Prosthetic & Orthotic Handbook

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Product and Pricing Guide

PROSTHETIC & ORTHOTIC PLASTICS

Professional Plastics is a stocking distributor of plastic sheet, rod, tube and film. Professional Plastics maintains a large variety of plastic materials suitable for the Prosthetic & Orthotic industry.

This is your guide to the Prosthetic & Orthotic material stocked at our facility in Fullerton, California. Please consider this book as a resource for all of your plastics materials. You may order partial sheets or full sheets for same day shipment. Custom cutting is available for an additional charge.

In this plastics guide you will find the following:

1) Typical stocked sizes and thicknesses.
2) Guide to typical thermoforming problems.
3) MSDS for all materials in the guide.

LDPE (Low Density Polyethylene) – **Natural**

Flex Modulus: 48,000

Of all the olefins, LDPE is the softest and most flexible. Approximate oven forming temperature ranges between 350 degrees and to 375 degrees Fahrenheit.

LDPE offers the following features:

- Low tensile strength.
- Easy formability.
- Very good flexibility.
- Offers a soft, comfortable feel for the patient.

Pricing is as follows:

Thickness	No. of Sheets	48 x 96	32 x 48	24 x 48
0.060	1			
	2 to 5			
	6 to 15			
	15+			
0.098	1			
	2 to 5			
	6 to 15			
	15+			
0.118	1			
	2 to 5			
	6 to 15			
	15+			
0.187	1			
	2 to 5			
	6 to 15			
	15+			
0.236	1			
	2 to 5			
	6 to 15			
	15+			
0.500	1			
	2 to 5			
	6 to 15			
	15+			

HDPE (High Density Polyethylene) – **Natural**

Flex Modulus: 160,000

This material is a flexible, tough, and cold resistant. HDPE is very resistant to stress cracks and abrasions with high strength and good energy absorption properties. Approximate oven forming temperature ranges between 350 degrees and 375 degrees Fahrenheit.

HDPE offers the following features:

- Very good thermoforming properties.
- If used in proper applications, a very durable product.

Pricing is as follows:

Thickness	No. of Sheets	48 x 96	32 x 48	24 x 48
0.060	1			
	2 to 5			
	6 to 15			
	15+			
0.098	1			
	2 to 5			
	6 to 15			
	15+			
0.118	1			
	2 to 5			
	6 to 15			
	15+			
0.187	1			
	2 to 5			
	6 to 15			
	15+			
0.236	1			
	2 to 5			
	6 to 15			
	15+			

Homopolymer Polypropylene – Natural & Black

Flex Modulus: 190,000

Of all the olefins Polypropylene is the most rigid. This material is very rigid, strong, and fatigue resistant. It has uses for body jackets, upper extremity and lower extremity orthoses such as the ankle and foot area, and rigid outer prosthetic sockets, although it is not suitable for low temperatures. Approximate oven forming temperature ranges between 350 degrees and 375 degrees Fahrenheit.

Homopolymer Polypropylene offers the following:

- The most rigidity.
- Excellent resistance to stress cracks.
- Very good formability.
- Overall durability is very good

Pricing is as follows:

Thickness	No. of Sheets	Natural 32 x 48	Black 32 x 48
0.060	1		
	2 to 5		
	6 to 15		
	15+		
0.093	1		
	2 to 5		
	6 to 15		
	15+		
0.125	1		
	2 to 5		
	6 to 15		
	15+		
0.156	1		
	2 to 5		
	6 to 15		
	15+		
0.187	1		
	2 to 5		
	6 to 15		
	15+		
0.250	1		
	2 to 5		
	6 to 15		
	15+		

Co-Poly Polypropylene – Natural

Flex Modulus: 170,000

This material is a combination of polypropylene and polyethylene, which gives it, improved impact strength, slightly increased flexibility and improved cold weather properties. Co-Poly Polypro is a medium stiffness material. Approximate oven forming temperature ranges between 350 degrees and 375 degrees Fahrenheit.

Co-Poly Polypro offers the following:

- Very good formability.
- Good resistance to cracks.
- Good rigidity combined with some flexibility.

