

General Product Selector Guide

INTRODUCTION

Advanced Composites Group (ACG), which has manufactured and supplied advanced prepreg systems for over 20 years, offers a range of standard prepregs moulded at high temperature and pressure (typically 120°C/250°F and 3 to 6bar/45 to 90psi in a high pressure autoclave). The Group also offers pioneering low temperature moulding with its LTM® low temperature prepregs.

Building on this experience, ACG now provides a unique and extensive range of products which are mouldable at low temperature and pressure. In particular, VTM®, ZPREG® and VTF surfacing technologies, which allow the moulder to achieve high mechanical properties and superb surface finishes via low cost processing routes - using only vacuum bag and oven curing, make prepreg technology a viable and cost effective composite processing option for all high performance components.

This general guide offers the prospective moulder an insight into the extensive range of ACG prepregs, while also acting as a brief guide to the material and process route options available.

Please refer to the ACG data catalogue for the complete range of products.

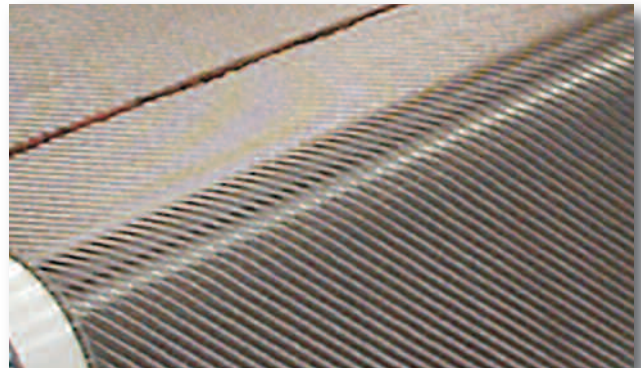


THE COMPOSITE ADVANTAGE

Advanced composites offer engineers a new freedom to design functional, aesthetically pleasing structures of optimum performance not previously possible with more traditional materials. The performance of these unique and exciting materials is now being realised in many everyday applications.

Composites offer:

- Low weight.
- High specific stiffness and strength.
- Fibre orientation with the directions of principle stresses.
- Excellent environmental and corrosion resistance.
- Very low coefficient of thermal expansion.
- Improved vibration damping properties.
- Good fatigue resistance.
- Relatively simple repair of damaged structures.
- Ease of manufacture of complex shapes.
- Low cost tooling options for one-offs, etc.



THE PREPREG ADVANTAGE

A prepreg consists of a reinforcement material (carbon, glass, etc.) in unidirectional or fabric form pre-impregnated at a pre-determined and controlled level with a resin matrix. Prepreg is a fully compounded, reactive system (no handling or mixing of potentially dangerous chemicals). Simply take it from the roll and laminate.

All prepregs have a clearly defined working life (or out life) at room temperature. Material is stored frozen to maximise its life. The reactivity of a particular prepreg system is predetermined and this, in turn, dictates the minimum temperature at which a particular resin system will cure.

The out life and the minimum cure temperature are key considerations when optimising material selection, balancing lay-up time (large structures) and selection of the mould material (low temperature curing - low cost tooling).

Prepregs are supplied with a controlled level of tack. Plies can be easily and accurately positioned on the mould to give a high level of fibre orientation control without the risk of movement, fibre wash out or the development of resin rich areas during subsequent processing, all of which will lead to loss of performance.

Cored structures (foam, honeycomb, etc.) are also easily produced using complementary, formulated film adhesive systems which offer high strength bonding and controlled and consistent bond line thickness, rather than just depending on the parent resin matrix.

Prepregs offer:

- Simplified storage and reduced health and safety issues.
- Low cost tooling options.
- Reduced part labour content.
- Rapid and accurately controlled lay-up, optimising and maximizing final component properties.
- Weight saving.
- Reduced processing risks compared to infusion processes.

	Wet Lay-Up	Infusion/Injection	Prepregnation
Advantages	<ul style="list-style-type: none"> • Low cost materials • Minimal equipment costs 	<ul style="list-style-type: none"> • Quality and repeatability • Low cost materials • Low void content • Relatively clean process, but still some potential resin handling issues 	<ul style="list-style-type: none"> • Quality and repeatability • Lower labour cost • Low void content • Control of resin content and properties • 'Cleaner' process
Disadvantages	<ul style="list-style-type: none"> • High labour costs • Poor control of resin content • Higher void content • Poor thickness control • 'Dirty' process • Health and Safety issues with mixing, etc. • Environmental / emission issues 	<ul style="list-style-type: none"> • High material wastage • Difficulties supporting dry reinforcement on complex or vertical tooling • Some compromise in material selection • Variable resin content and properties • High risk level for 'one-offs' • Similar equipment costs to prepreg • Health and Safety issues with mixing, etc. 	<ul style="list-style-type: none"> • Higher material costs • Additional equipment costs • Material must be stored frozen
Summary	<ul style="list-style-type: none"> • Low overall cost • Low performance • Poor overall control 	<ul style="list-style-type: none"> • Intermediate overall cost • Improved performance • Better but not total control 	<ul style="list-style-type: none"> • Higher overall cost • Higher performance • Total control

GLOSSARY OF PREPREG TERMINOLOGY

Debulking

Application of vacuum pressure periodically throughout a lay-up sequence to ensure all plies are consolidated, improving final laminate performance.

Fibre Volume Fraction (%Vf)

The proportion of fibre in the prepreg (by volume). This is a key determinant of laminate performance.

Glass Transition Temperature (Tg)

The temperature above which a resin will begin to soften, losing stiffness and strength. Generally, the maximum end use temperature for a resin should be at least 20°C below the Tg.

Out Life

Period of time a prepreg remains usable at room temperature (21°C/70°F) after removal from storage at -18°C/0°F.

Note: The out life is cumulative each time the material is removed from storage.

Partially Impregnated Prepreg Systems

Resin and fabric combined but not fully impregnated.

These systems offer a number of advantages, most particularly:

- Simple vacuum bag processing.
- Multiple or mixed ply construction for rapid lay up.
- Partial impregnation retains fabric drape and handleability.
- Inbuilt air paths optimising air removal and reducing void content.

Resin Weight (%RW)

The proportion of resin in the prepreg (by weight) quoted as a percentage of the TOTAL weight of the prepreg.

Shelf Life

The length of time the prepreg can be stored under specified conditions (usually -18°C/0°F) and remain suitable for its intended function.

