheaper than female molds.
3. Closer tolerances can be held on male molds.
4. 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.

Ultrasonic Technology

Ultrasonic welding is accomplished by means of non-audible sound waves.

In ultrasonic welding, vibratory energy is converted to heat through friction that melts and fuses the plastic. When the vibration stops, the plastic solidifies under pressure, producing a weld. Sintra is only weldable to Sintra or other Rigid PVC materials.

Essential components required to apply ultrasonic energy are:

Power supply—ultrasonic generator that supplies high-frequency electrical energy.

Converter—component that changes electrical energy to mechanical vibratory energy.

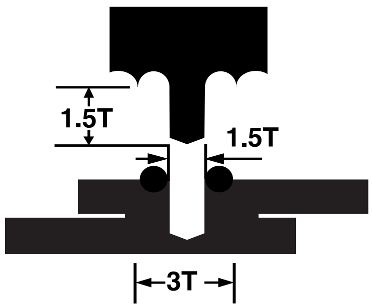
Booster Horn—increases or decreases the amplitude of vibration supplied to the horn.

Horn—tool that transmits the ultrasonic energy to the part.

The cell structure of Sintra sets certain limitations on this method of joining. If an ultrasonic process is under consideration, companies specializing in this type of work should be consulted.

Spot Welding: Utilizing ultrasonics for spot welding is accomplished with a spot welding tip as shown in figure 1. The tip should produce a head having a diameter of three times the thickness of the top layer. The length of the protruding tip should be one and one-half times the thickness of the top layer of material.

FIGURE 1

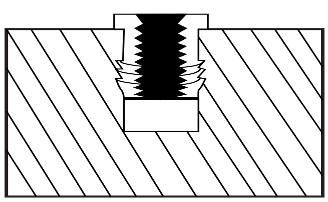


Ultrasonic spot welding produces one side with a cosmetic surface and the other having a hole through the top layer with a neat ring around the perimeter of the hole.

Insertion: The most common metal component for insertion into Sintra material would be a threaded insert which are designed with knurls, flutes, undercuts or threads to resist loads imposed on the finished product. The heat generated by the insert vibrating against the plastic causes the plastic to melt, permitting the insert to be pressed into place. A sufficient amount of plastic must be displaced to fill the undercuts, knurls, flutes, or threads of the insert to lock the insert in place.

For maximum pullout and torque strengths, the top of the seated insert should be flush or slightly above the surface of the part as in figure 2.

FIGURE 2

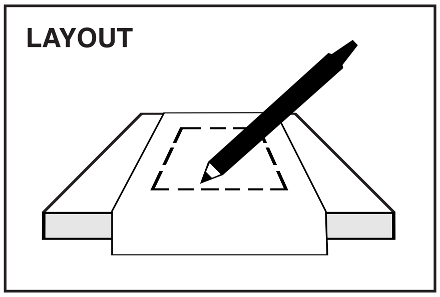


Section I: How to Form, Finish and Fabricate

Cutting, Drilling and Finishing

A. Layout

Laying out a pattern on the surface of Sintra material is best achieved with a soft pencil.



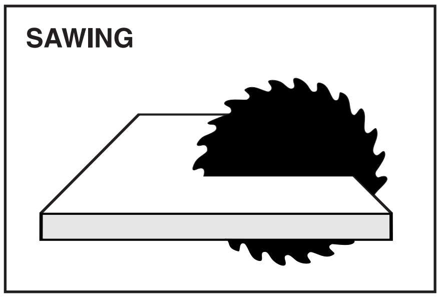
B. Sawing

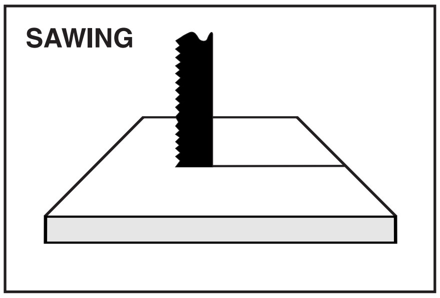
Sintra material up to 3 mm thick can be cut with a knife or blade. Thicker sheets can be cut with hand, circular or sabre saws. Wood-cutting saws can also be used. Fine-tooth hack-saws are not suitable since the finer tooth spacing creates excessive friction and produces an undesirable finish. For best results, in all cases, use saw blades that are identified as triple chip tooth configuration or "plastic cutting."

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

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

The suggested specifications and working conditions for various types of saws are summarized in Table 1.





C. Shearing and Guillotine Cutters

Power shears may not give the best results since the material is subjected to strong compression during the shearing process. This may result in an unsatisfactory cutting edge.

D. Drilling

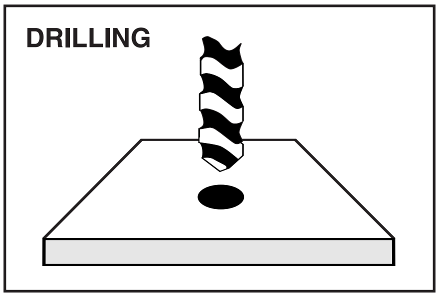
Sintra material can be drilled with conventional, high helix, high speed steel or carbide-tipped metal bits.

Quick removal of chips can be achieved by a process of high-revolution, slow-feed and occasional lifting of the drill bit. High pressure 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 Table 1.

