Allplastics

PERSPEX® Presentation

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ARCHITECTURAL & BUILDING

S A R
SUPER ABRASION RESISTANT

euromir
ACRYLIC MIRROR

ad
ALLFROST DOORS

PERSPEX®

PERSPEX® Acrylic Sheet

- Manufactured in the U.K. by Lucite International, a division of Mitsubishi Chemicals Corporation.
- Perspex® cast acrylic is available in clear, opal and a wide range of colours, textures and finishes – both in stock or as bespoke variants (Make-to-Order, MTO)
- Standard Sheet size is 3050 x 2030 mm
- Clear sheet guaranteed for 30 years in Australia for both internal and external applications. Printed masking.
- Colours and tints guaranteed for 10 years in Australia for both internal and external applications. Printed masking.

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PERSPEX® Manufacturing Processes

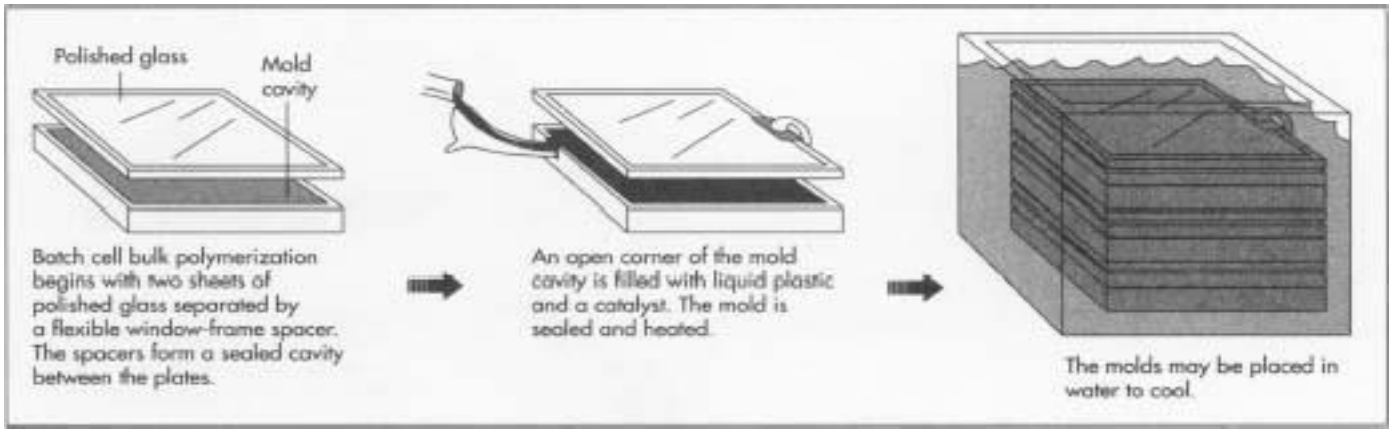
- Perspex® acrylic sheet is made by three different processes:
- Cell Casting (prevalent in Europe)
- Extrusion (global)
- Continuous Casting (prevalent in USA and Asia)
- Perspex® production begins with Methyl Methacrylate monomer. This is a water clear liquid and is derived through a series of complex processes from oil
- Lucite International has invented and patented the Alpha process which is much more environmentally friendly and less expensive than the ACH (Acetone Cyanohydrin) or C4 processes

