



UltraTuf® PETG, UltraTuf PETG Med, Ultros™ Renu,
Ultros™ 90 RPETG, Royalite® G50, UltraTuf® APET,
UltraTuf® APET FDA, UltraTuf APET AF, UltraTuf® T

COPOLYESTER FABRICATION GUIDE



CONTENTS

SPARTECH COPOLYESTER SHEET SOLUTIONS.....	3
COPOLYESTER AT-A-GLANCE	
MATERIALS SELECTION	4
FOCUS MARKETS	4
MATERIAL DYNAMICS.....	4
FABRICATION	5
MATERIAL ADVANTAGES	6-7
CHEMICAL RESISTANCE.....	7
RECOMMENDED THERMOFORMING CONDITIONS	8
CHEMICAL BONDING	9
DRILLING	10
SAWING AND DRILLING	10
ROUTING.....	11
HEAT BENDING	11
PROPER CLEANING TO PROTECT UV SHEETS	11-12
CHARACTERISTICS OF PLASTIC.....	12
PLASTIC SHEET COMPARISON CHART	13
REFERENCES	14



SPARTECH COPOLYESTER SHEET SOLUTIONS

Spartech provides a complete line of material solutions, including a variety of specialty copolyester sheet solutions.

Polyesters offer a balance of impact strength, clarity, aesthetics, and ease of processing, making them ideal for a range of applications including, thermoformed trays for food and medical device packaging, skylights, point of purchase, graphic arts, and architectural panels. This user guide will help you utilize this material properly and to the full advantage. It is just another way we are continually shaping the future of plastics through material strength and application expertise.

COPOLYESTER AT-A-GLANCE

MATERIAL SELECTIONS

PETG:

UltraTuf® PETG, Spectar™ PETG, Ultros™ Renu, Ultros™ 90 RPETG, Royalite® G50, UltraTuf® PETG Med

APET:

UltraTuf® APET, UltraTuf® APET FDA

Tritan:

UltraTuf® T

FOCUS MARKETS

Building and construction:

- Store fixtures, POP displays, exhibit manufacturers
- Plastic fabricators/design houses
- Architectural and industrial products
- Skylights/lighting/indoor signage
- Vending faces
- Personal safety barriers and face shields

Graphic arts:

- Screen, digital, offset, litho and rotogravure printers

Packaging:

- Electronic packaging
- Medical device packaging
- General purpose packages
- Food Packaging
- Thermoforming

Others:

- Prosthetics

MATERIAL DYNAMICS

- Excellent clarity
- Superior toughness (allows down gauging)
- Cold formable (will not stress or whiten)
- Machinable (can be sawed, routed or drilled)
- Surface scratches can be removed with a heat gun
- Edges can be polished
- Easily die cuts (up to .080")
- Sealable and sterilizable (various methods)
- Printable
- No corrosive fumes during processing
- Excellent chemical resistance
- Eastar™ and Spectar™ comply with the compositional requirements of FDA food-contact regulation 21 CFR 177.1315(b)(1). Eastar™ approved for medical use
- UL Listed (flammability rating of 94 V-2 on .118" for Spectar™ and UltraTuf® PETG, under .118" HB
- ICC Approval on Spectar™ and UltraTuf® PETG
- PETG UV Stabilized sheet available

FABRICATION

Fabricating:

- Die cutting
- Drilling
- Tapping
- Laser Cutting
- Punching
- Routing
- Sawing
- Shearing

Forming:

- Cold bending
- Brake forming
- Strip heat bending
- Thermoforming

Bonding and fastening:

- Solvent bonding
- Mechanical fastening
- Welding
- RF sealing

Finishing:

- Sanding
- Scratch removal
- Edge finishing:
*Jointing, Flame solvent
and diamond polishing*
- Routing

Decorating:

- Hot stamping
- Screen printing
- Painting



MATERIAL ADVANTAGES

- Copolyester provides excellent impact strength properties with 20 times that of standard acrylic.
NOTE: Acrylics break easily, leaving dangerous pointed edges.
- Copolyester has excellent chemical resistance that is superior to acrylic, modified acrylic or polycarbonate.
NOTE: Acrylics have poor chemical resistance and can craze/shatter when exposed to certain paints, caulks and chemicals found in common cleaning solutions. Gasoline, chlorinated solvents and rubbing alcohol will all attack and soften acrylics. Polycarbonates are also susceptible to attack and can haze or embrittle easily when exposed to certain chemicals.
- Coextruded UV resistant cap layer provides excellent weatherability.
- With copolyester there is excellent dimensional stability for screen printing registration and distortion printing.
NOTE: Due to their higher forming temperatures, acrylics and polycarbonates can be more difficult to form and hold registrations.
- Spartech offers new masking films that can allow for easy feeding into new printing applications.
- Scratches and scuffs can be removed from copolyester using a hot air gun.
NOTE: Like acrylics, modified acrylics and polycarbonates, PETG will haze with abrasion. However, Spartech PETG sheet can be “refreshed” by passing a hot air gun over the scratched area causing the finer scratches to “heal”.
- No pre-drying is required with copolyester.
NOTE: Polycarbonates as well as some acrylics require pre-drying prior to thermoforming and some printing processes. Any Spartech copolyesters can be formed and printed without pre-drying.
- Copolyester offers a shorter forming cycle than acrylic or polycarbonate.
NOTE: Acrylics and polycarbonates require higher initial temperatures to soften, so it is more costly to process in a thermoforming operation. Spartech copolyester sheet forms easily at lower temperatures with excellent definition. The lower temperature also means faster cooling and part removal.
- Spartech copolyester sheet can be cold bent without crease whitening or blushing and it retains a cold bent shape better than modified acrylics.
NOTE: Acrylics break when cold formed while modified acrylics crease whiten and tend to revert to their flat state after being cold bent. Spartech copolyester sheet has excellent impact properties, which makes fabrication easier.
- Other advantages of Spartech copolyester sheet include the fact that it can be:

MATERIAL ADVANTAGES (continued)

- Die cut and punched, cut with conventional saws, routed and drilled
- Solvent welded and painted
- Silk-screened, offset or digital printed
- Readily hot stamped and laminated

The edges of the Spartech copolyester sheet can be flame polished, chemically polished or buffed to a brilliant edge using a commercial edge polisher. In addition, copolyester sheet is available in clear, tinted or colors and a variety of copolyesters to fit most application requirements.

CHEMICAL RESISTANCE

Spartech copolyester sheet has excellent chemical resistance and performs better than most clear plastics. Its chemical resistance is also a detriment in the fact that bonding of copolyesters take longer than most other plastics. The chemical resistance of all plastics can be greatly affected by temperature, duration of exposure, strength/dilution of the chemical, inherent stress in the part. The only practical way to predict chemical resistance requires testing the actual part with the actual chemicals. This may be encountered under the same typical environmental conditions. For additional chemical resistance information contact Spartech customer service.

THERMOFORMING

- Excellent material distribution
- Minimal thickness variation and webbing
- Distortion and registration grade for printing
- Material savings
- Excellent part definition and detail
- Wide processing window on UltraTuf® PETG and Spectar™
- Lower forming temperature for all copolyesters
- Faster cycle times result in energy savings
- No pre-drying required
- Low mold shrinkage (easy release and well suited for complex designs)

RECOMMENDED THERMOFORMING CONDITIONS

Spartech copolyester sheet offers the following advantages when compared to acrylic and polycarbonate materials:

- Lower forming temperature
- Wider forming temperature “window”
- Faster cycle times
- No pre-drying required
- Superior material distribution
- Less shrinkage

Spartech PETG offers the following advantages when compared to acrylic and polycarbonate materials:

	SPARTECH PETG	POLYCARBONATE	GP ACRYLIC	DR ACRYLIC
Optimum Forming Temp	300° F	375° F	350° F	325° F
Forming Temp Range	250-300° F	370-415° F	290-350° F	275-350° F
Heating Cycle Hot Air Infrared	<12 min 3.75 min	12 min 6 min	12 min 5 min	12 min 4 min
Cooling Cycle	<1 min	1 min	2.5 min	180–185
Part Removal Temperature	140° F	180	180	180
Forming Time	<10 sec	15 sec	75 sec	50 sec
TOTAL FORMING CYCLE:				
Hot Air Infrared	<13 min <5 min	13 min 7 min	14.5 min 7.5 min	14 min 6 min
	No Pre-Drying	PLUS Pre-Drying Cycle Time		

CHEMICAL BONDING

Solvents, cements and various adhesives can be used to bond Spartech copolyester sheet to itself, to dissimilar or to other non-plastic materials. Suggested bonding agents, include the following:

- Weld-on #3 or #4 water thin solvent cements, weld-on 55/58 or 40/42 two-part adhesive *IPS Corporation, Gardena, CA (www.assemblyadhesives.com)*
- Plexus MA300 and MA310 and Tru-Bond 18200 series: *Devcon, Danvers, MA (www.devcon.com)*
- Hysol E-05CL, Light Cure 3104/3105: *Loctite (www.loctite.us)*
- Scotch-Weld DP100: *3M Company, St. Paul, MN (www.3M.com)*
- Ultra Light-Weld 3016, 3025, 3072: *Dymax (www.dymax.com)*
- Caseway, SC-200: *Caseway Industrial Products, Orange Park, FL (www.casewayproducts.com)*
- MC-Bond, Acrylic Cement: *Polysciences, Inc., Warrington, PA (www.polysciences.com)*