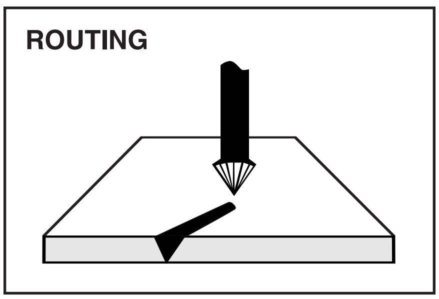


E. Routing

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 summarized in Table 1.



F. Industrial Laser Cutting Sintra Material

Industrial lasers may be used to cut or engrave Sintra material. This operation must be accomplished with adequate ventilation to rout the emitted smoke away from operators. Decomposition of the Sintra material will occur when material temperatures exceed 350° Fahrenheit. As described in the Material Safety Data Sheet for Sintra material, the product will burn in the presence of supported combustion, and emit hydrogen chloride gas, benzene, water, carbon monoxide, carbon dioxide, and smoke. The cut edge of the material may char, unlike acrylic plastics which glaze when exposed to intense heat. Edge conditions and cutter feed speed will be dependent upon the type of laser used and the gauge of cut.

G. Milling

Sintra material 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 Table 1.

H. 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.

I. Surface Finishing

Surface finishing with cutting tools is possible. Grinding or polishing is not recommended since this may damage the surface and expose cut cells.

Short bursts of hot air from a heat gun can be used to remove small surface scratches and small dents.

TABLE I — SPECIFICATIONS AND WORKING CONDITIONS CHART

CUTTING DRILLING & ROUTING METHODS	WHERE USED, 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.
Band 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 edge or "V" tooth blade.
Sabre 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.
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.
Routing	Used particularly for making slots prior to heat bending. Can be stationery 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 in./min.	Most high-speed carbide bits, available at hardware stores.
Milling		Rake angle: 5°-20°. Free angle: 10°-25°.	Cutting speed: 3,000-3,300 FPM. Feed rate: 8"-20"/min.	

Section II: Attachment and Fastening

Basic Comments

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 (INCHES) VS.
TEMPERATURE CHANGE FOR COMMON SHEET SIZES:

TOTAL TEMPERATURE CHANGE (°F)	48 INCHES	60 INCHES	96 INCHES	120 INCHES
20	.032	.040	.064	.079
40	.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

Temperature Fluctuations

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 AND RIVET JOINTS	
SHEET SIZE	DISTANCE BETWEEN FASTENING
2 mm	6 – 8 in.
3 mm	12 – 16 in.
4 mm	20 – 28 in.
5 mm	31 – 43 in.
6 mm	47 – 70 in.

Section II: Attachment and Fastening

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° Fahrenheit
Maximum temperature (summer)	140° Fahrenheit
Installation temperature	70° Fahrenheit

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/contraction for the width of the panel in the same manner:

Winter	Summer
65° x 0.000033 in/in/°F x 39 in. = 0.08 in.	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:

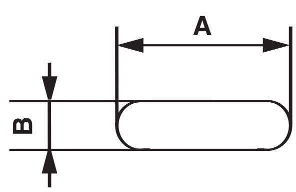
Holes diameter = Expansion/contraction + bolt shank diameter
= 0.226 + 0.196 = 0.422

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.

SLOTS:

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")



COMPARISON OF THE THERMAL EXPANSION OF VARIOUS PLASTICS AND OTHER CONSTRUCTION MATERIALS (96 IN. SHEET LENGTH) FOR A TEMPERATURE INCREASE OF 100° FAHRENHEIT.

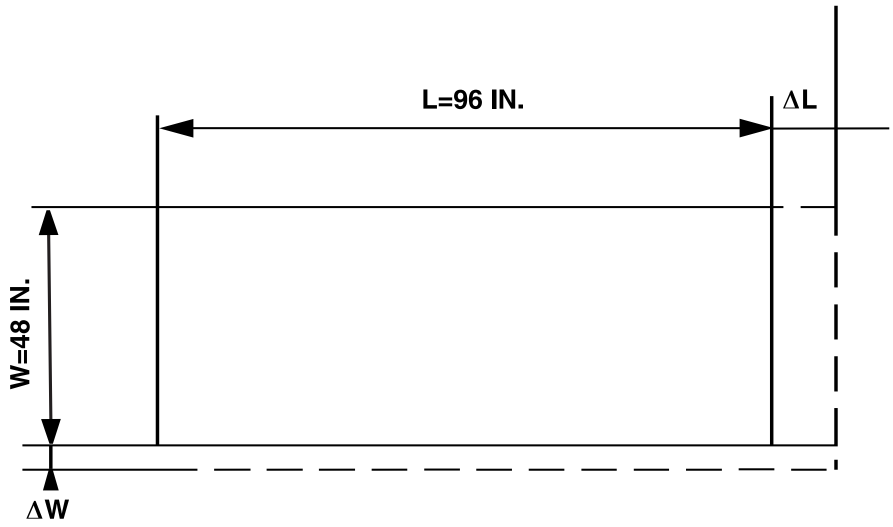


FIGURE 2

MATERIAL		THERMAL EXPANSION IN INCHES LENGTH	WIDTH
Cellulose acetate	CA	.497	.249
Polyethylene	LD PE	.621	.312
Polyethylene	HD PE	.466	.234
Polyamide 6	PA 6	.261	.132
Polyamide 12	PA 12	.280	.140
Polycarbonate	PC	.199	.101
Polymethylmethacrylate	PMMA	.236	.117
Polypropylene	PP	.435	.218
Polystyrene	PS	.217	.109
Polystyrene	SAN	.249	.125
Polystyrene	ABS	.249	.125
Polyvinylchloride	PVC	.317	.158
Sintra Material (700 Density)		.317	.158
Wood		.019	.008
Aluminum		.126	.063
Steel		.031	.016
Concrete		.037	.016

Section II: Attachment and Fastening

Exterior Signs

Sintra Material used correctly and with basic mechanical fixing methods is suitable for exterior use. The following tips have been compiled to be used as a general guide for fixing Sintra Material for a minimum amount of breakage. Using Sintra Material can provide an excellent weatherproof sign substrate ready for screen printing, painting, or vinyl graphics.

