

# Advantages of Composites Materials and Glossary



# Advantages of Composites Materials

Items manufactured with Fibre Reinforced Polymers (FRP) - commonly referred to as composite materials - are used in a wide variety of applications due to their inherent characteristics and adaptability.

Advanced composites materials are extremely versatile. They are low in weight, corrosion and chemical resistant and offer a highly cosmetic finish to manufacturers. Unlike many traditional materials, composite technology is exceptionally durable and can withstand weathering and fatigue.

They are very well suited for the manufacture of structurally stable parts such as bridges, pipes, large-scale water treatment and containment plants due to their high strength, stiffness and load bearing capabilities.



The inherent light weight and low-drag, aerodynamic properties of composite materials also make them ideal for transport applications. Their use in automotive and rail parts can contribute to higher fuel efficiency and reduced CO2 emissions whilst delivering an impeccable finish.



For all of these reasons, composite materials can be tailored for an extraordinarily wide range of applications. From stable but lightweight structures for use in sporting goods such as surfboards and kayaks, to durable and attractive laminates ideal for swimming pools and ocean going yachts where high cosmetic appeal is just as important as functionality.



## DESIGN FLEXIBILITY

The level of design freedom achievable with composites materials has not been previously possible with traditional materials such as concrete, steel or aluminium.

The high strength-to-weight ratio of composites materials often allows a lighter weight solution. This combined with excellent durability, high degree of flexibility and multitude of aesthetic finishes presents an exciting proposition for architects and engineers only limited by the imagination.

## RESISTANCE AND IMPACT STRENGTH

Composite materials can be adapted to meet the demands of harsh environments requiring high chemical, corrosion and weather resistance.

They also fulfil the demands of highly engineered parts by offering stiffness, load bearing capabilities, fatigue resistance and impact strength.

## LARGE PARTS IN ONE STEP

Innovative manufacturing processes allow very large parts to be made in one step; therefore, significantly reducing production times, installation and labour costs.

For example, advanced closed mould processes have enabled manufacturers to produce an 83.5 meter wind turbine blade, or the entire hull of a 40 metre passenger ferry in one step.



## Non-conductive

Glass reinforced laminates can be safely used in electrical applications such as cherry-pickers, ladders, and electrical cross arms due to their non-conductive characteristic.

## Thermal resistance

Composites parts and structures can withstand extreme climates due to their heat resistance properties. Thermal insulation can be designed right into components allowing engineers and architects to achieve specific R-values. Some application examples would be portable dwellings and machinery covers.

## OTHER KEY CHARACTERISTICS

### Radio translucent and non-magnetic

Glass Fibre Reinforced Polymers (GFRP) are radio translucent and non-magnetic. These qualities make composites materials particularly suitable for use in defence applications such as submarines and radomes.



# Glossary of Terms

## A – H

**AAP** – Acetyl Acetone Peroxide: a chemical which acts as an initiator (catalyst) in composite processing.

**ABRASION** – Wearing away by friction.

**ABSORPTION** – The take up and retention of fluid into the interior of a material.

**ACCELERATOR** – A chemical that is used to speed up the reaction between the promoter and initiator especially where low temperatures are present. Also used when Benzoyl Peroxides are used as the Initiator. Sometimes they are also known as co-promoters.

**ACOUSTIC EMISSION** – A measure of integrity of a material as determined by sound emission when the material is stressed. Ideally, emissions can be correlated with defects.

**ADDITIVE** – An ingredient which is mixed into the resin, usually to improve its properties.

**ADHEREND** – A body that is held to another body by an adhesive.

**ADHESIVE** – A substance applied to mating surfaces to bond them together by surface attachment. May be liquid, film or paste.

**ADHESIVE FAILURE** – Rupture of an adhesive bond such that the separation occurs at the adhesive-adherend interface.

**ADSORPTION** – The adhesion, in an extremely thin layer, of a liquid to the surface of a solid body with which it is in contact.

**AIR ENTRAPMENT** – Occlusion of air in a laminate giving rise to bubbles voids or blisters.

**AIRLESS SPRAYING** – Application of resin and catalyst using equipment consisting of a fluid pump at high pressure, hose and spray nozzle to produce atomisation of the fluid without the use of compressed air or other propellant.