Tack

Measurement of the capability of an uncured prepreg to adhere to itself and to mould surfaces.

Tack Life

The length of time the prepreg can be stored at room temperature (20°C/68°F) and continue to have sufficient tack.

ACG ADVANTAGE

ACG leads the way in the development and supply of prepreg materials into high performance markets such as aerospace, motorsport, marine and sports equipment, and in the provision of innovative new material formats and low cost processing options.

ACG's Low Temperature Moulding (LTM®) prepregs revolutionised moulding and contributed to the development of the Group's Variable Temperature Moulding (VTM®) flexible moulding system. The VTM® system offers optimised low temperature, low pressure processing, and flexible cure temperatures between a modest 65 and 120°C (149 and 248°F), eliminating the necessity for autoclave curing. In addition, the 30 days out life presents a wider process window in which to complete the laminating process.

Complemented by an extensive portfolio of Medium Temperature Moulding (MTM®) (120°C/248°F) and High Temperature Moulding (HTM®) systems (180°C/356°F), ACG offers an unsurpassed range of processing and performance options to the composite industry.

Building on its Out-of-Autoclave (OoA) processing experience, ACG is now realising the next generation of prepreg and film infusion systems for high performance applications. MTM® OoA processing systems now meet the levels of performance, laminate quality and damage tolerance demanded by the aerospace industry, offering simplified processing, reduced costs and increased production rates necessary to meet the new challenges of this rapidly advancing market sector.

RESINS

ACG prepreg resin systems are classified in terms of the temperature at which they are cured.

Series	Prepreg Description	Cure °C (°F)/Out life	Features
LTM®	Low Temperature Moulding	30 to 80 (86 to 176) 2 to 6 days	Low temperature vacuum bag/autoclave cure, but short out life.
MTM®	Medium Temperature Moulding	80 to 120 (176 to 248) 30 days	120°C (248°F) cure systems. Generally autoclave/press cure, but will vacuum bag process.
HTM®	High Temperature Moulding	180 (356) 30 days	180°C (356°F) cure systems. Generally autoclave cure.
VTM®	Variable Temperature Moulding	65 to 125 (149 to 257) 30 days	Flexible cure vacuum bag processing. Long out life. Particularly suited to large structures.

REINFORCEMENTS

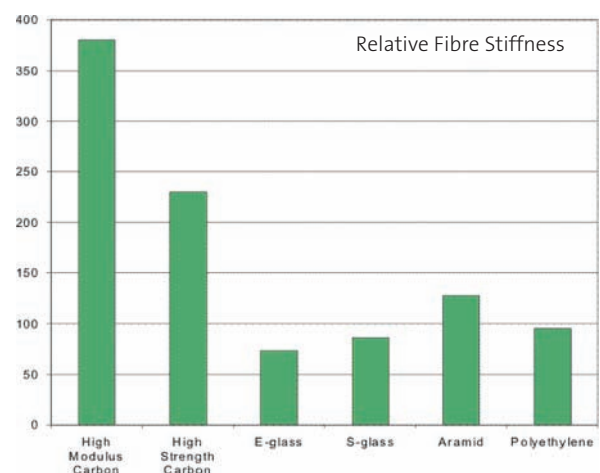
ACG prepregs are produced using a wide range of fibre reinforcements.

Carbon

Fibres are available in high strength, intermediate modulus, high modulus, and ultra high modulus grades. These fibres are mostly used in high strength, high stiffness applications, where benefit from weight saving outweighs the additional material cost.

Glass

Most commonly used and lowest cost reinforcement is E-Glass. S-Glass is a higher strength alternative. Glass is much denser than carbon and has lower strength and stiffness values.



Aramid

More commonly known as Twaron® or Kevlar®, aramid is a low density fibre normally applied to areas or incorporated into components where there is a likelihood of impact. Aramid has the ability to absorb and dissipate energy, while also exhibiting excellent abrasion resistance properties, but it is poor in compression.

Polyethylene

Better known as Dyneema® or Spectra®, Polyethylene has similar energy absorption characteristics to aramid fibres, but is a much lighter, more expensive fibre. Polyethylene has little or no compressive strength and begins to shrink and lose its properties at a relatively low temperature (100°C/212°F).

Hybrids

All the above fibres can be mixed or hybridised, yielding property combinations not normally available with the individual fibres.

FORMATS

	Description	Applications
Prepreg	Full, partial or one sided impregnation. Woven or non-crimp fabrics.	All moulding applications.
Unidirectional	Full impregnation. 100% aligned fibres.	High stiffness applications.
Surfacing Films	Formatted for the production of high class surface finishes.	Optimised surfacing products for the production of high quality finishes for low pressure vacuum bag processing.
ZPREG®	Multi-layer and partially impregnated rapid lay up formats.	Rapid lay up of large parts. Partially impregnated format allows efficient air release during cure for the production of high quality surfaces and thick laminates for low pressure vacuum bag processing.
DForm®	Selectively slit UD prepreg presented in a multi-layer 0/90 stack.	An innovative prepreg system that combines short fibre conformability with the handling and laminate characteristics of a conventional long fibre composite.
Syntactic/Core Plies	Filled, lightweight resin film products.	Rapid thickness builds up with low weight.
Adhesive Films	Toughened resin film.	Core bonding and part assembly.
Tooling	Resin systems formatted for stability at high temperatures.	High accuracy mould tools capable of operating at high temperatures.

STORAGE

Prepregs should be stored, wrapped and sealed in polythene, at -18°C (-0°F) for maximum shelf life. The material must be fully thawed before breaking the polythene seal to avoid moisture contamination.

HEALTH AND SAFETY

Prepregs are low-risk in terms of handling hazards, but the usual precautions should still be applied. Gloves and protective clothing must be worn and mechanical exhaust ventilation used when heat curing prepreg systems and machining cured composites.



MOULDING PROCESS SELECTOR

The production processes for the manufacture of advanced composites components from prepreg require two elements. These are:

- Pressure to consolidate the laminate being moulded.
- Heat to reduce the resin viscosity and to activate the prepreg resin curing mechanism.

Vacuum Bag

Vacuum bagging techniques have been developed for fabricating a variety of components, but mainly for complex shapes, double contours and relatively large components.

The process is particularly suited to the moulding of low cost components which are too large and/or complex to be pressurised by other means. The technique utilises a flexible sealed bag under which a vacuum is drawn, thus exposing the laminate in the mould below to atmospheric pressure (1 atmosphere = 14 psi). The assembly is then heated in an oven to promote flow and cure the resin. This method requires low cost equipment and tooling, and is capable of producing advanced composite components to a quality which is acceptable for many applications.