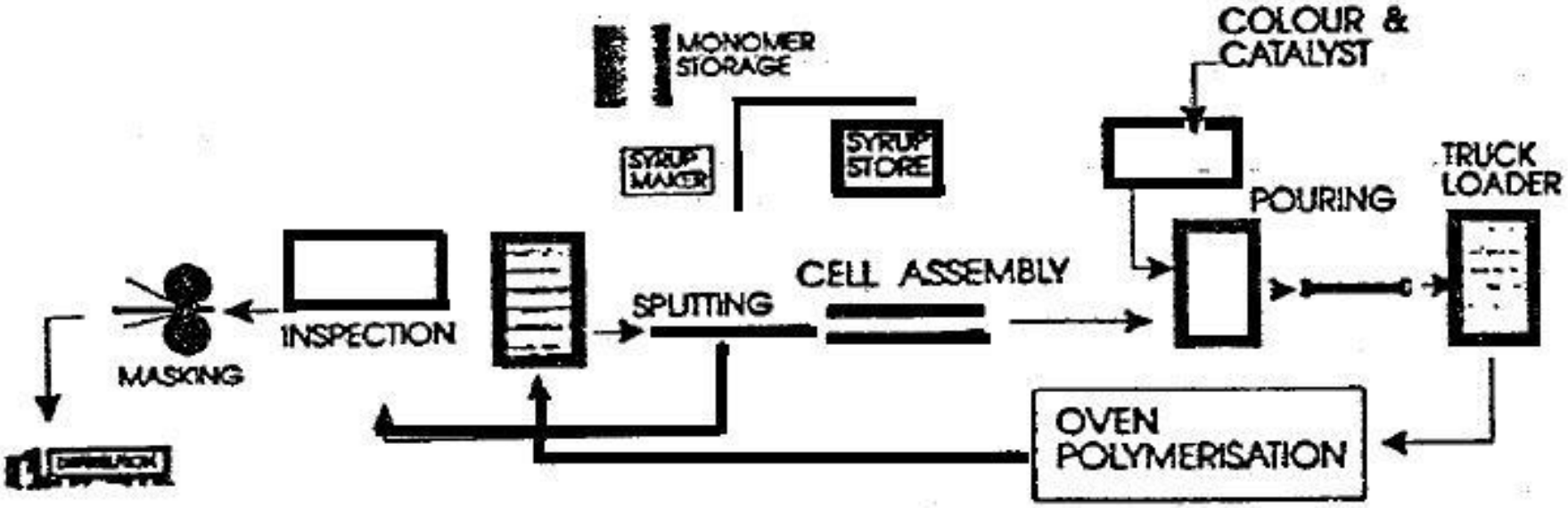
- http://www.ingenia.org.uk/ingenia/issues/issue45/harris.pdf

Cell Casting

- Cell casting is the original process used for the manufacture of Perspex® acrylic sheet. Although much developed, it is still used today and produces sheet with superior properties and characteristics to acrylic sheet produced by other manufacturing processes.
- The process starts with Methyl Methacrylate (MMA). This is mixed with colour pigments and other ingredients before being poured into a cell which is constructed of two plates of glass, separated by a gasket. In addition to containing the syrup within the cell, the gasket also determines the thickness of the sheet to be cast.
- When a number of cells have been filled, usually nineteen, they are loaded into an oven. As the oven temperature is increased a chemical reaction occurs causing the syrup to polymerise, or solidify. The oven temperatures are carefully monitored to control the reaction to ensure thorough polymerisation, thereby maintaining the high quality properties of the finished Perspex® sheet.
- After polymerisation, the cells are removed from the oven and the glasses separated to allow the Perspex® sheet to be removed, inspected, masked, trimmed and despatched.