**AIR SPLICE** – The coupling of two rovings which is made by a jet of air entwining the two strands together. The air splice is used instead of a knot.

**ALLIGATORING** – Wrinkling of the gel coat resembling alligator hide. Also called Triping.

**ANISOTROPY** – The characteristic of a material where it exhibits different properties along its different directions.

**ANTIMONY TRIOXIDE** – Fire retardant additive for use with resins.

**ARAMID** – Aromatic polyamide fibres. Common trade names are Kevlar and Twaron.

**AREAL WEIGHT** – Weight of a fibre reinforcement per unit area of tape or fabric.

**ASPECT RATIO** – The ratio of length to diameter of a fibre.

**AUTOCLAVE** – A closed vessel in which heat and pressure are applied for processing composites.

**AXIAL WINDING** – Filament winding where the filaments are parallel to the axis.

**BAG MOULDING** – A manufacturing process where an airtight film is placed over the laminate on the mould then pressure is applied by a vacuum, an autoclave, a press or by inflating the bag. Heat may be applied. When an autoclave is used the process is also known as autoclave moulding.

**BAGGING** – A manufacturing process where an impermeable layer of film is sealed to airtight over an uncured part and vacuum drawn to consolidate the laminate.

**BALANCED LAMINATE** – A laminate in which all laminas except those at 0°/90° are placed in plus/minus pairs (not necessarily adjacent) symmetrically about the lay-up centreline.

**BARCOL HARDNESS** – Hardness of a laminate as measured by the Barber-Coleman Impresser (Bar Col), generally model 934-1.

**BIAXIAL WINDING** – Filament winding where helical bands are laid in sequence, side by side with no gaps or overlap between the fibre.

**BINDER** – A bonding agent used to hold individual fibres together in the manufacture of glass fibre (or fibreglass) reinforcement, especially those in mat construction. May be in the form of an emulsion or a powder.

**BLEEDER CLOTH** – A layer of fabric that allows excess gas and resin to escape during cure. The bleeder cloth is removed and does not form part of the final composite.

**BLEEDOUT** – Excess liquid resin appearing at the surface primarily during filament winding.

**BLOOMING, FIBRE** – A surface condition in pultrusion exhibiting a fibre prominence that usually has a white or bleached colour and a spark appearance.

**BOG** – Resin/filler putty: used for filling gaps.

**BPO** – Benzoyl Peroxide: a chemical which acts as an initiator (catalyst) in composite processing.

**BREATHER** – A loosely woven fabric that does not come in contact with the resin but ensures a continuous vacuum path over a part in production. The breather is removed after cure and does not form part of the final composite.

#### **BRIDGING**

1. Fibres which do not conform to sharp concave radii.
2. Fabric plies over a curved edge that do not come in full contact with the core (refer to sandwich construction).
3. Resin that has formed on edges during cure.

**B-STAGE** – An intermediate stage in processing where the resin has been allowed to partially cure.

**BUILD UP** – Glass bundles or chopper fuzz which collect on the chopper, cot, static bars or machine frame. Term can also be from resin / glass overspray and wax residue on mould surfaces.

**BULK MOULDING COMPOUND (BMC)** – A premixed blend of thermosetting resin, reinforcements, catalysts and fillers for use in compression, transfer or injection moulding processes.

**CAD/CAM** – Computer Aided Design / Computer Aided Manufacturing.

**CAST POLYMER/CASTING** – Cured unreinforced resin.

**CATALYST** – A chemical which initiates or speeds up a chemical reaction without being consumed in the reaction. This term is commonly, but incorrectly, used in the composites industry to refer to the initiator. The true catalysts used in the polyester resins used in the composites industry are the Promoters.

**CATENARY** – The loop caused by a difference in length of the strands in a specified length of roving.

**CAUL SHEET** – Smooth plate or sheet the same size and shape as the part used in contact with a composite lay-up during curing to transmit normal pressure and provide a smooth surface on the finished part.

**CAVITY** – The space between matched moulds in which the laminate is formed. Commonly used term for a female (cavity) mould.

**CENIPOISE (CPS)** – Measurement of a fluid's viscosity as compared to water (1 centipoise at 21°C).

**CENTRIFUGAL CASTING** – A processing method for composites where the resin and reinforcement is placed inside a rotating hollow cylindrical mandrel which is then heated as the resin cures.