Autoclave

An autoclave is simply a large, heated pressure vessel. Autoclave moulding is similar to the vacuum bag process, except the lay-up is subjected to additional pressure, whilst heat is applied to cure the resin. Vacuum is usually applied during the initial stages of the cure cycle to remove volatiles and trapped air, but without causing excessive resin flow. Autoclave pressure may be maintained during the entire heating and cooling cycle.

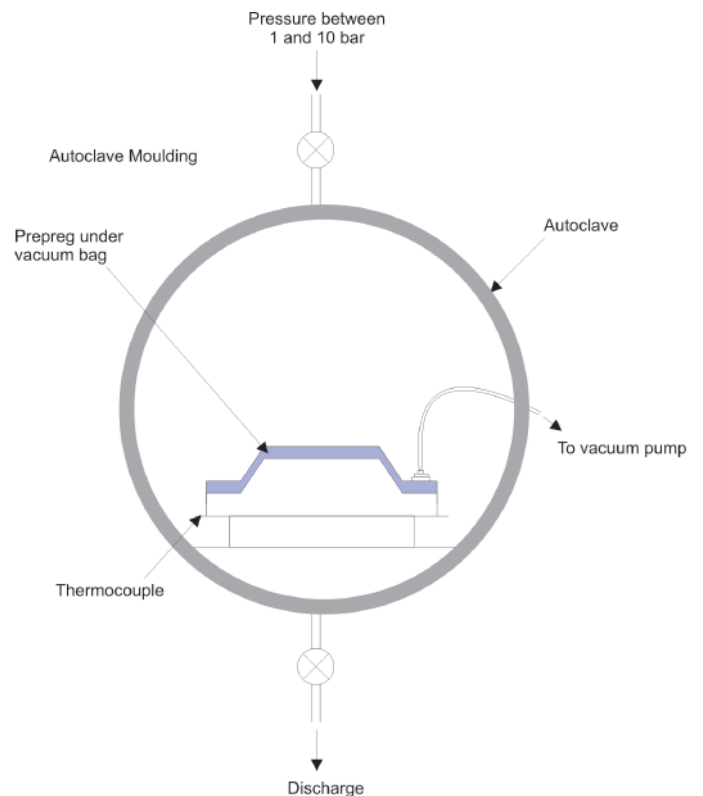
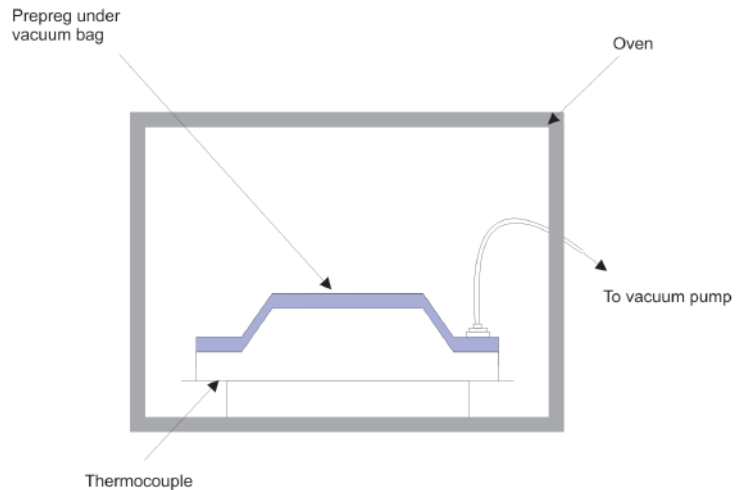
The pressure exerted on the lay-up is normally within the range 50-100 psi. The autoclave moulding process produces laminates of high quality with minimum void content and control of laminate thickness is much better than that achieved by the vacuum bag moulding method. However, the capital equipment costs are high and the output relatively low, which restricts the use of the autoclave moulding process to higher value markets where high quality is essential. Many large primary structural components for aircraft, such as fins, wing spars and skins, fuselages and flying control surfaces, are manufactured by this method for guaranteed reproducibility.

Press Moulding

The prepreg is laid into the mould or preformed into a shaped charge to facilitate rapid loading in a hot tool.

The moulds/tools, which are usually machined or cast metal, are produced as matched male and female halves, the space between them defining the shape and wall thickness of the component being made.

The tool is mounted on the platens of a press. The tool is usually directly heated by electricity, oil or steam. In the case of direct oil or steam heating, flow passages are built into the tool. When using electricity, cartridge heaters may be installed within the mould. On small components, heat may be supplied via heated platens on the press.



Cure cycles can be accurately controlled, so components can be produced to very high quality and consistency, with very accurate moulding tolerances being achieved and the process is also readily automated.

Due to the high costs of capital equipment and tooling, this method is best suited to high volume production. For short production runs, less expensive nickel electroformed, glass fibre or sprayed metal tooling can be used.

Pressure Bag

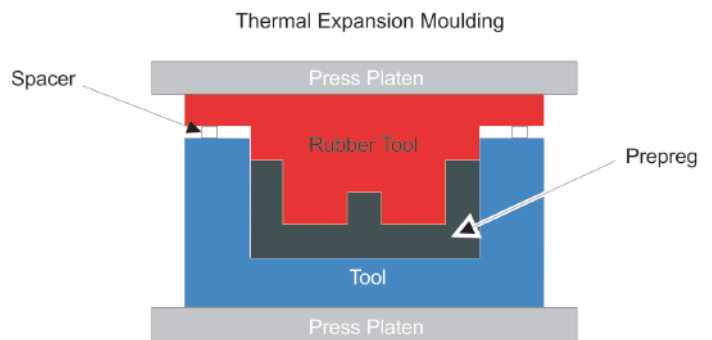
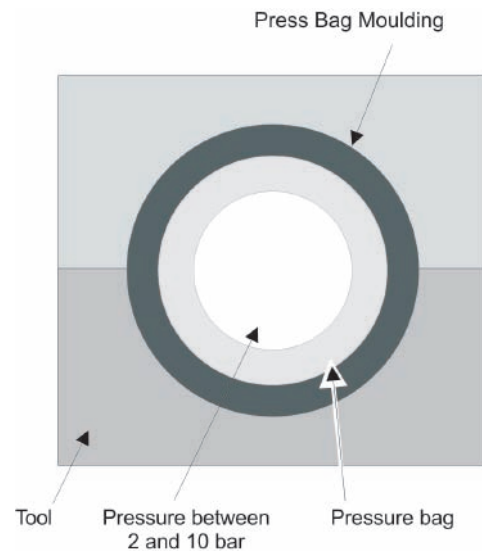
This method is suitable for the production of hollow mouldings. A flexible bag, often manufactured from silicone rubber, is placed inside the structure and inflated to apply consolidation pressure. The part can be cured in an oven with temperature and pressure applied for consolidation, using compressed gas or fluid. This method is often applied to simple sections such as tubes, e.g. sail boat masts, but it should be noted that the tooling must be rigid enough to withstand the internal pressure without distorting.