Cell Casting

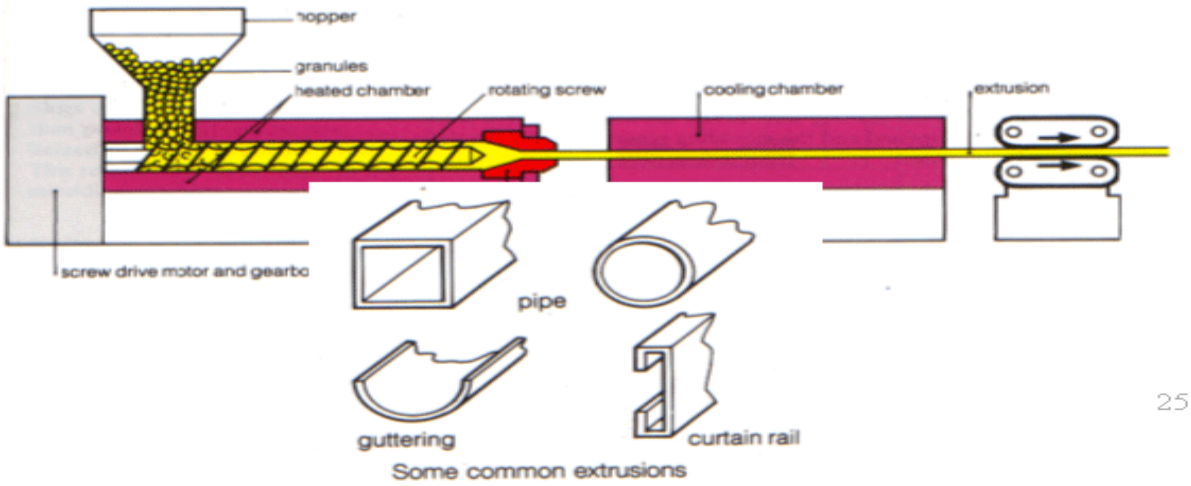




Extrusion

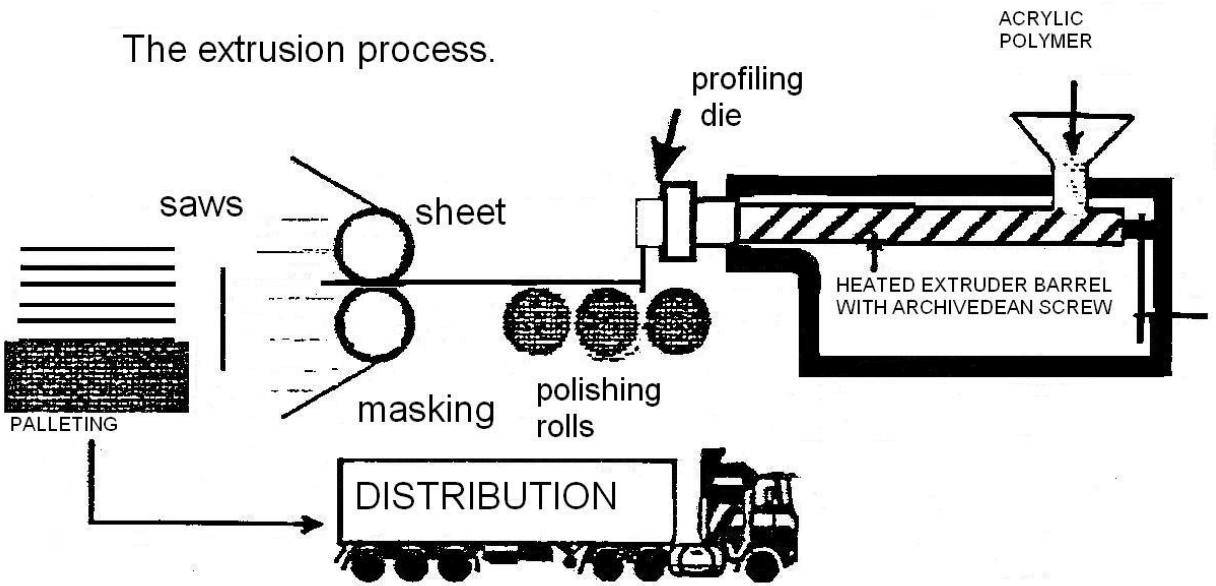
- In contrast to the batch flexibility of cell casting, extrusion is best suited to high volume, continuous production. It is a less flexible process than casting and therefore offers fewer variants.
- The extrusion process starts with an acrylic polymer in granule or powder form. This is gravity fed into the extruder barrel via a hopper, or large funnel. The barrel is heated along its length and contains an Archimedean screw. As this screw rotates it moves the polymer through the barrel, gradually heating it to its melt point. When the melt reaches the end of the barrel it exists through a nozzle into the profiling die, where it is formed into a continuous length of sheet. The sheet then enters a set of rollers which support it as it exits the die, polish out any imperfections in the surfaces and cools the sheet so that it becomes rigid. Thickness inspection, masking and cutting operations can then be performed, after which it is palleted and despatched.
- Although chemically the same, the molecular weights and chemical structures of cast and extruded sheet are different. It is these differences which affect the successful approach to fabrication and which determine the suitability of the sheet type for specific applications.