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.

Major Items to be Considered

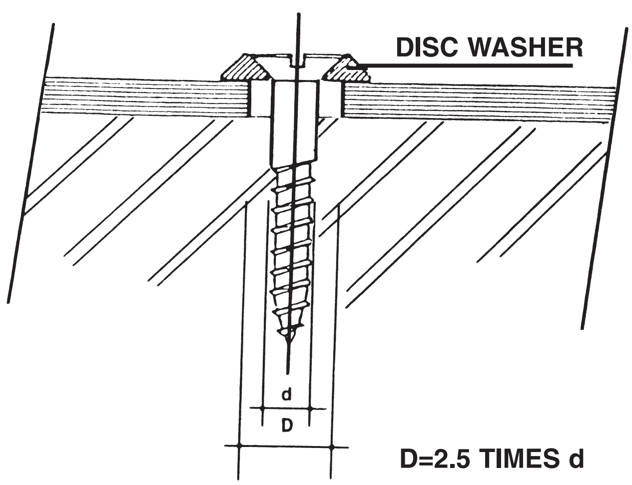
1. Bolt holes should always be larger than the bolt shaft to allow for thermal expansion and contraction, thus eliminating the possible stress at bolt fixing points. The use of washers spread the compressive load when bolts/nuts are tightened. Never over-tighten—this will only weaken the connection.

2. 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



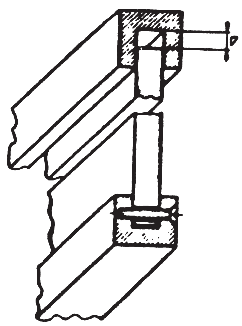
Section II: Attachment and Fastening

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.

Frame Fastening of Flat Sintra Material Sheets

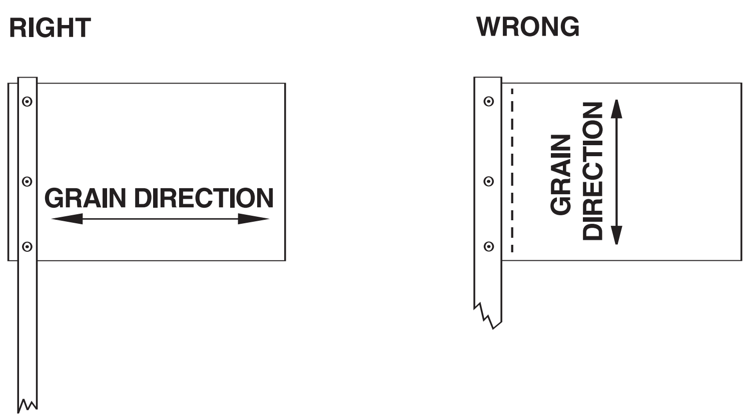
Besides the inherent rigidity of Sintra material sheets, which is dependent on thickness, all possible exterior stresses, e.g., wind pressure, etc., must be taken into consideration in frame fastening. For appropriate mechanical and elastic property values the data sheet should be consulted. Dimensional changes due to thermal expansion (or contraction) must be taken into consideration by leaving sufficient clearance between the sheet edge and the frame. Relative thermal expansion values for various frame materials can be taken from Figure 2.



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.

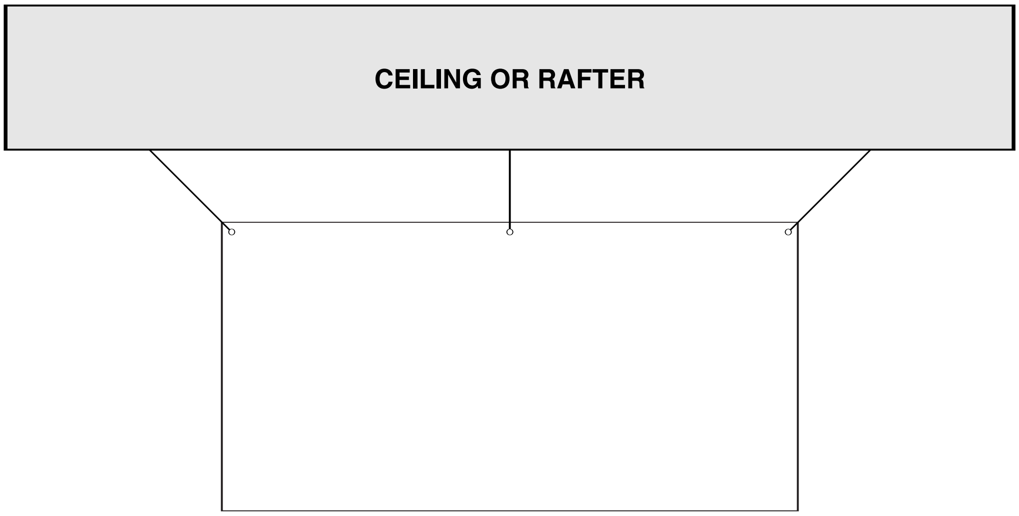


Section II: Attachment and Fastening

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.