Thermal Expansion

This method is used to mould integrally stiffened structures with complex forms. The process involves wrapping prepreg layers over blocks of rubber or foam, which are then restrained in a metal cavity, and the assembly heated. As the temperature increases, differential thermal expansion between the metal and rubber takes place (the rubber expands much more than the metal). Very high pressures are generated and the lay-up is consolidated.

Components with very complex shapes can be moulded in a single cure cycle, thus reducing the number of joints and parts. Therefore, significant weight and production cost savings can be achieved.

A variant of this process adopts a solid mandrel, which is fabricated from a material known to have a very high coefficient of thermal expansion, e.g. silicone rubber. This mandrel is wrapped in prepreg and placed in a simple rigid tool. The assembly is then heated and, during the curing process, the mandrel expands, generating consolidation pressure and, on cooling, it can be extracted to leave a hollow component.



PRODUCT SELECTOR GUIDE

The following tables offer an introduction to ACG's extensive range of materials; the full range is available in the Data Catalogue on the ACG web site.

STRUCTURAL EPOXY PREPREG RESIN SYSTEMS LTM®: LOW TEMPERATURE MOULDING				
Resin System	LTM®23	LTM®26 Series	LTM®40 Series	LTM®45-1
Maximum Tg after post-cure (TMA)	130°C (266°F)		210°C (410°F)	
Resin Type (Rapid cures possible at higher temperatures)	Toughened Epoxy			
Typical Initial Cure	40°C (104°F) for 30 hours 70°C (158°F) for 3 hours	60°C (140°F) for 10 hours	65°C (149°F) for 12 hours 80°C (176°F) for 5 hours	
Out Life at Room Temperature	2 to 3 days	5 to 6 days	6 to 7 days	
Key Features	40°C (104°F) initial cure. Toughened. Honeycomb bondable.	Toughened LTM structural system. Wet service temperature 90°C (194°F). Excellent resin clarity and UV resistance.	Toughened LTM structural system. Wet service temperature 130°C (266°F).	Toughened LTM structural system. Wet service temperature 130°C (266°F). Autoclave quality from vacuum bag processing.
Typical Applications	Prototypes. Low cost structural parts. Offshore structure repair.	Light aircraft. UAVs. Automotive prototypes. Flame retarded and low smoke variants.	Aircraft prototypes. UAV's. Automotive engine parts.	Aircraft prototypes. Structural aircraft components. Automotive engine parts.

STRUCTURAL EPOXY PREPREG RESIN SYSTEMS MTM®: MEDIUM TEMPERATURE MOULDING							
Resin System	MTM®27	MTM®28 Series	MTM®29FR/SFR	MTM®44-1	MTM®45-1/FR	MTM®46	MTM®47
Maximum Tg after post-cure (DMA onset)	110°C (230°F)	75°C (167°F)	115°C (239°F)	190°C (374°F)	190°C (374°F)	190°C (374°F)	200°C (390°F)
Resin Type	Toughened Epoxy						
Typical Cures	120°C (248°F) for 1 hour or 150°C (302°F) for 15 minutes	120°C (248°F) for 1 hour	135°C (275°F) for 45 minutes plus post-cure 125°C (257°F) for 1 hour	130°C (266°F) for 2 hour dwell plus 180°C (356°F) for 2 hours or 130°C (266°F) for 4 hour plus free-standing post-cure 180°C (356°F) for 2 hours	80°C (176°F) for 20 hours, 120°C (248°F) for 4 hours or 130°C (266°F) for 2 hours plus free-standing post-cure 180°C (356°F) for 2 hours	120°C (248°F) for 1 hour plus free-standing post-cure 180°C (356°F) for 1 hour	120°C (248°F) for 2 hours plus free-standing post-cure 180°C (356°F) for 2 hours
Out Life at Room Temperature	30 days +		30 days	21 days	10 days tack life 21 days out life	60 days	15 days tack life 30 days out life
Key Features	Modified flow for good wet-out and hot demoulding in reduced production cycles. Good damage tolerance.	Good handling. Variants to meet specific handling requirements. Excellent damage tolerance. Honeycomb bondable.	MTM®29FR (UD) and MTM®29SFR (fabric) halogen-free, flame retarded variants, self-extinguishing to FAR25.853.	OoA processing. Low density 1.18g/cc.	OoA processing. 90°C (194°F) initial cure for prototypes. Conventional 180°C (356°F) cure for production. Low density 1.18g/cc. MTM®45-1FR: flame retarded variant available.	OoA processing. Excellent wet service capability. Long out life. Flexible cure 80°C (176°F) to 180°C (356°F).	Excellent hot/wet open hole compression properties.
Typical Applications	Sports goods.	Widely used structural material for commercial applications.	Rail, marine and transport structural parts.	Primary aircraft structures.	Primary aircraft structures for prototypes and series production.	Civil and military aircraft secondary structures and light aircraft.	OoA production of large aircraft structures.

