

LUMEX[®]G

Premium Quality Modified Polyethylene
Terephthalate

LUMEX[®]G



Fabrication Manual



Thank you for choosing a 3A Composites product for your graphic display applications.

We have compiled this Fabrication Manual based on our Fabrication Guide, which is divided into the following sections:

Cutting and Trimming

Machining

Forming

Bonding

Mechanical Fastening

Finishing

Chemistry

Additional Notes

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

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

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

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

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LUMEX® G is a premium quality modified polyethylene terephthalate sheet. The material is intended for such applications as medical appliance packaging, food containers, poster glazing, machine guards, vacuum- & thermoforming parts, signage, and displays. Its biggest advantage is that no pre-drying is required before thermoforming, saving time and energy costs.

The sheets are extruded and clear, and available in .8mm (.03"), 1mm (.04"), 1.5mm (.06"), 2mm (.08"), 3mm (.118"), 4.5mm (.177"), and 6mm (.236").



Why Choose LUMEX® G?

- NO PRE-DRY required before thermoforming
- Great optical properties and brilliant surface
- Very good chemical resistance
- Excellent low temperature performance
- High impact properties allow for a thinner gauge
- Low water absorption
- Easy to recycle
- FDA Regulation 21 CFR 177.1315



APPLICATION GUIDE

	POP Display	Exhibits & Kiosks	Signage	Poster Glazing	Machine Guards	Containers & Packaging
LUMEX® G	●	●	●	■	■	●

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

- Short-term application life
- Medium-term application life
- Long-term application life

FABRICATION GUIDE

	Vinyl & Laminating	Digital Printing	Screen Printing	Painting	Knife Cutting	Saw Cutting	Routing & Punching	CNC & Laser Cutting	Forming Curves
LUMEX® G	◇ ¹	◇ ²	◇ ³	◇		◇	◇	◇	◇

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

- 1 Only use PET-compatible films & vinyls
- 2 Using PET-compatible screen print inks
- 3 PET-compatible paints & lacquers are recommended

Cutting & Trimming by Hand

Lumex[®] G sheets should not be cut or trimmed by hand, for example with a general purpose knife (cutter knife). This is dangerous (slipping of the knife blade) and would result in inaccurate cuts.

Shearing & Punching

LUMEX[®] G sheets up to about 2mm thick can be sheared on guillotine shears as well as punched and die-cut. Thicker sheets should be sawed, milled or routed.

- For straight cuts of LUMEX[®] G on guillotine shears, a blade-gap of about 0.02mm between upper and lower knife proved successful. The smaller the blade-gap, the better the quality of the cut, but also the bigger the wear of the blades. These must always be kept very keen to minimize burring.
- Thin LUMEX[®] G sheets can also be die-cut to almost any contour using steel rule dies. Due to the toughness of Lumex[®] G, the steel strips need to be very keen and must be replaced quite often. The edge quality benefits from asymmetrically ground bevelled cutting blades.
- LUMEX[®] G sheets should not be die-cut at temperatures below 20°C. On the other hand, some slight warming of the sheets improves the quality of the cut and prevents stress cracking.

Sawing

Hand saws with fine teeth are only really useful in emergencies or for special jobs, whereas stable band saws with sharp, fine-toothed saw blades produce good curved cuts. The more stable the band saw and the smaller the cutting gap, the less vibration.

However, the most suitable method for cutting Lumex[®] G sheets to format is on a smoothly running circular saw.

- Never remove the protection film before sawing because the surfaces of the LUMEX[®] G sheets are sensitive to scratches caused by chips or rough machine tables.
- The most suitable circular saw blades for cutting LUMEX[®] G sheets have tungsten carbide tipped teeth with an alternate bevelled tooth design because these promote heat dissipation. Dependent on the diameter of the saw blade, the speed should be between 2000 and 3000 rev/min.
- The tooth pitch should be about 10mm but may vary dependent on the most frequently sawn sheet thickness. The rake angle should be 10° positive, the clearance angle about 15° and a slight chamfering of the teeth results in a better quality of the cuts.
- When sawing LUMEX[®] G, burring may occur on the exit side of the saw blade due to excessive frictional heat. Provided the blade is keen, other remedies to consider are a saw blade with a larger tooth pitch, an increased feed rate, the reduction of the rotational speed and cooling with compressed air.
- In the event of vibrations causing chipping of the edges, reduce the feed, use a down-holding device or even consider a sacrificial plate beneath the LUMEX[®] G sheets.

Safety Notes

In view of the high rotational speeds of cutting tools, it is very important for all protective devices on the machinery to be in good working order and that they are being used. It is mandatory that the prescribed personal safety equipment - at least a pair of safety goggles - be worn at all times during chip generating cutting operations.