Long hanging signs should also have a support in the center of the sign.

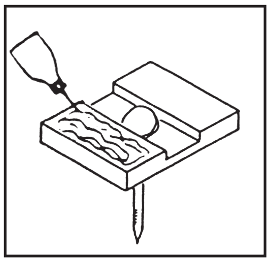
Section II: Attachment and Fastening

Concealed Fastening On Brickwork of Cut-Out Advertising Letters and Figures Made Out of Sintra Material

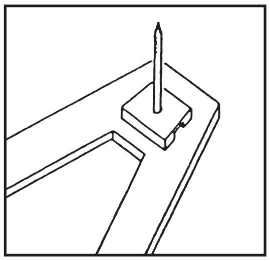
The system described here is a method of concealed fastening, not visible to the observing public. For the sake of aesthetics, a certain distance between the type print and the backing wall is often desired, whereby the system is ideally suited. The mounting is quick, easy and inexpensive.

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

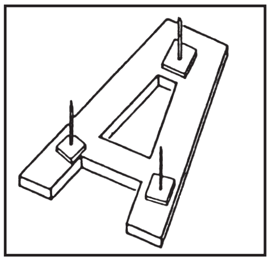
1. Construct a mounting plate with Sintra Material as shown. Drill hole 2.5 times larger than shank of the pin, but smaller than the head of the pin. Apply THF solvent to upper side of mounting plate with an acrylic glue applicator bottle.



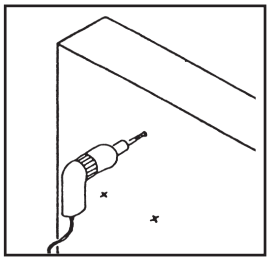
2. The treated side of the mounting plate is pressed into position of the Sintra cut-out letter and pressed firmly. Run a bead of the THF solvent around the seams of the pad and the letter and let the



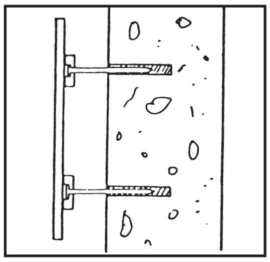
3. Repeat step 2 for the desired number of fastening points according to the letter type and size.



4. 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.



5. 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.



Section III: Engineering/Specifications

SHEET DIMENSION TOLERANCES

	DIMENSIONS	TOLERANCES
WIDTH	48" or 60"	0 to .125"
LENGTH	96" or 120"	0 to .250"
DIAGONAL		±.250"

GAUGE (THICKNESS) TOLERANCES

GAUGE		TOLERANCES	
METRIC (MM)	U.S. (APPROX. IN.)	METRIC (MM)	U.S. (IN.)
1	.039	±.20	±.008
2	.078	±.20	±.008
3	.118	±.25	±.010
4	.157	±.30	±.012
5	.197	±.35	±.014
6	.236	±.40	±.016
10	.394	±.60	±.024
13	.512	±.75	±.030
19	.748	±1.05	±.041

GAUGE VS. WEIGHT AND DENSITY

GAUGE		APPROX. WEIGHT	APPARENT DENSITY	SPECIFIC GRAVITY
METRIC (MM)	U.S. (APPROX. IN.)	(LBS./FT.^{2})	(LBS./FT.^{3})	(G/CC)
1	.039	.144	44	0.70
2	.078	.287	44	0.70
3	.118	.429	44	0.70
4	.157	.576	44	0.70
5	.197	.722	44	0.70
6	.236	.858	44	0.70
10	.394	1.03	31	0.50
13	.512	1.34	31	0.50
19	.748	1.95	31	0.50

IMPACT RESISTANCE

AT 70°, 30° AND 0° FAHRENHEIT (ASTM D-2794, GARDNER IMPACT TESTER)

GAUGE		IMPACT RESISTANCE (INCH/POUNDS)		
METRIC (MM)	U.S. (APPROX. IN.)	70°F	30°F	0°F
1	5/128	1	<0.5	<0.5
2	5/64	2	1	<0.5
3	1/8	5	3	2
4	5/32	7	5	3
5	3/16	15	13	12
6	1/4	28	22	16
10	3/8	160+	120	105
13	1/2	160+	160+	140

Section III: Engineering/Specifications

SINTRA MATERIAL TECHNICAL SPECIFICATIONS

PROPERTY	ASTM TEST (IF APPLICABLE)	UNIT OF MEASURE	VALUES			
			1-6 MM*		10, 13 AND 19 MM**	
DENSITY AND HARDNESS:						
Specific gravity	ASTM D-792	g/cc	0.70 (Nominal)		0.50 (Nominal)	
Apparent density	ASTM D-1622	lb./ft.^{3}	44		31	
Shore hardness	ASTM D-2240	"D"	66		78	
STRESS-STRAIN/ FLEXURAL			**MACHINE DIRECTION**	**TRANSVERSE DIRECTION**	**MACHINE DIRECTION**	**TRANSVERSE DIRECTION**
Tensile strength	ASTM D-638	PSI	2,850	2,070	1,460	1,450
Elongation at break	ASTM D-638	%	38	37	36	45
Flexural modulus	ASTM D-790	PSI	235,000	190,000	160,000	115,000
Flexural strength	ASTM D-790	PSI	5,000	3,900	3,550	2,670
PERFORMANCE AT ELEVATED TEMPERATURE:			**MACHINE DIRECTION**	**TRANSVERSE DIRECTION**	**MACHINE DIRECTION**	**TRANSVERSE DIRECTION**
A. Dimensional change	ASTM D-1042					
120 min. at 158° F		%	+0.2	+0.4	+.03	+.03
75 min. at 284° F		%	-6.3	+2.0	+1.3	-2.1
B. Deflection temperature under load (HDT)	ASTM D-648	°F@ 264 PSI	160	162		
ELECTRICAL PROPERTIES						
Dielectric strength	ASTM D-149	KV/CM	112			
Surface resistivity	ASTM D-257	ohms	10^{14}			
Volume resistivity	ASTM D-257	ohms cm	2.4×10^{15}			
Dielectric constant 50 cps	ASTM D-150		1.9			
Dissipation factor 50 cps TAN	ASTM D-150		0.013			
WATER ABSORPTION	ASTM D-2842	% BY WT.	1.0		1.0	