STRUCTURAL EPOXY PREPREG RESIN SYSTEMS
MTM®: MEDIUM TEMPERATURE MOULDING - CONTINUED

Resin System	MTM®48	MTM®49 Series	MTM®52	MTM®55	MTM®56 Series	MTM®57 Series	MTM®58B/FRB
Maximum Tg after post-cure (DMA onset)	110°C (230°F)	160 to 180°C (320 to 356°F)	100°C (212°F)	120°C (248°F)	125°C (257°F)	100°C (212°F)	140°C (284°F)
Resin Type	Flame Retarded Epoxy	Toughened Epoxy	Epoxy	Toughened Epoxy			Epoxy
Typical Cures	120°C (248°F) for 1 hour	MTM®49L: 120°C (248°F) for 2 hours. MTM®49-1L and MTM®49-3: 135°C (275°F) for 90 minutes	110°C (230°F) for 10 minutes	120°C (248°F) for 1 hour	80°C (176°F) for 5 hours or 120°C (248°F) for 10 minutes	120°C (248°F) for 1 hour	
Out Life at Room Temperature	30 days	30 to 60 days	2 days	30 days			60 days
Key Features	Good tack and drape. Good environmental resistance. Meets requirements of UL94 and self-extinguishing to FAR25.853. Honeycomb bondable.	MTM®49L: Good balance of temperature resistance and toughness. MTM®49-1L: Improved toughness. 80°C (176°F) wet service. MTM®49-3: High temperature resistance and wet service. Honeycomb bondable for lightweight motorsport bodywork.	Rapid cure for press moulding.	Good tack and drape characteristics. Exceptional surface clarity. Toughness and impact resistance.	Rapid cure system. MTM®56FR: Flame retarded woven prepreg. MTM®56-1: Unidirectional prepreg. Black pigmented variants available.	MTM®57*: Low cost, aesthetically clear resin, offering good UV resistance. MTM®57B: Black pigmented. MTM®57FRB: Flame retarded, black pigmented. MTM®57-2: Reduced flow, controlled tack. MTM®57-3: Low tack.	Excellent tack and drape. Good hot/wet performance. MTM58FRB fire retarded and self-extinguishing to FMVS302/ISO3795 and FAR25.857. MTM58B self-extinguishing to FMVS302/ISO3795.
Typical Applications	Honeycomb sandwich structures and secondary structures.	Automotive and motorsport structures, e.g. chassis, wings and roll hoops.	Skis, snowboards, wake-boards.	Sports equipment and cosmetic parts.	Commercial rapid cure/production components.	Component manufacture. Cosmetic interior and exterior automotive panels.	Automotive components.

*Customers are advised to consult their ACG sales representative when selecting MTM57 for a cosmetic application.

STRUCTURAL EPOXY PREPREG RESIN SYSTEMS
MTM®: MEDIUM TEMPERATURE MOULDING - CONTINUED

Resin System	MTM®59	MTM®70	MTM®71	MTM®79	MTM®220	MTM®228	MTM®2485	MTM®249
Maximum Tg after post-cure (DMA onset)	140°C (284°F)	190°C (374°F)	154°C (310°F)	220°C (428°F)	130°C (266°F)	110°C (230°F)	100°C (212°F)	200°C (392°F)
Resin Type	Toughened Epoxy				Flame Retarded Epoxy	Toughened Epoxy	Flame Retarded Epoxy	Toughened Epoxy
Typical Cures	120°C (248°F) for 1 hour	135°C (275°F) 90 minutes	120°C (248°F) for 1 hour	135°C (275°F) 90 minutes	120°C (248°F) for 90 minutes	120°C (248°F) for 1 hour	125°C (257°F) for 1 hour	135°C (275°F) for 3 hours
Out Life at Room Temperature	30 days							21 days
Key Features	High optical clarity. High X-Ray transparency.	Good mechanical performance with intermediate and high modulus fibres.	Good tack and handling.	High service temperature and honeycomb bondable.	Self-extinguishing to FAR25.853. Excellent wet service capability. Honeycomb bondable.	Excellent damage tolerance.	Self-extinguishing to FAR25.853. High level of adhesion to a number of substrates and honeycomb cores.	Good dry property retention up to 180°C (356°F). Low density 1.18g/cvc. High toughness.
Typical Applications	Medical equipment.	Structural components operating at elevated service temperatures.	Motorsport chassis and side intrusion structures.	Motorsport bodywork.	Honeycomb cored secondary structures.	Motorsport impact panels.	Ballistics encapsulating armour plate.	Motorsport chassis and impact structures at high service temperatures.

STRUCTURAL EPOXY PREPREG RESIN SYSTEMS - HTM®: HIGH TEMPERATURE MOULDING

Resin System	HTM®45	HTM®60
Maximum Tg after post-cure (DMA onset)	198°C (388°F)	230°C (446°F)
Resin Type	Toughened Epoxy	Epoxy
Typical Cures	180°C (356°F) for 2 hours	
Out Life at Room Temperature	21 days	30 days
Key Features	Good damage tolerance. High compression strength. 130°C (266°F) wet service temperature.	High temperature resistance. 155°C (310°F) wet service temperature. Honeycomb bondable.
Typical Applications	Primary and secondary civil and military structures.	High temperature motorsport structural and bodywork applications.

STRUCTURAL EPOXY PREPREG RESIN SYSTEMS - VTM®: VARIABLE TEMPERATURE MOULDING

Resin System	VTM®243FRB	VTM®244FRB	VTM®263	VTM®264/264FRB	VTM®266	VTM®267/267FRB
Maximum Tg after post-cure (DMA onset)	170°C (338°F)		100°C (212°F)			
Resin Type	Toughened/Flame Retarded Epoxy		Toughened Epoxy	Toughened/Flame Retarded Epoxy	Toughened Epoxy	Toughened/Flame Retarded Epoxy
Typical Cure	65°C (149°F) for 16 hours 180°C (356°F) for 2 hours post-cure		65°C (149°F) for 16 hours 120°C (248°F) for 1 hour			
Out Life at Room Temperature	21 days		30 days			
Key Features	Fabric reinforcement weights up to 300g/m². Excellent vacuum-bag consolidation for low void laminates. Good dry property retention up to 150°C (302°F).	Fabric reinforcement weights up to 700g/m². Excellent vacuum-bag consolidation for low void laminates. Good dry property retention up to 150°C (302°F).	Fabric reinforcement weights up to 300g/m². Excellent vacuum-bag consolidation for low void laminates.	Fabric reinforcement weights up to 700g/m². Excellent vacuum-bag consolidation for low void laminates. Flame retarded variant.	Fabric reinforcement weights greater than 700g/m². Excellent vacuum-bag consolidation for low void laminates.	Low tack variant. Differentially coated heavy reinforcements. Flame retarded variant.
Typical Applications	Large OoA structures for marine, automotive and other industries.					