**CFRP** – Carbon Fibre Reinforced Plastic

**CHALKING** – Dry, powder like appearance on gel coat surface.

**CHEESE** – A tubeless cylindrical package consisting of wound glass roving. Otherwise referred to as a doff, pack or spool.

**CHOPPED STRAND** – Continuous strand yarn or roving cut up into short uniform lengths, usually from 1 to 60 mm.

**CHOPPED STRAND MAT (CSM)** – A mat form of reinforcement consisting of a randomly distributed multitude of glass filament bundles cut to approximately 50mm long and bound together with a styrene soluble binder, in either emulsion or powder form.

**CHOPPER GUN** – A spray depositor which chops glass rovings into pre-determined lengths and deposits them together with catalysed resin onto the mould. Used for spray-up laminating.

**CLOTH** – A fine weave of woven glass fibre.

**CO-CURED** – Cured and simultaneously bonded to another prepared surface.

**COHESION** – Tendency of a single substance to adhere to itself. Also, the force holding a single substance together.

**COMPOSITE** – A material composed of two or more substituents. Nuplex Composites and their customer use this term to refer to a material composed of a thermosetting resin matrix reinforced with fibres.

**COMPRESSION MOULDING** – A processing method where fibre and resin are placed into a mould cavity, the mould is closed and heat and pressure are applied until the material has cured.

**CONFORMABILITY** – Ability of reinforcements to conform to tight radii without Springback or Bridging.

**CONTACT MOULDING** – A alternative term used to refer to a processing method which uses open one sided moulds. See Hand lay-up or Spray-up.

**CONTINUOUS FILAMENT** – An individual small diameter reinforcement that is flexible and of great length.

**CONTINUOUS ROVING** – Parallel filaments coated with sizing, gathered together into a single strand with no catenary. Supplied wound into a cylindrical package.

**CO-PROMOTED** – The use of more than one promoter in a resin to alter the speed of the curing reaction. This may be to achieve a long gel time and quick cure.

**CORE** – The central component of a sandwich construction to which the inner and outer skins are attached.

**COUNT** – For woven fabric, the number of warp or weft yarns per inch.

**COUPLING AGENT** – A chemical designed to react with the reinforcement and resin to form a bond at their interface.

**CRAZING** – Ultra-fine cracks that may develop on or under a resin surface.

**CREEL** – Shelves or racks for holding the required number of roving spools or other supply packages in position for unwinding.

**CREEP** – Dimensional change (beyond instantaneous elastic deformation) in a material which is under stress over a long time.

**CROSS LINKING** – The process of forming a network of chemical links between polymer chains. This occurs upon curing as the resin turns from a liquid to a solid.

**CHP** – Cumene Hydroperoxide: a chemical which acts as an initiator (catalyst) in composite processing. In some parts of the world, CHP also refers to cyclo hexanone peroxide - make sure which is being referred to.

**CURE** – An irreversible chemical reaction where links are formed between polymer chains. This changes thermosetting resins from liquid to solid.

**CURE TIME** – The time required for the liquid resin to reach a solid cross-linked state after the catalyst (initiator) is added.

**DAMPING** – Diminishing the intensity of vibrations.

**DEBOND** – An unplanned separation of bonded surfaces. In composites this usually relates to separation of laminate layers.

**DELAMINATE** – In plane separation of ply layers due to adhesive failure. This also includes the separation of layers of fabric from the core.

**DEMOULD** – Removal of a part from a tool/mould.

**DENIER** – A numbering system for yarn and filament in which yarn number is equal to weight in grams of 9000m of yarn.

**DENSITY** – Measurement of the mass of a substance per cubic volume (i.e. kg/m<sup>3</sup>). However, commonly used term when referring to mat or fabric reinforcements, but refers to the mass per square metre (g/m<sup>2</sup>), i.e. 450g/m<sup>2</sup> chopped strand mat.

**DILUENT** – Diluting (reducing or thinning) agent. Solvent.

**DMA** – Dimethylaniline: a promoter used with polyester and vinyl ester resins.

**DOUBLER** – Extra layers of reinforcement added to provide stiffness or strength. This is usually positioned where fasteners are to be applied or other abrupt load transfers occur.