*Values in table are typical for 4 mm.
**Values in table are typical for 10 mm.

Archival Qualities

An important criteria for materials expected to be in long term contact with photos, documents, and other artifacts is that they are "archival grade." This is often a consideration in museum work. Archival attributes of Sintra material include its being "Acid Free" and having minimal "Outgassing" qualities.

Acid Free

Both .700 specific gravity and .500 specific gravity Sintra materials are "acid free"/pH neutral—where the pH is slightly above 7.0.

Outgassing

Both .700 specific gravity and .500 specific gravity Sintra materials have exhibited <0.001% HCL released when subjected to 158 degrees F for a total of 14 days.

AIRBORNE SOUND INSULATION

GAUGE		AVERAGE SOUND REDUCTION INDEX 100 TO 3500 HZ DECIBEL (DB)	CRITICAL FREQUENCY FG. IN. KHZ
METRIC (MM)	U.S. (APPROX. IN.)		
6	1/4	25	5.4
10	3/8	28	
13	1/2	30	

NOTE: Effective sound insulating systems can be produced by double-walled construction with Sintra material sheets where the gap between the two sheets is filled with glass wool or soft foam material.

LINEAR EXPANSION/CONTRACTION

A. COEFFICIENT OF LINEAR EXPANSION:

GAUGES	ASTM TEST	BASIS	VALUE
ALL	D-696	IN./IN./°F	.000033

EXAMPLE: How much should be allowed for expansion/contraction for an outdoor sign 4' x 8' (48" x 96") in a location where the minimum temperature is 0° F and the maximum temperature is 100° F (total temperature change is 100° F)?

ANSWER: The change in length is: 96" x 100° F x .000033 = 0.317"

The change in width is: 48" x 100° F x .000033 = 0.158"

NOTE: Reversible expansion/contraction applies only to temperatures below the maximum service temperature of 150° F. Above this temperature, you may encounter dimensional changes due to stress relief (shrinkage in the machine direction).

B. DIMENSIONAL STABILITY AND EXPANSION/CONTRACTION

1. As with all plastic materials, allowances should be made for expansion/contraction with temperature changes. It is extremely important that proper mounting techniques are followed.

2. The degree of dimensional stability is directly related to the thickness of the sheet. For this reason, thicker gauges (4 mm+) can be expected to have better dimensional stability than thinner gauged sheets.

THERMAL INSULATING PROPERTIES

A. THERMAL CONDUCTIVITY:

		1–6 MM	10 MM	13 MM	19 MM
BTU / FT.^{2}hr°F/IN.	=	.52	.52	.456	.36

B. "R" VALUES

GAUGE		
METRIC (MM)	U.S. (APPROX. IN.)	"R" VALUES
1	5/128	.07
2	5/64	.14
3	1/8	.21
4	5/32	.28
5	3/16	.35
6	1/4	.42
10	3/8	.72
13	1/2	1.10
19	3/4	2.08

LOAD CAPACITY

Maximum span of 4' wide sheet determined when center of sheet deflects less than 1/2" as load is applied at center. Sheet is supported at 1/4" width around perimeter.

GAUGE			MAXIMUM SPAN (INCHES)		
METRIC (MM)	U.S. (APPROX. IN.)	NO LOAD	10 LBS.	20 LBS.	30 LBS.
1	5/128	24	<24		
2	5/64	30	<24		
3	1/8	36	<24		
4	5/32	40	<24		
5	3/16	54	24	<24	
6	1/4	60	36	24	
10	3/8	96	60	48	
13	1/2	96+	96+	96	60

NOTE: The assumption is that the whole weight is applied at the center. If the weight was distributed over the area of the sheet, a longer span could be used to support the same weight.

EXAMPLE: What are the options in building a shelf to support 20 lbs.?

1. If we choose not to space supports closer than 2' (24") apart, the minimum thickness which could support this weight would be a 6 mm sheet. It would take three center supports for a 4' x 8' sheet.
2. If we choose a 10 mm sheet, we could place the supports 48" apart (roughly one center support for a 4' x 8' sheet).
3. If we choose a 13 mm sheet, we could use the whole 4' x 8' sheet without any center supports.

Section IV: Chemical Resistance

Resistance to Standard Reagents

Generalizations:

Mineral Acids	Resistant to most (check resistance to specific acids)
Bases	Resistant
Salts	Resistant
Alcohols	Resistant
Paraffinic Hydrocarbons	Resistant
Oils and Greases	Resistant
Chlorinated Hydrocarbons	Not resistant
Aromatic Hydrocarbons	Not resistant
Esters	Not resistant
Ketones	Not resistant

Resistance to certain other fluid mixtures such as fuel oils with moderate aromatic content cannot be determined on the basis of immersion testing alone. Actual use data must be obtained.