FLAME RETARDED STRUCTURAL EPOXY PREPREG RESIN SYSTEMS

Resin System	LTM®26ELFS	MTM®29FR/SFR	MTM®45-1FR	MTM®48	MTM®58FRB	MTM®56-2FRB
Maximum Tg after post-cure (DMA onset)	120°C (248°F)	115°C (239°F)	190°C (374°F)	110°C (230°F)	125°C (257°F)	100°C (212°F)
Resin Type	Flame Retarded Epoxy					
Typical Cure	60°C (140°F) for 10 hours, 120°C (248°F) for 30 minutes.	135°C (275°F) for 45 minutes plus post-cure 125°C (257°F) for 1 hour.	80°C (176°F) for 20 hours, 120°C (248°F) for 4 hours or 130°C (266°F) for 2 hours plus free-standing post-cure 180°C (356°F) for 2 hours.	120°C (248°F) for 1 hour		120°C (248°F) for 30 minutes 150°C (302°F) for 10 minutes
Out Life at Room Temperature	5 to 6 days	30 days	10 days tack life 21 days out life	30 days	60 days	30 days
Key Features	Low smoke emission FAR 25.853(A). M1 rating to NFPG2-501. Good vacuum bag processing.	MTM®29FR (UD) and MTM®29SFR (fabric) halogen-free, flame retarded variants, self-extinguishing to FAR25.853	OoA processing. 90°C (194°F) initial cure for prototypes. Conventional 180°C (356°F) cure for production. Low density 1.18g/cc.	UL94.VO FAR 25.853(a). Excellent tack and drape. Honeycomb bondable.	Excellent tack and drape. Good hot/wet performance. Self-extinguishing to FMVS302/ISO3795 and FAR25.857.	Rapid cure, controlled viscosity system ideal for press moulding. Self-extinguishing to FAR 25.853(a).
Typical Applications	Mass transit interior components.	Used for general commercial applications.	Primary aircraft structures for prototypes and series production.	Light aircraft and industrial components. Sandwich panels.	Automotive structures and prototypes.	Aircraft and automotive seat components. Automotive structures.

FLAME RETARDED STRUCTURAL EPOXY PREPREG RESIN SYSTEMS - CONTINUED

Resin System	MTM®57FR	MTM®220	MTM®248S	VTM®243FRB	VTM®244FRB	VTM®264FRB	VTM®267FRB
Maximum Tg after post-cure (DMA onset)	100°C (212°F)	125°C (257°F)	100°C (212°F)	177°C (351°F)	170°C (338°F)	100°C (212°F)	
Resin Type	Flame Retarded Epoxy						
Typical Cure	120°C (248°F) for 90 minutes		125°C (257°F) for 1 hour	65°C (149°F) for 16 hours 120°C (248°F) for 1 hour			
Out Life at Room Temperature	30 days			21 days		30 days	
Key Features	Self-extinguishing to FAR 25.853(a).	Self-extinguishing to FAR25.853. Excellent tack and drape characteristics. Honeycomb bondable.	Self-extinguishing to FAR25.853. High level of adhesion to a number of substrates and honeycomb cores.	Self-extinguishing to ABD0031, FAR 25.853 and FMVSS302. Excellent vacuum bag consolidation for low void laminates.			Meets requirements of FAR25-853 and FMUS302. Low tack variant. Differentially coated on heavy reinforcements.
Typical Applications	Component manufacture. Cosmetic interior and exterior automotive panels.	Honeycomb cored secondary structures for the aerospace sector.	Ballistics encapsulating armour plate.	Large structures manufactured OoA with high service temperature		Large structures and general automotive structures and prototypes.	Large structures manufactured OoA.

PHENOLIC SYSTEMS

Resin System	MTM®80S	MTM®82S-C	MTM®82S	MTM®83	MTM®85S
Resin Type	Phenolic	Phenolic - controlled flow		Phenolic - low tack for UD	Phenolic - high flow
Typical Cure	160°C (320°F) for 30 to 60 minutes	135°C (275°F) for 75 minutes		125°C (257°F) for 90 minutes	160°C (320°F) for 15 minutes
Maximum Service Temperature	250°C (482°F)	80°C (175°F)		90°C (194°F)	75°C (167°F)
Out Life at Room Temperature	30 days				90 days
Autoclave	Recommended				Not applicable
Vacuum Bag	Recommended				Not applicable
Press Moulding	Recommended			Acceptable	Recommended
Key Features	High temperature resistance.	Flame retarded - BS 6853 Cat 1A; NF F 16-101 Rating M1, F1; DIN 5510 Rating S4; SR2 and ST2.	Flame retarded - FAR25.853 App F Part I, Smoke - FAR25.853 App F Part V, Heat Release - FAR25.853 App F Part IV, Toxic Gas- AITM 3.0005		Supplied on a range of fabrics and fibres for ballistics applications.
Typical Applications	Ballistics, ablatives Carbon-Carbon composites precursor.	Rail interiors and general mass transit.	Aircraft interiors. Airbus approved.	Aircraft interiors and general mass transit.	Helmets and armour.

STRUCTURAL POLYIMIDE/BISMALEIMIDE PREPREG RESIN SYSTEMS - HTM®: HIGH TEMPERATURE MOULDING

Resin System	HTM®501	HTM®552	HTM®556
Maximum Tg after post-cure (DMA onset)	250°C (482°F)	280°C (536°F)	270°C (518°F)
Resin Type	Polyimide		BMI
Typical Cures	180°C (356°F) for 1 hour plus 250°C (480°F) for 24 hours.	190°C (374°F) for 6 hours plus post-cure 240°C (464°F) for 8 hours.	190°C (374°F) for 6 hours plus post-cure 240°C (464°F) for 6 hours.
Out Life at Room Temperature	30 days		
Key Features	Exhibits zero tack, excellent mechanical and electrical characteristics and outstanding thermal ageing resistance at 250°C (482°F).	Withstands excursions to 280°C (536°F).	Controlled flow. No hot debulks required. Withstands excursions to 250°C (482°F).
Typical Applications	High temperature applications.	High service temperature motorsport and aircraft components.	Structural applications where continuous service temperatures exceed 200°C (392°F).