When bonding Spartech copolyester sheet to other plastics, you can use the following recommended bonding agents:

- Weld-on #'s 4, 4007 (surface-to-Surface) or 55
- Cyanoacrylate
- Hot melt adhesives

Recommended solvents for use with Spartech copolyester sheet include:

- Dichloromethane (DCM, Methylene Chloride, Methylene Dichloride)
- Methyl Ethyl Ketone (MEK)
- Extru-Fix: *Evode Specialty Adhesives, Ltd. Leicester, England*

General bonding and solvent guidelines:

Spartech copolyester sheet edges must be clean, smooth, and straight.

Solvent, adhesive or cement should be applied and allowed to be sufficiently active in order to properly soften the mating surface.

Spartech copolyester sheet should be allowed to set properly before additional fabrication or packaging occurs.

DRILLING



The use of standard twist drills designed for wood or metal is acceptable for drilling Spartech copolyester sheet. Please note: We recommend using a drill bit that is especially designed for plastics.

Drilling tips:

- For a clean hole, use only a drill bit with two flutes and with a point of an included angle that is 60° to 90°
- A drill speed of approximately 1725 RPM works best
- Use moderate pressure, do not force the drill
- Back out the drill occasionally, freeing any chips that may collect
- For safety, hold or clamp the sheet securely to prevent slipping or movement

SAWING AND DRILLING



Sawing recommendations: *(Important variable = Correct blade and saw speed)*

CUT TYPE	SAW TYPE	BLADE DESIGN	TEETH TYPE	SPEED
Straight	Circular	Triple Chip	7 ¼" Dia., 40 teeth (Carbide Tip) or 7 ¼" Dai., 200 teeth (Plywood Blade)	4,500 rpm
Curved	Saber or Jigsaw	Finishing	7 teeth per inch	2,000 ft/min
Curved	Band	½"	3 teeth per inch	2,000 ft/min
Trimming	Router	Carbide Tip or High Speed Steel, Double Fluted	3/8" Dia.	20,000 rpm

Drilling recommendations: *(Important variable = Correct bit and drill speed)*

0° rake angle bits	100 to 200 feet/min	0.010 to 0.025 in/revolution
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ROUTING



Routing can be used to create unique edge finishes on Spartech copolyester sheet (Note: this material can be routed similarly to wood and trimming or shaping the edges can also be easily accomplished). A variety of router bites are available to produce the desired edge such as chamfered, bullnose, half-bullnose as well as tongue and groove.

Router trimming should be done with care using the suggested bits:

- Single straight and up-spiral flutes (1/4" diameter bits)
- Double straight and up-spiral flutes (3/8" diameter bits)

Routing safety tips:

- Saw close to the lines
- Use the router to trim and shape the sheet.
- Either clamp securely or hold the sheet firmly while moderately feeding the sheet against the rotation of the router bit.
- Always remember to keep the router bits sharp

HEAT BENDING



To heat bend Spartech copolyester sheet you need to use a 1/2" strip heater (800° f) and follow the following process guidelines:

- Heat .236" SPARTECH copolyester sheet for approximately 2½ minutes
- Always bend the heated side so that it forms the outside radius
- If bending occurs before the sheet is properly warmed, stresses may be created that will result in a brittle part

CAUTION: Overheating can cause bubbles in the bend area.

PROPER CLEANING TO PROTECT UV SHEETS

Spartech copolyester sheet should be cleaned periodically following a regular, once-a-year cleaning program. With this in place it will help prevent noticeable weathering and dirt build-up.

Cleaning steps:

1. Rinse the sheets with lukewarm water
2. Remove dust and dirt from sheets with a soft cloth or sponge and a solution of mild soap and liquid detergent in water. A 50:50 solution of isopropyl alcohol and water also works well.
3. Rinse thoroughly with lukewarm water.

It's important to note that to remove grease and residue from tape it is recommended you clean using naphtha followed by a water wash and following these guidelines:

- Always use a soft, damp cloth and blot dry
- Rubbing with a dry cloth can scratch the material and create a static charge
- Never use scrapers or squeegees on copolyester sheet
- Avoid scouring compounds, gasoline, benzene, acetone, carbon tetrachloride, deicing fluids, lacquer thinner or other strong solvents
- Rub with a dry cloth
- NEVER use a squeegee or strong solvents

Note: If a material is found to be incompatible in a short-term test, it will usually be found to be incompatible in the field. The opposite is not always true. Favorable performance is no guarantee that actual end-use conditions have been duplicated. That is why these results should be used as a guide only and it is recommended that the user test the products under actual end-use conditions.