It should be noted that in addition to temperature and reagent concentration, other factors such as stress level can also affect the chemical resistance of Sintra material. Because of this, the final determination of suitability must often depend on some in-service testing.

CODE:

1–Resistant 2–Limited Resistance 3–Little Resistance 4–Not Resistant

(Chemical resistance of Sintra material at an ambient temperature to standard reagents according to ASTM D-543)

Acetic acid
 .glacial 2
 .5% 1
Acetone 4
Ammonium hydroxide:
 .conc. 1
 10% 1
Aniline 4
Benzene 4
Carbon tetrachloride 3
Chromic acid 10% 1
Citric acid 10% 1
Cottonseed oil 1
Detergent solution 0.025% 1
Diethyl ether 1
Dimethyl formamide 4
Distilled water 1
Ethyl acetate 4
Ethyl alcohol:
 95% 1
 50% 1
2-ethylhexyl sebacate 4
Heptane 1
Hydrochloric acid:
 conc. 1
 10% 1
Hydrofluoric acid 40% 1
Hydrogen peroxide:
 28% 1
 3% 1

Isooctane	1
Kerosene	1
Methyl alcohol	1
Mineral oil	1
Nitric acid	
conc.	4
40%	1
10%	1
Oleic acid	1
Olive oil	1
Phenol solution 5%	1
Soap solution 1%	
Sodium carbonate solution:	
20%	1
2%	1
1 Sodium chloride solution 10%	1
Sodium hydroxide solution:	
60%	1
10%	1
1%	1
Sodium hypochlorite solution 6%	1
Sulfuric acid:	
conc.	1
30%	1
3%	1
Toluene	4
Transformer oil	1
Turpentine	1

Rigid P.V.C. Type I Qualification Testing

REQUIREMENTS AND TEST RESULTS

CHEMICAL RESISTANCE	REQUIREMENTS GRADE 1	REQUIREMENTS GRADE 2	REQUIREMENTS GRADE 3	SINTRA MATERIAL
H_2SO_4/93%/14d/55° C				
Change in weight: increase max. %	5.0	25.0	5.0	3.2
Flexural yield strength: decrease max. %	25.0	50.0	25.0	4.3
H_2SO_4/80%/30d/60° C				
Change in weight: increase max. %	NA	5.0	NA	0.8
Flexural yield strength: increase max. %	NA	15.0	NA	6.9
ASTM OIL NO. 3/30d/23° C				
Change in weight: increase max. %	1.0	1.0	1.0	0.7

Sintra material compiles with the requirements of ASTM D-1784 for Rigid P.V.C. Type I.

Section V: Weatherability

General Comments

Field performance over a 2–4 year period shows good weatherability in outdoor applications currently in operation in various environmental conditions. Reliable predictions, however, can only be made on the strength of long-term outdoor ("real-time") weathering. Such testing is currently in progress at various geographical locations.

Outdoor Mounting of Sintra Material

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

A. Tensile

The effects of medium altitude outdoor exposure with a comparatively high U.V. level on Sintra material during 24 months show virtually no change in tensile strength.

B. Color Changes

Field testing reported by many Sintra material customers shows acceptable color maintenance using white material. In general, white has been found to have superior weatherability over colors. Black Sintra also has had success outdoors. 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.

Sintra material exterior color fastness may be improved when used with some PVC compatible UV resistant, non-yellowing inks, clear top coat paints or clear laminates. (See Table III on page 6.) In addition to coatings and films, many light fixture manufacturers produce UV filtering diffusers that may also reduce or minimize these color changes for interior use.

Sintra Material is a P.V.C., therefore it will experience "browning out" or fading over time. This phenomenon is significantly less in white. While Sintra Material has been used in a variety of exterior applications, the degree of generic P.V.C. "browning out" cannot be predicted in advance of a specific application. Therefore no guarantee on color fastness can be made.

C. Impact Resistance and Environmental Stress

1. Effect of Temperature—With decreasing temperature, there is a tendency towards decreased impact resistance. However, measurement of the cold crack temperature with a bending apparatus for sheets of 2 mm and 3 mm thickness and a 1/2" mandrel show that under normal winter conditions, no immediate serious embrittlement is to be expected. A 2 mm, white Sintra material sheet can be bent around a 1/2" mandrel for 180° at an ambient temperature of -15° C (5° F) without fracture.

2. 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.

Section VI: Fire Characteristics

UL 1975
Fire Test For Foamed Plastics Used For Decorative Purposes

The purpose of this test method is to determine the ability of foamed plastics used for decorative purposes to resist rapid heat release when subjected to a flaming ignition source.

Section 11.303.c of the 1991 Uniform Fire Code regulates the use of Flammable Decorative Material. Section 11.303.c.4 defines the limits for the use of foam plastics as being:

A. Exhibit booth construction shall have a maximum heat-release of 100 kilowatts when tested in accordance with nationally recognized standards. (See section 2.304.b).

B. Decorative objects, including but not limited to mannequins, murals, and signs, shall have a maximum heat-release rate of 150 kilowatts when tested in accordance with nationally recognized standards. (See section 2.304.b.)

Section 2.304.b lists the UL 1975 as the standard for Fire Test for Foamed Plastics Used for Decorative Purposes.

The following Table provides a summary of the test results.