Extrusion



Some common extrusions

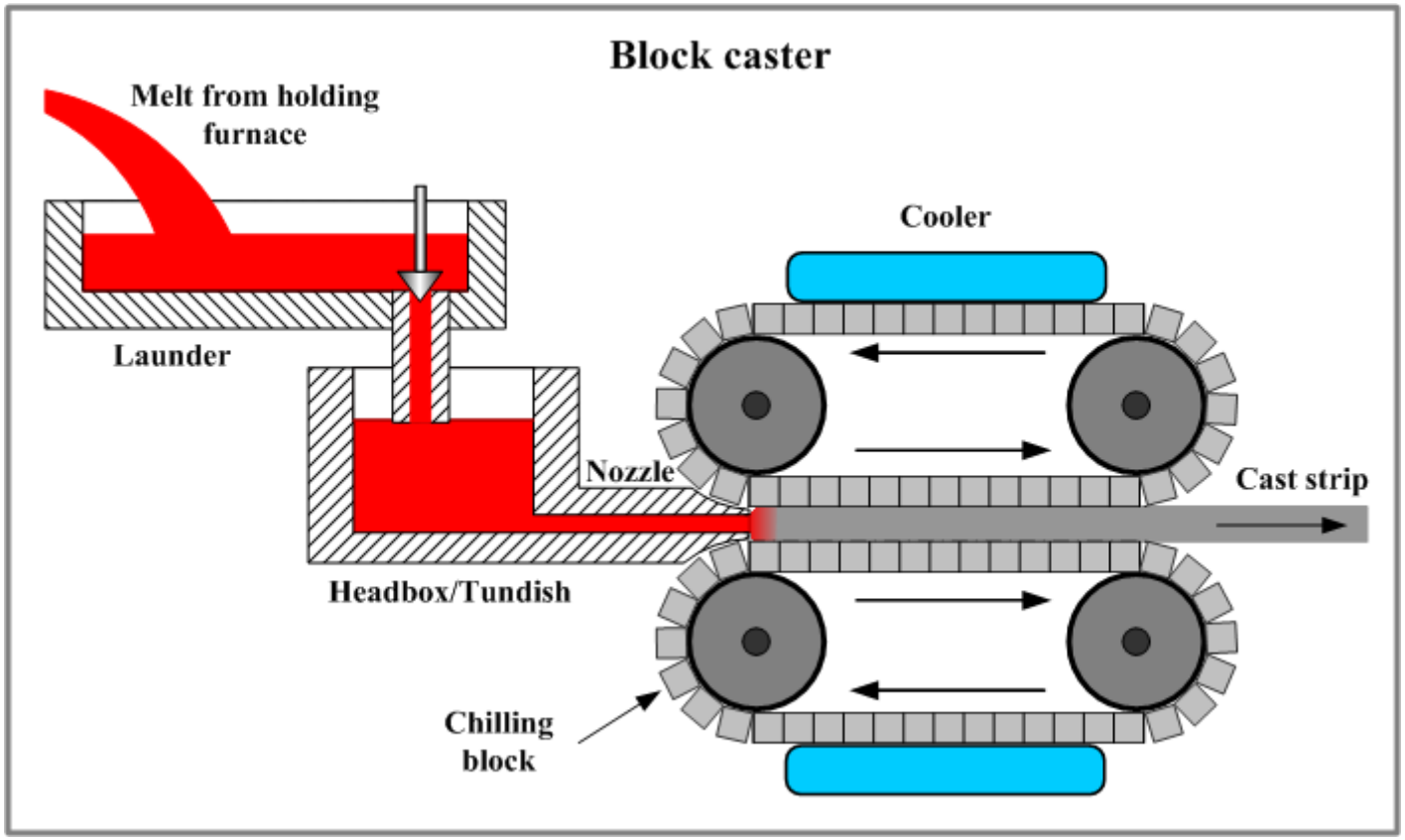
The extrusion process.