Pricing is as follows:

Thickness	No. of Sheets	48 x 96	32 x 48	24 x 48
0.090	1			
	2 to 5			
	6 to 15			
	15+			
0.118	1			
	2 to 5			
	6 to 15			
	15+			
0.156	1			
	2 to 5			
	6 to 15			
	15+			
0.187	1			
	2 to 5			
	6 to 15			
	15+			
0.236	1			
	2 to 5			
	6 to 15			
	15+			

PETG – Clear

Flex Modulus: 309,000

This material is a rigid clear product with excellent impact properties. Excellent for use as check sockets. PETG has other uses such as sports masks for both professional as well as amateur players, and for use with burn patients as an alternative to Uvex. Approximate oven forming temperature ranges between 325 degrees and 350 degrees Fahrenheit.

Critical heating process – this material can be very strong when not overheated. To gauge when material is ready to be removed from the oven, bubbles will appear around the edges. If bubbles have moved to the center of the sheet, it has been overheated. This can cause material to become brittle; it may crack or even shatter.

PETG offers the following:

- Provides good thermoformability at a lower temperature than other plastics.
- Gives an optically clear product, providing a superior viewing of underlying tissues and pressure points.
- Can be formed by hand draping or using a frame.
- Is thermobondable at forming temperature.
- Has no need to be pre-dried under normal conditions.
- Can be modified with a heat gun after initial forming.

Pricing is as follows:

Thickness	No. of Sheets	48 x 96	32 x 48	16 x 16
0.187	1			
	2 to 5			
	6 to 15			
	15+			
0.250	1			
	2 to 5			
	6 to 15			
	15+			
0.375	1			
	2 to 5			
	6 to 15			
	15+			
0.500	1			
	2 to 5			
	6 to 15			
	15+			

Kydex

Flex Modulus: 335,000

Kydex is a unique blend of Acrylic and PVC. With a very high flex modulus, this blend gives the material rigidity, toughness, and decorativeness. Black, Pinstripe (gray), Beige, and White are common colors with many more colors available upon request. This material has become quite popular for neck braces, body jackets and other upper extremity orthoses. Approximate oven forming temperature ranges between 350 degrees and 375 degrees Fahrenheit.

Kydex offers the following:

- A wide range of color selection, as mentioned above.
- Is abrasion resistant and come with a haircell texture on one side.
- Rigidity, and easy thermoformability.
- Can be easily die cut.

Pricing is as follows:

Thickness	No. of Sheets	Beige 32 x 48	White 32 x 48
0.060	1		
	2 to 5		
	6 to 15		
	15+		
0.093	1		
	2 to 5		
	6 to 15		
	15+		
0.125	1		
	2 to 5		
	6 to 15		
	15+		
0.187	1		
	2 to 5		
	6 to 15		
	15+		
0.250	1		
	2 to 5		
	6 to 15		
	15+		

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Troubleshooting Guidelines

Troubleshooting Guideline

Incomplete Forming

This occurs when the sheet or one area of the sheet fails to adequately conform to the mold resulting in poor formed detail.

CAUSE	*CURE*
1. Sheet too cold	1. Increase heating time. 2. Increase heater temperature. 3. Increase watt density. 4. Increase heating uniformity.
2. Insufficient vacuum	1. Check for clogged vacuum holes. 2. Increase number of vacuum holes. 3. Check for proper location of vacuum holes. 4. Increase size of vacuum holes.
3. Vacuum not drawn fast enough	1. Check for vacuum leaks. 2. Check vacuum system design as meeting required evacuation rate. 3. Increase size of vacuum holes. 4. Increase vacuum surge or pump capacity
4. Cold clamping frame	1. Preheat clamping frames.
5. Part draw ratio too large	1. Add plug, pressure or frame assist.

Sheet Scorched

Scorched sheet turns yellow. This is usually evidenced by a color change in the sheet.

CAUSES	*CURE*
1. Top or bottom surface too hot	1. Decrease heating cycle time. 2. Decrease heater temperature.

Webbing

Also referred to as bridging or wrinkling.

CAUSES	*CURE*
1. Sheet too hot	1. Decrease heating cycle time. 2. Decrease heater temperature.
2. Not enough vacuum	1. Check vacuum system for leaks. 2. Check for clogged vacuum holes. 3. Increase number of vacuum holes. 4. Check for proper location of vacuum holes. 5. Increase size of vacuum holes.
3. Poor design or layout	1. Use drape assist or stretch assist. 2. Use female instead of male molds.