THICKNESS	DENSITY (lbs/ft^3)	MAX. INST. RHR (kW)
1 mm	44	38
6 mm	44	42
10 mm	28	80
19 mm	28	62

SwRI Project No. 01-3780-220

Section VI: Fire Characteristics

FIRE TEST RESULTS

TEST	UL 94V-0	UL 94-5V	ASTM E-84	
TEST DESCRIPTION	5"x1/2" bar mounted vertically. Flame applied to each of five specimens. Two consecutive 10 second burns on each specimen.	Vertical test like 94V-O, except more severe. Length of burner flame increased, and flame applied at 20° to one of the bottom corners of the bar. Flame applied to each specimen five times at 5 second intervals, each burn lasting 5 seconds.	Test also called UL Steiner Tunnel Test. 20"–24" wide by 24' long sample fits under roof of 25' long tunnel forming ceiling of tunnel. Gas Burners at one end impinge flame on 7 square feet of specimen. Rate of progression of flame observed as it passes side windows—decrease of light measured by photometer. Flame progression plotted as distance (of windows vs. time when flame passes window). Photometer data plotted as percent of absorption vs. time. Ratios of areas under curve to those of red oak, tested similarly and calculated. Red oak has a *flame spread index* of 100 and a *smoke developed index* of 100.	
CRITERIA	A. No burning up to specimen clamp. No dripping. B. 10 seconds max. time of flaming after each burn. C. 50 seconds max. total time of flaming for all burns of 5 specimens. D. 30 seconds max. time of glowing after last burn of specimen. E. Repeat (A) to (D) after conditioning 168H at 70° C.	**94-5VA Criteria** A. Not have any bar specimens that burn with flaming or glowing combustion for more than 60 seconds after the fifth flame. B. Not have any bar specimens that drip flaming particles that ignite dry absorbent surgical cotton located 12 inches below the test specimen. C. Not have any plaque specimens that exhibit a burn through (hole). **94-5VB Criteria** A. Not have any bar specimens that burn with flaming or glowing combustion for more than 60 seconds after the fifth flame. B. Not have any bar specimens that drip flaming particles that ignite dry absorbent surgical cotton located 12 inches below the test specimen. C. Permit a burn through (hole) on plaque specimens.		
	SINTRA MATERIAL PERFORMANCE VS. ABOVE CRITERIA: **A B C D E**	**UL 94 FLAMMABILITY CLASSIFICATION**	**SINTRA MATERIAL PERFORMANCE VS. ABOVE CRITERIA:**	
			FLAME SPREAD	**SMOKE DEV.**
1 mm White	Pass →	94-5VB		
2 mm White	Pass →	94-5VA		
2 mm Grey	Pass →	94-5VA	20	380
3 mm all colors	Pass →	94-5VA	20	315
4 mm	Pass →	94-5VA	20	425
5 mm	Pass →	94-5VA	20	>450
6 mm all colors	Pass →	94-5VA	20	>450
10 mm White	Pass →	94-5VA	25	>450
13 mm White	Pass →	94-5VA	>25	>450
19 mm White	Pass →	94-5VA	>25	>450

Section VI: Fire Characteristics

Relative Flammability Comparisons to Other Materials

In addition to its unique balance of performance properties, Sintra material has the following advantages as fire-retardant material:

1. Self extinguishing—remove the flame and the burning stops.
2. Relatively high ignition resistance—the heat content of Sintra material is 8,600 BTU/LB. Heat produced by a flame from Sintra material is not enough to produce those necessary vapors which combine with atmospheric oxygen to create a combustible mixture. Because of its low heat of combustion, Sintra material will not support combustion.
3. High oxygen index—ASTM D-2863 measures the percent of oxygen in an oxygen/nitrogen mixture which barely supports burning. The oxygen content of the earth's atmosphere is about 21%. Materials with oxygen index values of approximately 26 and above should not continue burning after the flame source is removed, because the normal atmospheric oxygen content is insufficient to support combustion.

   The oxygen index values of Sintra material is 46–49%. Many other plastics and natural products have values under 26, as this title indicates.

LIMITING OXYGEN INDICES (LOI) OF PLYMERS
(A LOW LOI VALUE INDICATES HIGH FLAMMABILITY)

BELOW 22 (MATERIAL BURNS BY ITSELF)	**22–28** (MAY BURN UPWARDS)	**ABOVE 28** (MATERIAL WILL NOT BURN BY ITSELF)
Polyacetal 15	Red Oak .23	Polysulfone 30-50
Cotton 16-17	Polyvinyl fluoride 23	Polyimides 31-45
Polymethylmethacrylate 17	Polyphenylene oxide 24	Polyphenylene sulfide 40
Polyethylene 17	Nylon 6/6 .24	Rigid polyvinyl chloride 40-49
Polypropylene 18	Polycarbonate 25	**Sintra® material** 46-49
Polystyrene 18	Nylon 6 26	Polyvinylidene fluoride 44
Filter paper (cellulose) 18	Plasticized polyvinyl chloride . .22-32	Chlorinated PVC 45-60
ABS 19		Polyvinylidene chloride 60
Cellulose acetate 19		Polytetrafluoroethylene 95
Styrene acrylonitrile 19		
Polyethylene terephthalate 20		
Birch 20.5		
Fir 21.5		

4. No "flaming drip"—Some burning polymers produce molten flaming drips which contribute to flame spread. Sintra material produces a form-retaining carbonaceous char. This char totally prevents fire-spreading flaming drips.