Continuous Casting

- Continuous Cast materials are also high volume but don't utilise die-blocks or rollers
- Large vats of methyl methacrylate monomer and catalyst are batch mixed and then poured onto highly polished stainless steel belts around 3 m wide and 100 m long and separated on the top and bottom by a space equal to the thickness of the material desired
- These belts continuously convey material through a series of cooling and heating zones to regulate the curing (polymerisation) of the acrylic sheet
- Moving saws at the end of the line cut the material to it's final size
- Due to the high cost of polishing these belts and the capital investment to build a continuous cast sheet line, the cost of materials is typically higher than extruded, but because it is again totally automated, still cheaper in general, than cell-cast acrylic

Continuous Casting



Physical Structure of Acrylic Sheets

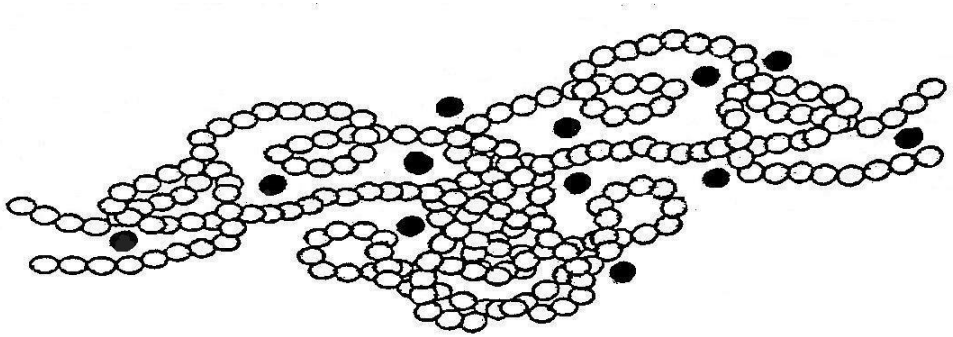
- The structure of Perspex® acrylic sheet comprises of chains, formed when molecules of Methyl Methacrylate join together, resulting from the chemical reaction which takes place during the polymerisation process.
- The processes by which Perspex ® are made produce sheets of different chain structures.
- Cell cast Perspex® has very long chains which form a three dimensional, complex, entangled matrix. Cell cast acrylic is therefore referred to as having a high molecular weight.
- The extrusion process used to make Perspex® Extruded orientates much shorter chains so that they form a more linear structure. This type of sheet has a low molecular weight.
- Because of the big differences in molecular weights and structures, acrylic sheets produced by these two processes will have slightly different properties and handling characteristics.

Physical Structure of Acrylic Sheets

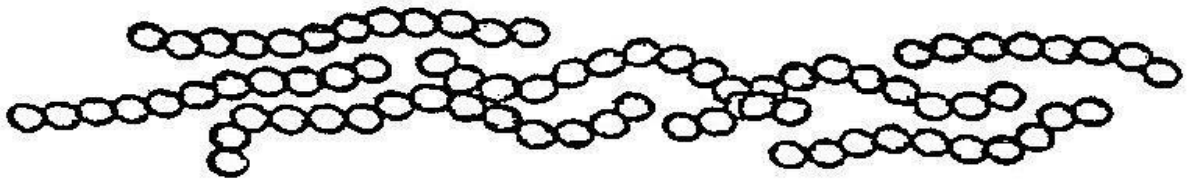
- Another factor which will affect the performance of acrylic sheet is its free monomer content. Free monomer is a number of Methyl Methacrylate monomer molecules which remain unattached from the chains formed in the polymerisation process and is the result of poor polymerisation.
- High free monomer content is most common in poorer quality cast acrylic and will reduce the property values of acrylic sheet causing progressive deterioration in weathering, craze resistance, heat distortion point as well as reducing the performance of other mechanical properties.
- The free monomer content of Perspex® is low which significantly contributes to its high specification.
- The diagrams below give a crude visual impression of the molecular structures for both cast and extruded acrylic sheet. The number of molecules per chain length will vary from one manufacturer to another, and may contribute to the slight differences sometimes experienced when working with sheet from alternative manufacturers.