	CAUSES	CURE
Excessive Sheet Sag	1. Sheet too hot	1. Decrease heating cycle time. 2. Decrease heater temperature.
	2. Sheet area too large	1. Use preferential heating by the use of screens, particularly in the sheet center.

	CAUSES	CURE
Varying Sag Level Between Sheets	1. Sheet-to-sheet temperature variation	1. Undesirable air drafts through heater section. 2. Sheet not cooled sufficiently after extrusion.
	2. Uncontrolled use of regrinds	1. Control quality of regrinds. 2. Decrease or control percentage of regrinds.

	CAUSES	CURE
Chill Marks	1. Stretching stops when sheet meets cold mold or plug	1. Increase mold temperature. 2. Increase plug temperature.
	2. Improper mold or plug design	1. Relieve mold or plug in critical areas.

	CAUSES	CURE
Appearance Surface Marks	1. Dirty Mold	1. Clean mold or clean more frequently.
	2. Mold too hot or too cold	1. Increase mold temperature. 2. Decrease mold temperature.
	3. Poor mold surface quality for desired part appearance	1. Upgrade mold surface.
	4. Dirty or surface damaged sheet	1. Improve handling and storage techniques to protect sheet. 2. Clean sheet.
	5. Mold surface wear	1. Use mold material proper for projected mold service requirements.
	6. Air entrapment over smooth mold surface	1. Reduce polish on mold. 2. Add vacuum holes in affected area.
	7. Insufficient vacuum	1. Check for clogged vacuum holes. 2. Check vacuum system for leaks. 3. Increase number of vacuum holes. 4. Check for proper location of vacuum holes.
	8. Contaminated Sheet	1. Control quality and type of regrind 2. Check with sheet supplier.
	9. Dust in atmosphere	1. Reduce airborne dust by better housekeeping. 2. Isolate area and provide filtered air.

Part Warpage

CAUSES	CURE
1. Part too hot when removed	1. Increase sheet cooling by: a) Increase cooling cycle time b) Add more cooling capability by using fans. 2. Decrease mold temperature.
2. Improper part design	1. Redesign with tapers, fillets, etc…
3. Uneven part cooling	1. Increase mold temperature and/or temperature uniformity. 2. Check operability of cooling system.
4. Poor material distribution	1. Check sheet gauge variation. 2. Check for uneven heating of sheet 3. For deep draw use plug assist and/or prestretch.

Poor Mold Release

CAUSES	CURE
1. Part or mold too hot	1. Increase cooling cycle time. 2. Decrease mold temperature.
2. Mold undercuts	1. Use of stripping frame. 2. Add or increase air eject pressure and/or duration.
3. Inadequate mold draft	1. Increase taper/draft. 2. Convert from male to female forming.
4. Poor mold surface	1. Use mold release. 2. Improve mold surface.

Distortion of Part Upon Removal

CAUSES	CURE
1. Part not cooled adequately	1. Check operability of cooling system. 2. Increase cooling cycle time. 3. Increase cooling capacity of cooling system.

Poor Material Distribution

Known also as poor wall thickness control.

CAUSES	CURE
1. Highly variable sheet gauge	1. Check sheet gauge. 2. Improve sheet extrusion control.
2. Uncontrolled sheet heating	1. Check heaters for operability. 2. Use screening or shading to control heating. 3. Check for drafts or air current in system of mold.

POOR MATERIAL DISTRIBUTION – Continued

	CAUSES	*CURE*
	3. Mold too cold	1. Increase mold temperature. 2. Check for uniform heating of mold. 3. Check temperature control system of mold.
	4. Sheet slipping out of frame	1. Improve frame-clamping capability. 2. Preheat frame to normal operating temperature. 3. Check heaters around clamp area for inoperability.
	5. Wrong forming method for part	1. Balance part design with forming methods available.

Non-uniform Billow

CAUSES	*CURE*
1. Uncontrolled sheet heating	1. Check heaters for operability. 2. Use screening or shading to control heaters. 3. Check for drafts or air currents in heating system.
2. Non-uniform air pressure within bellow	1. Check pressurized air systems for leaks. 2. Check sheet sealing on billow box. 3. Redirect incoming air to billow box.