Drilling

- Individual holes in LUMEX® G sheets can easily be drilled with normal, freshly sharpened twist drills for metalworking. For large volume jobs, it may be worth purchasing twist drills which were especially developed for machining soft plastic materials. They have a point angle of less than 90°, a helix angle of 30° and generous flutes for swarf removal.
- The cutting speed should be 40 to 50 m/min. (i.e. approx. 3000 rev/min. for a 5mm twist drill).
- Withdraw the twist drill regularly from deep holes to prevent overheating by jammed swarf. If necessary, use compressed air for cooling. Avoid liquids for cooling and never use cutting fluids formulated for metalworking (danger of stress cracking).

CNC Machining

LUMEX® G sheets can be machined with excellent results on CNC machines on which both plotter cutting and routing / milling are possible.

- LUMEX® G sheets must be securely clamped to prevent vibrations. Especially when plotter cutting small formats, the vacuum power needs to be set to the highest level for maximum retention.
- Use a stable, double-edged drag knife for plotter cutting LUMEX® G. For easy weeding, set the drag knife about 0.4mm deeper than the thickness of the sheet. Choose a medium acceleration setting and a feed rate of 200 mm/sec for cutting a 1mm thick LUMEX® G sheet.
- For routing LUMEX® G use a keen (new!) single-edged end mill with a polished flute. Example: For a routing job on 3mm thick LUMEX® G sheet, choose a dia. 4mm end mill, set the tool speed to about 50000 rev/min, select medium acceleration and set the feed rate to 160 mm/sec.

Laser Cutting

LUMEX® G can be cut on CO2 laser machines.

- The power and frequency settings should be lower compared to PMMA whereas more air assist will be needed. After laser cutting release tensions by annealing.
- Leave the protection film in place also when laser cutting the sheet since it will prevent vapour deposits on the surfaces. And be sure to switch on the ventilation (smell!).
- Allow for relaxation of the component after laser cutting before continuing with further work.

Cold Bending & Folding

LUMEX[®] G sheets up to about 2mm thickness can be cold bent and folded. Thicker sheets should be hot bent to prevent distortion due to massive internal stress.

- The minimum bending radius (cold bending radius) for LUMEX[®] G sheets is about 150 times the thickness of the sheet (e.g. about 300mm for bending a 2mm sheet).
- When folding (bending very small radii), the bent leg must be over bent to compensate for the rebound. The resulting stresses in the bending zone will relax only very slowly and must never be brought into contact with aggressive chemicals and solvents (risk of stress cracking).
- High internal stresses will possibly brighten up the bending zone of coloured LUMEX[®] G sheets.

Hot Line Bending

LUMEX[®] G sheets can be line bent by heating the material along the bending edge to about 110°C with a heater rod or wire and then bending it, thus obtaining a pretty small radius.

- Remove the protection film along the bending zone.
- The larger the bending angle and the greater the desired radius (at least three times the material thickness), the wider the heated zone must be.
- If single-sided heating from below is employed for thin sheets up to 2mm thickness, the work-piece must be flipped over regularly to forestall bubbles formation due to overheating. The last warming cycle prior to bending must then be at the outer face of the bend. Two-sided heating is required for bending sheets thicker than 2mm and for series productions.
- Because of the thermal expansion taking place in one direction only, components made of thick sheets are subjected to distortional stresses. Consider a tempering sequence after bending.

Thermoforming

LUMEX[®] G sheets are particularly cost-effective to thermoform (mostly vacuum forming) because they do not need to be pre-dried. Here is more material specific advice:

- Machines with separately adjustable upper and lower heater banks and prestretching and water mist cooling equipment are particularly well suited for quickly and evenly heating up the LUMEX[®] G sheets, prestretch them if necessary and suppress possible crystallization of Lumex[®] G through efficient cooling.
- LUMEX[®] G sheets are thermoformed at temperatures between 120° and 160°C.
- Slanted walls with draft angles between 4 and 6° and mould shrinkage between 0.5 and 0.6% must be taken into account when designing the mold.
- Thermoforming and large scale machining processes cause stress in the LUMEX[®] G sheets which can lead to stress cracking. Dependant on the thickness, LUMEX[®] G sheets should be annealed after thermoforming for 2 to 4 hours at a temperature of about 60°C.

General Information

LUMEX® G sheets and components made thereof can be bonded with solvent adhesives.

- Only expert advice by the adhesive manufacturers will guide the user through the multitude of adhesives with their different characteristics and enables him to select the product which matches best the adherends and the particular application. The working directives published by the manufacturers must be followed exactly.

Bonding LUMEX® G

For structural bonding (cold welding) of LUMEX® G and also for bonding it to materials of similar composition such as PS, PC, PMMA, a transparent solvent adhesive based on methylene chloride is the best choice.