Physical Structure of Acrylic Sheets

- Cell cast (5M – 8M molecules per chain)



- Extruded (60K – 100K molecules per chain)



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Choice of Acrylic Sheet

- Cell cast acrylic has the best optical clarity, greater surface hardness and machines more cleanly than continuous cast or extruded. It comes in many more colours and thicknesses and it is much easier to get custom colours and special effects. However, it also has the downside of having more thickness variation than the other methods, which may present difficulties in applications where thickness tolerance is very important e.g. fitting into extrusions
- Continuous cast is the next best in clarity and has the benefit of maintaining uniform thickness as sheets and in thermoformed parts. During thermoforming it doesn't exhibit the differences in the amount of (directional) shrinkage that extruded materials exhibit. It has the down side of not being as hard as cell cast materials which means that it may show scratches more readily and does not machine as cleanly as cell cast (without adjustments to feed rates etc.) In addition, it isn't offered in very many colours or thicknesses, making it somewhat limiting in design options when compared to cell cast.
- Extruded sheets are the most uniform in their thickness and because of the automation are also the most economical. The high volume manufacturing method means that small runs of custom colours aren't feasible. Extruded has the lowest hardness in the acrylic family and there is a risk of "gumming" during fabrication. It also absorbs fast drying solvents faster than cell cast and extruded, so complaints of joint failures or incomplete glue joints are not uncommon. Finally, this material exhibits shrinkage along the direction of extrusion and expanding across the direction of extrusion (which may present difficulties during thermoforming if the former does not anticipate this in advance)
- The bottom line is that we need to understand what a particular application requires before we select a product to use. Not all clear acrylic is created equal for all applications and the price should be the last consideration when planning the project, not the first.

Comparison of Plastics Properties

Property	Perspex®	Polycarbonate	PVC	Polystyrene	Plate Glass	PETG
Weathering	Excellent	Fair	Fair	Poor	Excellent	Fair
Colour Stability	Excellent	Poor	Good	Poor	Excellent	Poor
Flexural Strength	Excellent	Fair	Fair	Fair	Excellent	Fair
Abrasion Resistance	Good	Poor	Poor	Good	Excellent	Poor
Impact Resistance	Good	Excellent	Good	Fair	Poor	Excellent
Chemical Resistance	Good	Poor	Excellent	Excellent	Poor	Excellent
Light Transmittance	Excellent	Fair	Fair	Fair	Good	Fair
Light Weight	Excellent	Excellent	Excellent	Excellent	Poor	Excellent
General Fabrication	Excellent	Fair	Excellent	Fair	Poor	Excellent
Vacuum Formability	Cast = Good XT = Excellent	Excellent	Pressed = Good XT = Excellent	Excellent	N/A	Excellent

Comparison of PERSPEX® vs. PC

Perspex

- Transparent, rigid plastic
- Cell cast process
- Low batch sizes
- Easy to get custom colours
- Large colour range
- Excellent light transmission
- Easy to fabricate
- Excellent UV resistance
- 30 year outdoor guarantee

Polycarbonate

- Transparent, rigid plastic
- Extrusion process
- Large batch sizes
- Very difficult to get colours
- Clear, opal and tint only
- Very good light transmission
- More difficult to fabricate
- Very poor UV resistance (need UV protective coating)
- Maximum 10 year outdoor guarantee (UV protected grades only. GP not recommended for outdoor use)

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Comparison of PERSPEX® vs. PC

Perspex

- Good surface hardness
- Reasonable scratch resistance
- Reasonable rigidity and sag resistance (for a plastic)
- Clean edge colour
- Good impact resistance
- Poor fire performance

Polycarbonate

- Softer surface
- More prone to scratching
- More flexible and prone to sag
- Yellowish edge colour
- Exceptional impact resistance
- Excellent fire performance
- Note: PC yellows on ageing with outdoor UV exposure. Yellowing causes loss of light transmission and a reduction in physical properties. A yellowed PC sheet will have lower impact strength than a Perspex sheet after the same time period outdoors

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Comparison of PERSPEX® vs. Glass