Thin Corners with Deep Draw Parts

CAUSES	*CURE*
1. Uncontrolled sheet heating	1. Check heaters for operability 2. Use screening or shading to control heaters. 3. Check for drafts or air currents in heating stage.
2. Uncontrolled material distribution	1. Consider other forming techniques such as prestretch billow and/or plug assist.
3. Too thin sheet gauge	1. Increase sheet gauge.
4. Non-uniform mold temperature	1. Check mold heating system for operability. 2. Redesign mold heat distribution.

Sheet Sticking to Assist Plug

CAUSES	*CURE*
1. Plug temperature too hot	1. Decrease plug temperature. 2. Lubricate plug. 3. Change plug surface characteristics: a) Flannel cover b) Permanent lubricant applied to surface.
2. Wooden plug assist	1. Lubricate plug. 2. Change plug surface characteristics: a) Flannel cover b) Permanent lubricant applied to surface.

Tearing of Sheet While Forming

CAUSES	CURE
1. Sheet too hot	1. Decrease heating cycle time. 2. Decrease heater temperature. 3. Preheat sheet.
2. Poor material distribution	1. Check sheet gauge variation. 2. Check for controlled heating pattern.
3. Prestretch too large	1. Reduce billow blowing rate. 2. Reduce billow temperature.
4. Sheet too cold	1. Increase heating cycle time. 2. Increase heater temperature.

Bubbles in Sheet

Also known as blisters or pits.

CAUSES	CURE
1. Excessive moisture	1. Predry sheet. 2. Preheat sheet. 3. Heat on both sides. 4. Protect sheets from moisture until ready to use them.
2. Heating sheet too rapidly	1. Use slower heating rate by: a) Lower heat temperatures. b) Increase distance between heaters and sheet.
3. Water dripping on hot sheet	1. Prevent leaking fluids from dripping onto sheet.

Nipples on Mold Side of Sheet

CAUSES	CURE
1. Sheet too hot	1. Decrease heating cycle time. 2. Decrease heater temperature.
2. Vacuum holes too large	1. Decrease hole size.

Loss of Color by Blushing or Degradation

CAUSES	CURE
1. Sheet over heated	1. Check for runaway heater(s) if localized. 2. Decrease heating cycle time. 3. Reduce heater temperature.
2. Overdrawing sheet	1. Increase sheet gauge. 2. Increase sheet temperature. 3. Provide predraw. 4. Provide plug assist for deep draw parts.
3. Mold too cold	1. Increase mold temperature.

LOSS OF COLOR BY BLUSHING OR DEGRADATION – Continued

	CAUSES	*CURE*
	4. Assist plug too cold	1. Increase plug temperature.
	5. Uncontrolled use of regrinds	1. Control quality of regrinds. 2. Decrease percentage of regrinds.
	6. Sheet cooling before formed	1. Decrease forming cycle time.

Whitening of Sheet	*CAUSES*	*CURE*
	1. Sheet too cold	1. Increase heating cycle time. 2. Increase heater temperature.
	2. Drawn beyond yield point of material	1. Increase speed of drape.

Loss of Embossing Distinctness	*CAUSES*	*CURE*
	1. Depth of embossing too low for draw ratio	1. Increase depth of embossing pattern. 2. Decrease draw ratio.
	2. Non-uniform drawing	1. Use screening or sheeting to control heating pattern. 2. Use plug assist and/or billow to prestretch sheet.

Cracking of Part In Use	*CAUSES*	*CURE*
	1. High formed-in-stress	1. Increase sheet temperature during forming. 2. Use proper forming sheet temperature and cooling rate for deep draw parts. 3. Increase fillets.
	2. Part thickness too low for draw	1. Increase sheet gauge.
	3. Uncontrolled sheet heating	1. Use screening or shading to control heating pattern.

PRICING REQUEST SHEET

Fax to: (866) 776–7527

E-Mail: sales@proplas.com

NAME: _____

COMPANY: _____

ADDRESS: _____

_____

PHONE: _____ **FAX:** _____

EMAIL: _____

	QUANTITY	THICKNESS	SHEET SIZE	PRICE
LDPE				
HDPE				
HOMOPOLYMER POLYPRO				
CO-POLYMER POLYPRO				
PETG				
KYDEX				