Section VII: Sources

Paints

Akzo Nobel/Wyandotte Paint Products Co.
5555 Spalding Dr.
Norcross, GA 30092
(770) 662-8464

Carbit Paint Co.
927 W. Blackhawk St.
Chicago, IL 60622-2519
(312) 280-2300

Hydracote Finishing Products, Inc.
P.O. Box 207
Green Camp, OH 43302
(800) 866-7578

Matthews Paint Co.
8201 100th St.
Pleasant Prairie, WI 53158
(800) 323-6593

Sherwin Williams Paint Co.
Contact local Sherwin Williams
stores nationwide

Spraylat Corp.
716 S. Columbus Ave.
Mount Vernon, NY 10550
(914) 699-3030

Primers

Masterchem Industries
31354 Old Hwy M
Imperial, MO 63052
(866) 774-6371

One Shot, LLC
5300 West 5th Avenue
Gary, Indiana 46406
(219) 949-1684

T.J. Ronan Paint Co.
749 E. 13th St.
New York, NY 10454
(800) 247-6626

Screen Print Inks

Naz-Dar Inc.
8501 Hedge Lane Ter.
Shawnee, KS 66227
(913) 422-1888

Sericol, Inc.
1101 W. Cambridge Cir. Dr.
Kansas City, KS 66110
(913) 342-4060

Vinyl Graphics

General Formulations
320 South Union St.
Sparta, MI 49345
(616) 887-7387

Intelicoat
700 Crestdale St.
Matthews, NC 28105
(704) 847-9171

3M Commercial Graphics Div.
3M Center Bldg. 207-1W-02
St. Paul, MN 55144
(651) 733-1110

Adhesives

Bostik Corp.
211 Boston St.
Middleton, MA 01949
(978) 777-0100

Dow Corning Corp.
P.O. Box 995
Midland, MI 48640
(989) 496-4400

Fisher Scientific
200 Parklane Drive
Pittsburgh, PA 15275
(412) 490-8300
(THF, MEK)

General Electric Co.
Technical Service Center
(800) 255-8886

Section VII: Sources

H.B. Fuller Company
315 S. Hicks Rd.
Palatine, IL 60067
(847) 358-9500

Henkel Consumer Adhesives.
32150 Just Imagine Dr.
Avon, OH 44011
(800) 321-1733

IPS (Weld-On)
455 West Victoria Street
Compton, CA 90220
(800) 421-2677

ITW TACC
56 Air Station Industrial Parkway
Rockland, MA 02370
(800) 503-6991

Lord Corp.- Chemical Products
2000 West Grandview Blvd.
Erie, PA 16514
(800) 458-0434 (ext. 3277)

MACCO Adhesives
(Liquid Adhesives)
15885 West Sprague Road
Strongsville, OH 44136
(800) 634-0015

National Casein
601 West 80th St.
Chicago, IL 60620
(773) 846-7300
(PVC-E)

3M Company
Technical Service Center
(800) 362-3550

Photomounting Adhesive

DryTac Corp.
5383 Glen Alden Drive
Richmond, VA 23231
(804) 222-3094

Henkel Adhesives
25817 Clawiter Rd.
Hayward, CA 94545-3217
(510) 786-3700

Hunt Graphics Americas/Seal Products
2020 West Front Street
Statesville, NC 28677
(800) 257-7325

MACtac
4560 Darrow Rd.
Stow, OH 44224
(800) 401-5005

Seal Graphics
7091 Troy Hill Drive
Elkridge, MD 21075
(800) 257-7325

3M Company
3M Center Building 230-2S-20
St. Paul, MN 55144
(888) 364-3577

Photomounting Presses

Advanced Greig Laminator
801 Burton Blvd.
DeForest, WI 53532
(608) 846-1025

Seal Graphics
7091 Troy Hill Drive
Elkridge, MD 21075
(800) 257-7325

Welding Equipment

Kamweld Technologies
89 Access Rd.
Norwood, MA 02062
(781) 762-6922

Laramy Products Co.
40 Sandy Lane
Lyndonville, VT 05851
(802) 626-9328

Line Bending Equipment

Big Chief Supply Co.
5150 Big Chief Dr.
Cincinnati, OH 45227
(513) 271-7411
(Bare Nickel Chromium Wire)

Section VII: Sources

Line Bending Equipment *(continued)*

FTM Inc.
6160 Cobblestone Rd.
Placerville, CA 95667
(530) 626-1986
(Strip Heaters, Acrylic Glue Applicator Bottles)

McMaster-Carr
600 County Line Rd.
Elmhurst, IL 60126
(630) 833-0300
(Bare Nickel Chromium Wire)

Staco Energy Corp.
301 Gaddis St.
Dayton, OH 45403
(937) 253-1191
Industrial Rheostat

Watlow Electric Mfg. Co.
12001 Lackland Rd.
St. Louis, MO 63146
(314) 878-4600
Heater Elements

Die Cutting Equipment

Brandtjen and Kluge
539 Blanding Woods Rd.
St. Croix Falls, WI 54024
(715) 483-3265

J.A. Richards Co.
903 North Pitcher St.
Kalamazoo, MI 49007
(800) 253-3288

Thompson National Press Co.
115 Dean Ave.
Franklin, MA 02038
(508) 528-2000

Router Bits

Onsrud Cutters
800 Liberty Dr.
Libertyville, IL 60048
(847) 362-1560
www.plasticrouting.com

Thermoforming Equipment

Brown Thermoforming
330 N. Ross St.
Beaverton, MI 48621
(989) 435-7741

Diamond Supply Inc.
200 Dalton Ave.
Charlotte, NC 28206
(800) 438-4139

Ultrasonic Welding

Dukane Corp.
Ultrasonics Div.
2900 Dukane Dr.
St. Charles, IL 60174
(630) 797-4900

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