Perspex	Glass
• Lower weight, approx. half that of glass	• Higher weight. More difficult to handle and install
• Good impact strength (5 x better than glass)	• Poor impact strength
• Doesn't shatter on breakage	• Shatters on breakage
• Extensive colour range	• Limited colour availability
• Easy to thermoform and fabricate. Can be worked on site.	• Very limited thermoformability. Can't be worked on site
• Reasonable surface hardness and scratch resistance	• Good surface hardness and scratch resistance
• Higher flexibility	• Lower flexibility
• Excellent outdoor performance	• Excellent outdoor performance
• Good price / performance balance	• Basic grades cheaper than Perspex; toughened grades more expensive

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PERSPEX® in Outdoor Applications

- Perspex® is fully guaranteed for use outdoors in Australia. This is a written guarantee and freely available to give to customers
- Clear = 30 year guarantee, colours = 10 year guarantee
- Perspex® Fluorescents and Perspex® Vario are indoor products only
- Euromir is not guaranteed for outdoor use
- Key design criteria
  - Wind load
  - Thermal expansion and contraction
  - Fixing methods e.g. fully framed, partially framed, clamped, bolted
  - Warping
  - Moisture absorption
  - Thickness specification
  - Notch sensitivity

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PERSPEX® for Food Contact

- Food contact materials must not transfer their components into the foods in unacceptable quantities (migration)
- Migration limits for plastic materials:
- Overall Migration Limit - 10mg of substances/dm² of the food contact surface for all substances that can migrate from food contact materials to foods
- Specific Migration Limit (SML) for individual authorised substances is fixed on the basis of a toxicological evaluation
- Perspex® passes both European Union (2002/72/EC) and US (FDA 21 CFR 177.1010) food contact legislation
- Migration limits also apply to pigments and dyes so each colour may (potentially) need its own food contact certificate
- Perspex® does not contain any hazardous substances as defined in the Restriction of Hazardous Substances 2002/95/EC (RoHS) directive

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BCA 2010 Fire Regulations

- The BCA 2010 requires a Material Group Number (MGN) for all materials used as finishes or linings to walls or roofs
- The fire tests defined in BCA 2010 are either direct measurement of MGN by ISO 9705 (full room burn test) or calculation of MGN by AS/NZ 3837 (cone calorimeter)
- Perspex® (and all other acrylic materials) score Material Group 4
- The only higher-rated plastics materials which might be readily available are polycarbonate, rigid PVC or glass-reinforced polyester (fibreglass)
- Whilst scoring better on the above test, all of these will still burn in a total fire situation and, in doing so, will generate far more toxic smoke and black fumes than Perspex®
- Applications other than wall or roof linings are covered by the older AS 1530.3 fire test
- We have fire test certificates for Perspex® to both standards

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PERSPEX® Clear

- A high quality cell cast acrylic sheet with exceptional clarity and light transmission (better than that of glass) and with half the weight of glass
- Sheet size 3050 x 2030 mm
- Thicknesses 1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 20, 25, 30, 35, 40, 45, 50, 55 and 60 mm
- Clear sheet guaranteed for 30 years in Australia for both internal and external applications

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PERSPEX® Opals

- Typical applications are signage, illumination and lighting (e.g. ceiling diffuser panels)
- Sheet size 3050 x 2030 mm
- Standard Thicknesses 3, 6, and 10 mm
- Spectrum LED Opals (1TL1 and 1TL2) are optimised for good diffusion with LED light
- Spectrum LED Block Opal (1T77) also available. 30 mm is standard, 10 and 20 mm are MTO

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PERSPEX® Impressions

- A range of Perspex® colours with an etched, textured surface
- The contemporary pattern is aimed at numerous end uses including retail, point of purchase, interior design, room partitions, furniture, artworks and architectural features
- 9 colours
- Sheet size 3050 x 2030 mm
- Thicknesses 3 and 5 mm

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PERSPEX® Naturals

- A range of solid Perspex® colours with a frosted surface
- Evoke a natural, stone-like feel
- 6 colours
- Sheet size 3050 x 2030 mm
- Thicknesses 3 and 5 mm

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PERSPEX® Frost

- Double-sided textured surface
- Effect of sand blasted or etched glass
- Highly popular in a wide variety of applications
- 23 colours
- Sheet size 3050 x 2030 mm
- Thicknesses 3, 6 and 10 mm