CHARACTERISTICS OF PLASTIC

Hazing: Loss of light transmission, clarity, distorted colors, caused by heat and exposure to the elements.

Yellowing: Discoloration due to exposure to the elements and solar radiation.

UV Degradation: Crazing and yellowing of the surface caused by UV light.

Flexural Strength: Stiffness based on the flexural modulus of a material.

Impact Strength: Ability to withstand surface impact as measured by a "falling dart" or IZOD impact test.

Tensile Strength: The amount of force required to stretch a material.

Coefficient of Linear Expansion: The amount of dimensional change due to a change in temperature.

Hardness: A measurement of the surface hardness based on the amount of indentation by a weighted ball pressed into a material's surface. Two scales used are Mohr's Scale and the Rockwell Scale.

Light Transmission: The percentage of visible light which passes through a plastic material. Glass will have about a 90% light transmission. Plastics will vary from 83% to about 94% light transmission.

Thermoforming: The process of heating plastic to its softening point and then forming it around (or into) a shaped mold. The process can be done using either a single male, single female or both male female molds.

Vacuum Forming: The use of vacuum assisted molds to draw heated plastic around (or into) a shaped mold. This process allows tighter radius and crisper edges to be used in a mold design.

Forming Cycle: The length of time required to heat, form, and cool a plastic sheet into a molded shape. The cycle time may also include the preheat, the pre-drying and both the loading and unloading times in fully automatic thermoforming equipment. The shorter the cycle time, the lower the fabricated cost of the part.

Forming Temperature Range: The temperature range in which it is possible to effectively form a plastic sheet into a desired shape. In most cases, the lower the forming temperature, the lower the fabricated cost of the part.

Pre-drying: The process of gently heating the unformed plastic sheet to release moisture which may exist. This moisture is picked up by the sheet after it has been extruded. Moisture left in a plastic sheet will appear as bubbles in the thermoformed part. These bubbles are voids in the plastic caused by the trapped moisture expanding during the forming cycle.

PLASTIC SHEET COMPARISON CHART

PROPERTY	SPARTECH PETG SHEET	GP ACRYLIC ACRYLIC SHEET	IMPACT MODIFIED ACRYLIC	POLYCARBONATE SHEET
Thickness (in)	0.125	0.125	0.125	0.125
Plaque Impact: (ft. lbs.) @ 73°F	44	<1	4.0	>42
(ft. lbs.) @ -10°F	44	<1	2.5	>42
Modulus of Elasticity (psi)	290,000	450,000	210,000	345,000
Tensile Strength	7,100	10,580	5,400	9,500
Elongation %	180%	5%	75%	80%
Coefficient of Thermal Expansion (in/in/F)	5.0 x 10 ⁻⁵	3.3 x 10 ⁻⁵	5.6 x 10 ⁻⁵	3.7 x 10 ⁻⁵
Specific Gravity	1.27	1.19	1.15	1.20
Gardner Impact: (.060" @ 0°F)	>13	–	–	>13
Deflection Temperature @ 264 psi	145	–	–	275

Note: Impact tests conducted on 4" x 4" plaques - ½" spherical head, 4 lb. weight.

REFERENCES

Spartech

spartech.com

Eastman Chemical Company

eastman.com

IPS Corporation

assemblyadhesives.com

Devcon

devcon.com

Loctite

loctite.us

3M Company

3M.com

Dymax

dymax.com

Caseway Industrial Products

casewayproducts.com

Polysciences

polysciences.com

Arkema/Trinseo

plexiglas.com/en

This fabrication manual is a general guide for working with Spartech thermoplastic sheet. Because actual results vary with differences in operating conditions, thickness, color, and composition, nothing contained herein can be construed as a warranty or representation that these products will perform in accordance with these general guidelines.

Important Notice: Our recommendations, if any, for the use of these products, are based on tests believed to be reliable. The greatest care is exercised in the selection of raw materials and in the manufacturing operations. However, because the use of these products are beyond the control of the manufacturer, no guarantee or warranty, express or implied, is made as to such use or effects incidental to such use, handling or possession of the results to be obtained, whether in accordance with the directions, or claimed so to be. The manufacturer expressly disclaims responsibility therefor. Furthermore, nothing contained herein shall be construed as a recommendation to use any product in conflict with existing laws and/or patents covering any material or use.

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11650 Lakeside Crossing Ct.
Maryland Heights, MO 63146

800-677-4338

www.spartech.com