STRUCTURAL CYANATE ESTER PREPREG RESIN SYSTEMS - HIGH TEMPERATURE SYSTEMS

Resin System	LTM®110 Series	LTM®123	MTM®110 Series
Maximum Tg after post-cure (DMA onset)	300°C (572°F) after 2 hours at 250°C (482°F)	250°C (482°F) after 2 hours at 240°C (464°F)	300°C (572°F) after 2 hours at 250°C (482°F)
Upper Service Temperature	300°C (572°F) +	220°C (428°F)	250 to 300°C (482 to 572°F)
Resin Type	Cyanate Ester	Toughened Cyanate Ester	Cyanate Ester
Typical Cures	70°C (158°F) for 16 hours	80°C (176°F) for 16 hours	135°C (275°F) for 2 hours
Out Life at Room Temperature	2 days		30 days
Key Features	Good thermal durability. Inherently flame retarded. Low gas and smoke generation. Good dielectric properties. LTM®110-5 : variant available for unidirectional prepregs. LTA®110-5 : film available for bonding applications.	Good tack and drape. Excellent dimensional stability. Very low moisture uptake. Good dielectric properties.	Good thermal durability. Inherently flame retarded. Low gas and smoke generation. Good dielectric properties. MTM®110-5 : variant available for unidirectional prepregs. MTA®110-5 : film available for bonding applications.
Typical Applications	Applications where best dimensional stability required over a wide temperature range, and where tooling suitable for high temperature autoclave curing is not available.	Structural applications requiring ultimate dimensional stability in a space environment. Suitable for radomes and radar absorbing structures. High service temperature structural motorsport applications.	Applications where extended room temperature out life is important.

STRUCTURAL CYANATE ESTER PREPREG RESIN SYSTEMS - HIGH TEMPERATURE SYSTEMS - CONTINUED

Resin System	HTM®110	HTM®143
Maximum Tg after post-cure (DMA onset)	330°C (626°F) after 2 hours at 250°C (482°F)	330°C (626°F) after 2 hours at 250°C (482°F)
Upper Service Temperature	350°C (662°F)	350°C (662°F)
Resin Type	Cyanate Ester	
Typical Cure	175°C (347°F) for 2 hours	175°C (347°F) for 2 hours
Out Life at Room Temperature	30 days	30 days
Key Features	Good thermal durability. Inherently flame retarded. Low gas and smoke generation. Good dielectric properties. HTM®110-5 : variant available for unidirectional prepregs.	Good thermal durability. Inherently flame retarded. Low gas and smoke generation. Good dielectric properties.
Typical Applications	Applications where longer work-life is important and where cure compatibility with other 180°C (356°F) cure materials is essential.	Applications where longer work-life is important and where cure compatibility with other 180°C (356°F) cure materials is essential.

**STRUCTURAL PREPREG RESIN SYSTEMS
ZPREG® SELECTIVE IMPREGNATION FOR OoA PROCESSING**

Enhanced air extraction and improved surface finish under vacuum only consolidation. Single and multiple-layer products, significantly reducing lay-up times.			
Resin System	ZPREG®264/264FRB ZPREG®267/267FRB	ZPREG®244FRB	ZPREG®57
Maximum Tg after post-cure (DMA onset)	100°C (212°F)	170°C (338°F)	100°C (212°F)
Resin Type	Toughened/Flame Retarded Epoxy		Toughened Epoxy
Typical Cure	65°C (149°F) for 16 hours 120°C (248°F) for 1 hour	65°C (149°F) for 16 hours 180°C (356°F) for 1 hour	120°C (248°F) for 1 hour
Out Life at Room Temperature	Up to 30 days	Up to 21 days	Up to 30 days
Key Features	Improved drape and handling. Multiple variants. Reduced void content.		
Typical Applications	Automotive, marine and industrial structures for rapid production OoA processing.	Automotive and aerospace structures requiring higher service temperature.	Rapid manufacture. Sports goods and industrial components.
The out life value of each product depends on process route and resin reinforcement type and weight.			

STRUCTURAL PREPREG RESIN SYSTEMS
ZPREG® TECHNOLOGY BODY PANEL SYSTEM. BPS240 - (2 PART SYSTEM)

Product Description	Surface Ply	Bulk Ply
Carbon	VTF242FRB/CF1200/CF1100	VTS®243FR/CF3500-0.75mm
Glass	VTF242FRB/GF1200/GF1100	VTS®243FR/GF1100-1.0mm
Maximum Tg after post-cure (DMA onset)	170°C (338°F)	
Typical Cure (oven vacuum bag and autoclave cure)	65°C (149°F) for 16 hours, 120°C (248°F) for 1 hour, 150°C (302°F) for 45 minutes	
Out Life at Room Temperature	7 days	30 days
Freezer Storage	12 months	
Key Features	Pit free finish under vacuum consolidation. Stable under environmental conditioning. Excellent drape and handling. Flame retarded.	Rapid build-up of part thickness. Excellent drape and handling. Stable under environmental conditioning. Flame retarded.
Typical Applications	Automotive body panels. Rapid prototype construction. Models.	
Note 1: BPS240 Carbon moulded thickness - 1.25mm and areal weight - 1.74kg/m ²		
Note 2: BPS240 Glass moulded thickness - 1.5mm and areal weight - 1.94kg/m ²		

STRUCTURAL PREPREG RESIN SYSTEMS
DForm® TECHNOLOGY BODY PANEL SYSTEM. BPSMK2 - (3 PART SYSTEM)

Product Description	Surface Film	Surface Ply	Bulk Ply
Material	VTF266/PV17	VTM®244FRB/DForm®	VTS®243FR/CF3500-0.75mm
Maximum Tg after post-cure (DMA onset)	170°C (338°F)		
Typical Cure (autoclave only)	65°C (149°F) for 16 hours, 120°C (248°F) for 1 hour, 150°C (302°F) for 45 minutes		
Out Life at Room Temperature	30 days	21 days	30 days
Freezer Storage	12 months		
Key Features	Paint-ready, sandable surface following autoclave cure.	400g/m ² (100g/m ² /0°, 200g/m ² /90°, 100g/m ² /0°). Slashes at 90°. Flame retarded, low print through, fast laminating.	Rapid build-up of part thickness. Excellent drape and handling. Stable under environmental conditioning. Flame retarded.
Typical Applications	Automotive body panels.		
Note: BPSMK2 moulded thickness - 1.38mm and areal weight - 1.77kg/m ²			

STRUCTURAL EPOXY PREPREG RESIN SYSTEMS - SURFACE PLIES FOR OoA PROCESSING

Enhanced air extraction and surface finish under vacuum only consolidation. Improved drape in single and multiple-layer products significantly reducing lay-up times.					
Resin System	LTM®245T	VTF261 (Cosmetic)	VTF261	VTF241FRB	VTF242FRB
Maximum Tg after post-cure (DMA onset)	120°C (248°F)	100°C (212°F)		200°C (392°F)	
Resin Type	Toughened Epoxy			Toughened/Flame Retarded Epoxy	
Typical Cure	50°C (122°F) for 16 hours 60°C (140°F) for 10 hours	65°C (149°F) for 16 hours 120°C (248°F) for 1 hour		65°C (149°F) for 16 hours 180°C (356°F) for 1 hour	
Out Life at Room Temperature	2 to 3 days	21 days		7 days	
Key Features	High quality cosmetic finish.		Paint ready and available in white.	Paint ready, high Tg, sandable.	Paint ready, high Tg.
Typical Applications	Aesthetic, automotive interior/exterior panels. Prototypes.		Marine, general large structures. Hulls, etc.	Surface ply for use with poor quality tooling.	Surface ply for automotive panels and large structures. High service temperatures, e.g. jet engine test nacelles.