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EuroMir® Acrylic Mirror

- A high quality acrylic mirror
- Exceptional reflectivity
- 15 decorative colours plus See-Thru and silver satin
- Lightweight with excellent shatter resistance
- Sheet size 2440 x 1220 mm*
- Standard thickness is 3 mm but 6 mm and 10 mm are also available on request
- Polycarbonate mirror also possible

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PERSPEX®

PERSPEX® Spectrum LED

- Optimised to transmit LED light
- Crisp, bright illumination with reduced risk of “hot spots” from LED’s
- Illuminated sign box has a longer lifetime (*Up to 100,000 hours)* meaning lower maintenance cost
- LED illumination enables slimmer light boxes
- 2 Opal grades and 9 colours available
- Sheet size 3050 x 2030 mm
- Thickness 3 mm (Opal 1TL2 also 6 mm)

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PERSPEX®

PERSPEX® Spectrum LED

- Perspex® Spectrum Opal 1TL1 = 36% L.T.
- Perspex® Spectrum Opal 1TL2 = 48% L.T.
- Perspex® Spectrum Yellow 2TL1 = 22% L.T.
- Perspex® Spectrum Yellow 2TL2 = 25% L.T.
- Perspex® Spectrum Orange 3TL1 = 18% L.T.
- Perspex® Spectrum Pink 4TL1 = 18% L.T.
- Perspex® Spectrum Red 4TL2 = 14% L.T.
- Perspex® Spectrum Red 4TL3 = 15% L.T.
- Perspex® Spectrum Green 6TL1 = 8% L.T.
- Perspex® Spectrum Green 6TL2 = 6% L.T.
- Perspex® Spectrum Blue 7TL1 = 12% L.T.

Perspex® Lux

- Edge lighting grades
- Light sources are used to inject light into the edges of the panel, which then illuminates over the face. The key challenge is bright, even face illumination, especially over large panel sizes
- Uses a special surface texture to “drag” light out of the face
- Available as both S-Lux (single sided texture) and D-Lux (double-sided texture)
- D-Lux emits light on both faces so loses the light much more rapidly. D-Lux is therefore only suitable for smaller, double-sided signs e.g. blade signs
- The main edge lighting competitive materials are Plexiglas Endlighten or Altuglas Elit 3. Both of these use a sophisticated particulate filler inside the sheet to direct light. Whilst better-performing than Lux, both of these are limited by long lead times and large MOQ’s
- The light comes out of Lux at an oblique angle so it must be used in conjunction with an image or film (on top of the Lux)

PERSPEX® SAR / Armadillo

- Abrasion resistant grades
- SAR is Perspex® (from the U.K.) with a hard coating applied in Germany
- Armadillo is the hard-coated, abrasion resistant acrylic sheet made by Plaskolite in the USA
- The hard coating brings the surface hardness of the sheet up to a level similar to that of glass
- The hard coating is also highly moisture resistant and highly chemically resistant
- Armadillo is available in both AR1 (spray-coated) and AR2 (flow-coated) versions
- The AR2 is the optical quality grade and is therefore more expensive than AR1. Both grades are suitable for outdoor use
- Armadillo is available as standard in the 2440 x 1220 mm sheet size and in 3 mm, 4.5 mm and 6 mm thicknesses. Other sheet sizes and thicknesses are available as special order

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Other PERSPEX® Products

- Perspex® Pearlescent (Single-sided product)
- Perspex® Fluorescent (Not suitable for outdoor use)
- Perspex® UV Absorbing Grades (VE/VA)
- Perspex® Noise Barriers
- Perspex® Duo (Engraving grade)
- Perspex® Coral
- Perspex® Vario (Not suitable for outdoor use)
- Perspex® Clear Silk SK 000
- Perspex® 1212 Dense White
- Perspex® Secret Sign (4 colours)

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PERSPEX® Colour Codes

- 1st number gives colour
  - 1 = white/opal
  - 2 = yellow
  - 3 = orange
  - 4 = red
  - 5 = brown
  - 6 = green
  - 7 = blue
  - 8 = purple
  - 9 = grey/black
- Letter denotes product
  - T = Constant Transmission (CT) colour
- 3rd and 4th number (or character) denotes shade

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