- Caution: Methylene chloride (Dichloromethane, CAS No. 75-09-2) is a very effective low-viscosity and highly irritant solvent belonging to the group of chlorinated hydrocarbons, which must only be used by trained persons wearing at least protective gloves. It is essential to consult the corresponding MSDS before use and ventilate the workplace well!
- Since bubbles in adhesives and imperfectly wetted joints show particularly well in transparent materials like LUMEX® G, the joining parts must be carefully prepared: They must be dry, free of dust and grease and the surfaces smoothed with a knife blade. Whenever possible, the adherends should be fixed in a jig to prevent them from slipping. Caution: Methylene chloride adhesives are not gap-filling.
- The best way to apply the adhesive is with a syringe and a very thin needle (the adhesive enters the joint by capillary action) or the immersion method whereby one adherend is dipped in a puddle of adhesive and afterwards carefully brought together with the other adherend.
- Components bonded with solvent adhesive can undergo further processing after about 3 hours but are fully fit for use only after 24 hours.
- Caution: Some adhesives and sealants can trigger stress cracks in LUMEX® G sheets even a long time after the actual bonding job. Use only adhesives specifically approved for use with PET.

Dimensional Change Due to Temperature Variations

LUMEX[®] G sheets expand in the heat (e.g. in sunlight) and contract in cold weather. This dimensional change due to temperature variations is called dilation (dilatation) and is an important consideration when using LUMEX[®] G sheets in areas with fluctuating temperature, as this may cause stress or distortion. It is also important to remember that thermal expansion is effective not only outdoors but also indoors, for example in poorly ventilated shop windows.

- The coefficient of linear expansion specifies by how much a sheet of 1 meter expands if the temperature increases by 1 Kelvin (i.e. 1°C). For every day's purposes, PETG sheets have a coefficient of linear expansion of 0.07 mm/mK.
- The thermal expansion of PETG can be calculated: If a 2 meter long LUMEX[®] G sheet with dark graphics on it is fitted on a spring day at an ambient temperature of 20°C, it will reach at least 50°C in midsummer. This temperature increase of 30°C will cause the sheet to become longer by: $0.07\text{mm} \times 2 \text{ [m]} \times 30[\text{°C}] = \text{approximately } 4\text{mm}$.

Fastening With Screws

- For fixing small components on the surfaces of LUMEX[®] G sheets, self-tapping pan head screws especially developed for thermoplastics can be used. Caution: Thread forming screws also cause stresses in the LUMEX[®] G sheets!
- As an alternative especially for constraint-free structures, flathead through bolts with nuts on the opposite side are the best solution. Don't tighten the nuts too tightly.
- For mounting LUMEX[®] G sheets outdoors to support structures of wood or metal facade fixing screws with pre-mounted washers and rubber seals are suitable. Prefer stainless steel types in humidity prone areas.
- Under no circumstances may countersunk screws be used on LUMEX[®] G sheets, because these cause stress cracking and hinder constraint-free installations.

Holes for Fastening Elements

- A margin of about 10mm should be left between the holes and the edge of the sheet.
- The clearance holes for screws need to be drilled approximately 5 to 6mm larger than the diameter of the screw shanks to permit the unrestricted thermal expansion of the sheets. Place the screws in the center of the clearance holes and tighten them only firmly enough for the sheets to expand and contract freely (constraint-free installation).
- The spacing between the holes depends on the thickness of the sheet but should not exceed 500mm.

Surface and Edge Finishing

There are several methods for polishing the surfaces and edges of LUMEX® G, all of them requiring experience. Great care must be taken that the material isn't overheated during the polishing process. Typical mistakes with mechanical polishing are rounded edges as a result of long and forceful pressure against the polishing wheel and distortions caused by overheating when flame polishing the edges.

Surface Protection and Cleaning

- The surfaces of all LUMEX® G sheets are masked on both sides with protection film and therefore ready for use. The protection films on LUMEX® G (white) adhere with different strength, depending on the type of the sheet and its thickness. They should be left in place until the end of all machining operations. The protection film on LUMEX® G is within certain limits suitable for thermoforming but should be removed before annealing.
- Caution: The protection film should be removed with a slow, steady movement to keep electrostatic charges as low as possible. Blowing over the surfaces with ionized air has proven useful for removing dust particles without scratching the surfaces.
- Use cleaning fluids conservatively and only in case of severe staining. Use only water or IPA and rub as lightly as possible to prevent even the faintest of scratches.
- With the exception of isopropyl alcohol, all liquid cleaners must be checked for suitability before use. They most of the time leave residues (even methylated spirit), etch or dull the surfaces (especially acetone) or cause stress cracking (many solvents contain a high proportion of aromatic components).
- Caution: Liquid antistatic agents impair the adhesion of paints and films.