STRUCTURAL EPOXY PREPREG RESIN SYSTEMS - SURFACE FILMS FOR OoA PROCESSING

Enhanced surface finish under vacuum only consolidation.

Resin System	MTF246	VTF266
Resin Type	Flame Retarded Epoxy	
Typical Cure	120°C (250°F) for 1 hour	65°C (149°F) for 16 hours 120°C (248°F) for 1 hour
Out Life at Room Temperature	30 days	
Key Features	Paint ready, grey, sandable.	
Typical Applications	Surface improvement film compatible with ACG's OoA processing prepregs.	

VARIABLE TEMPERATURE CURING EPOXY SYNTACTIC FILMS

Product	Maximum Service Temperature	Out Life	Uncured Sheet Thickness (mm)	Description
VTS®263	100°C (212°F)	30 days	0.5, 1, 2	Variable temperature cure syntactic film.
VTS®243FR	180°C (356°F)	30 days	0.5, 1, 2	Variable temperature cure, high service temperature flame retarded syntactic film.
VTF261 SORIC	100°C (212°F)	30 days	2, 3	Variable temperature cure mouldable core.

EPOXY FILM ADHESIVES

Type	VTA®260	MTA®240	MTA®241	MTA®263	HTA®240
Typical Cure	80°C (176°F)	120°C (248°F)			180°C (356°F)
Max Cure Temperature	120°C (248°F)	175°C (347°F)	180°C (356°F)	120°C (248°F)	180°C (356°F)
Low Temperature Cure Option	65°C (149°F)	80°C (176°F)	Not applicable.	80°C (176°F)	130°C (266°F)
Out Life at Room Temperature	30 days				
Maximum Service Temperature	100°C (212°F)	130°C (266°F)	180°C (356°F)	90°C (194°F)	180°C (356°F)
Lap Shear Strength	36MPa	40MPa	34MPa	32MPa	
Climbing Drum Peel Strength	78Nm/m	100Nm/m	81Nm/m	75Nm/m	91Nm/m
Features/Comments	Good tack for vertical assembly. Adhesion of VTM260 series resins to cores.	Used for bonding aluminium or composite laminates and for bonding metal or composite skin to core materials.	Used for bonding aluminium and composite substrates either to themselves or to honeycomb core materials. High service temperature. Compatible with MTM®45-1 when the initial cure temperature exceeds 120°C (248°F).	Used for bonding aluminium or composite laminates and for bonding metal or composite skin to core materials.	Used for bonding aluminium and composite substrates either to themselves or to honeycomb core materials. High service temperature. Compatible with MTM®44-1 OoA.

TOOLING

Resin System	LTM				HTM			LTM		LTF
	10 Series	202	210 Series	13	512	512-1	515-1	317-1B	318-1B	318B
Resin Type	Epoxy				Bismaleimide (BMI)			Epoxy		
Out Life at Room Temperature	10 = 2 to 3 12 = 3 to 4 16 = 6 to 7	Prepreg = 4 DForm = 2	212 = 1.5 to 2.5 213 = 6 to 7 217 = 10	2 to 3	21		30	21	30	7
Minimum Initial Cure °C (°F) for duration (hours)	10 = 22 (72) 144 12: 30 (86) 70 16: 40 (104) 48	45 (113) 16	212 = 35 (95) 40 213 = 45 (113) 34 217 = 55 (131) 20	30 (86) 70	190 (374) 6			65 (150) 16		
Maximum Initial Cure °C (°F) for duration (hours)	10 = 60 (140) 3 12 = 70 (158) 3 16 = 60 (140) 12	60 (140) 8	212 = 35 (95) 8 213 = 65 (149) 9 217 = 80 (176) 5	70 (158) 3	190 (374) 6			80 (176) 5		
Post-Cure °C (°F) for duration (hours)	200 (392) 0.25 plus 190 (374) 8				240 (464) 8		230 (440) 6	140 (284) 2 or 180 (356) 2	200 (392) plus 190 (374) 8	
End Use °C (°F)	All: 200 (392)	200 (392)	All: 210 (410)	180 (356)	250 (482)			150 (302)	180 (356)	
Maximum Tg °C (°F) (TMA Onset)	All: 205 to 210 (400 to 410)	210 (410)	All: 210 (410)	180 (356)	280 (536)	290 (554)	260 (500)	170 (338)	220 (428)	
Shelf Life at -18°C (0°F) (months)	10 = 12 12 = 6 16 = 12	12			6			12		
Processing Options	Autoclave							Out-of-Autoclave (OoA)		
								Bulk Ply		Surface Ply

Data given above relates to carbon reinforcement; refer to the relevant data sheets for glass reinforcement data.

TOOLING GEL COAT

Product	Description	End Use Temperature	Pack Sizes	Colour
GC331	Two-part thixotropic gel coat	160°C (320°F)	5kg and 10kg	Black

GC331 is compatible with most of ACG's LTM tooling systems. However, consult ACG literature prior to use.

TOOLING BLOCK

Product	Density	CTE/°C	Heat Distortion Temperature °C (°F)	Description
TB720	750Kg/m ³	40 to 45 x 10 ⁻⁶	100 (12)	Standard grade, epoxy based tooling block, machinable to satin finish.
TB750	750Kg/m ³	40 x 10 ⁻⁶	110 (230)	Premium grade, epoxy based tooling block, machinable to gloss finish.
CB1100	1100Kg/m ³	2.3 x 10 ⁻⁶	Maximum 1000°C (1832°F). Limited by adhesive.	Ceramic master model, tool and encapsulated tooling.

A full range of tooling block ancillary products is available. Please consult the full ACG Data Catalogue.

Why Choose ACG?

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