Painting

- When spray painting LUMEX® G sheets use only types of paints and lacquers which are approved for use with PET. No specific products or manufacturers are recommended here since all major suppliers offer different coating systems for indoor and outdoor applications, primers, topcoats, transparent lacquers, etc.
- The drying temperature must not exceed 60°C.

Printing

- LUMEX® G sheets may only be printed with PET-compatible screen printing inks to prevent stress cracking due to overly aggressive solvents.
- LUMEX® G sheets are also increasingly printed using direct digital printing technology. However, the substrate sheets are only one of several influencing variables in the context of this printing technology. It is assumed that competence in the technology is abundant as well as knowledge about the relation between imaging layout, protection film, printing machine, machine operation and environmental conditions.

Laminating

- The surfaces of LUMEX® G sheets are well suited to the application of PET-compatible lettering films and vinyl graphics. In order to choose the right film for the purpose, the location (indoor or outdoor use) and the desired period of use (durability) need to be taken into account.

REACH Regulation & RoHS Directive

- LUMEX® G sheets fulfill the requirements of the most current version of the chemicals regulation of the European Union (REACH regulation). In particular, these sheet materials don't contain any of the substances appearing on the most current version of the Candidate List of Substances of Very High Concern (SVHC) issued by ECHA.
- LUMEX® G sheets also meet the requirements of the RoHS directive of the European Union on the restriction of certain hazardous substances. Lumex® G sheets don't contain any lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE).

Harmful Substances

- LUMEX® G sheets don't contain any formaldehyde, any CFC's, any asbestos, any plasticisers or any silicon.
- On the other hand, Lumex® G sheets must not be brought into contact with the following common solvents (e.g. for cleaning) because these may etch, swell or even completely destroy the surfaces after prolonged contact: acetone, benzene, methyl ethyl ketone (MEK), carbon tetrachloride and toluene.
- Methylene chloride (also known as dichloromethane) also dissolves PET with this property being exploited to the advantage for solvent bonding LUMEX® G sheets.

Chemical Resistance

- Thermoplastics are prone to stress cracking which is particularly well visible in the transparent LUMEX® G sheets as well as in PMMA and PC. Stress cracking may be caused by external forces but can also result from internal residual stresses due to heat (manufacturing by extrusion process, hot line bending, thermoforming) or extensive machining. If simultaneously a chemical substance (typically a solvent, an adhesive or an ink) is brought into contact with the sheet, cracks may appear which would soon lead to the complete failure of the component or at least to ugly little cracks. Annealing will help to remove stresses and strains.
- Caution: LUMEX® G must not be brought into contact with acids in concentrations above 25%, amines (ammonia derivatives), bases, hydrocarbons, hydro fluorocarbons and ketones. And finally, LUMEX® G may not be brought into contact with hot water since PET is sensitive to hydrolysis.
- Service: The chemical resistance of LUMEX® G sheets against a multitude of substances and chemical compounds has been documented. Relevant questions may be addressed to the customer service or the technical service department of 3A Composites.

Storage and Handling

- LUMEX® G sheets must be stored flat, horizontally and stress-free (remove packing straps from pallets) in a dry place at temperatures around 20°C .
- Packaged sheets and wrapped pallets must not be stored in the open because of the risk of deformation due to heat build-up in sunlight. Beware of heat build-up in non-ventilated lorries and delivery vans!
- Never place LUMEX® G sheets on dusty floors to prevent dirt from being deposited onto the sheets by electrostatic charges.

Responsibility of User

- The information contained in this publication is based on our current level of knowledge and is, in our opinion, reliable. However, we cannot guarantee the correctness of this information for every application and for the results arising from their use.
- The user or processor is always responsible for ensuring that the materials and processes are appropriate, cost-effective and suitable for the intended purpose and location, and that they comply with the local laws and regulations.
- Technical knowledge and skills as customary in trade and industry, a normally developed capacity to make judgements as well as knowledge and observance of the applicable regulations appertaining to work safety and hygiene are assumed.
- To ensure up-to-date relevance and impartiality of this publication, 3A Composites has decided to neither recommend any particular ancillary product and material nor their manufacturers, but provide generic terms instead.

Quality After Sales

LUMEX® G sheets are produced by the company Foamalite Ltd. in Ireland to the stringent quality control measures imposed by the ISO 9001 standard. Nevertheless, should you encounter problems or simply wish to ask additional questions concerning the processing or use of these sheet materials, the Customer Service and Technical Services Department at 3A Composites will be pleased to offer further information. Please do get in touch with us! We have put all modern communication facilities at your disposal and will do our utmost to help and provide additional assistance.

Conclusion

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LUMEX®

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

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

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

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