**DRAFT ANGLE** – A tool's (or mandrel's) taper or slope for ease of part removal.

**DRAIN OUT** – The leaking of resin from the laminate.

**DRAPE** – The ability of fabric to conform to the shape of a contoured surface.

**DRY FIBRE** – A condition in which fibres are not fully encapsulated or wet-out by resin during laminating. In a defined area this is called a dry spot.

**DRY LAMINATE** – A laminate containing insufficient resin for complete bonding of the reinforcement.

**E-GLASS** – Commonly type of glass used for manufacture of continuous glass fibre utilised as reinforcement. Characterised by its high electrical resistance.

**EMULSION BOUND MAT** – Commonly called Emulsion Mat. Chopped strand mat in which the fibres are bound together with an emulsion (often poly-vinyl acetate) which is both water and styrene soluble.

**END** – A strand of roving consisting of a given number of filaments gathered together.

**END COUNT** – The number of strands contained in a roving.

**EPOXY RESIN** – A thermosetting polymer characterised by epoxide groups.

**EXOTHERM** – The heat released during a chemical reaction (e.g. curing).

**EXTENDERS** – Low cost materials added to resins to increase volume without significantly increasing cost or decreasing properties.

**FABRICATION** – The process of making a composite part or tool.

**FABRIC (NON WOVEN)** – A material formed by fibres or yarns without interlacing.

**FABRIC (WOVEN)** – A material constructed of interlaced yarns, fibres or filaments. Produced by the weaving process.

**FADING** – Loss of colour in the gel coat.

**FATIGUE** – A failure mechanism of materials when they are exposed to repeated stress over time.

**FATIGUE STRENGTH** – Maximum cyclical stress withstood for a given number of cycles before a material fails.

**FEA** – Finite Element Analysis

**FEATHER EDGE** – The process of tapering the edge of an overlapping material to blend with the adjoining surface.

**FEEDERS** – Components on a filament winding machine through which roving is dispensed onto the mandrel.

**FIBRE / FIBER** – An individual rod/filament of glass of sufficiently small diameter to be flexible.

**FIBRE CONTENT** – The amount of fibre in a composite relative to resin. Expressed as either a volume or weight ratio or percentage.

### **FIBREGLASS / FIBERGLASS**

1. Glass fibres constructed in various forms to act as a reinforcement medium.

2. Abbreviation referring to a composite laminate consisting of a resin matrix reinforced with glass fibre reinforcement.

**FIBRE ORIENTATION** – Direction of fibre alignment in a composite laminate. Refers to where most of the fibres are placed in the same direction to give higher strength in that direction.

**FIBRE REINFORCED PLASTICS / POLYMER (FRP)** – A composite that consists of a resin matrix and reinforcing fibres. Often used to describe glass fibre reinforced plastics (GFRP).

**FIBRE WHITENING** – An incompatibility between the resin and glass within the laminate to produce visual white fibres upon laminate curing.

**FILAMENT** – Individual fibres of very small diameter and extremely long length.

**FILAMENT WINDING** – A manufacturing process for composites where tape, roving or single strands are fed from a creel through a bath of resin and onto a rotating mandrel. The mandrel may be cured at room temperature or in an oven.

**FILL THREADS** – Fibres woven at 90° to the warp fibres in a woven fabric. Fibres woven across the fabric from edge to edge. Also called weft.

**FILLERS** – Relatively inert materials added to resin, gel coat or flow coat to alter its properties or lower cost.

**FISH EYE** – A circular separation in a gel coat film generally caused by contamination such as silicone, oil, dust or water.

**FLAME RETARDANT** – In composites terms this refers to a substance that reduces the flammability or delays combustion of the finished laminate.

**FLEXURAL MODULUS** – The ratio, within the elastic limit, of the applied stress on a sample in flexure to its strain in the outermost fibres of the sample. Simply put “how much a sample bends when load is applied”.

**FLEXURAL STRENGTH** – The strength of a material in bending expressed as the stress of a bent test sample at the instant of failure.

**FLOW LINE** – A mark on a moulded product made by the meeting of two liquid fronts during moulding. Also called striae, weld-mark or weld-line.

**FLY** – Loose filaments of fibre that have broken from their strand and are freely floating in the air.

**FRP** – Fibre Reinforced Plastics.

**GEL** – A partial cure stage of resins. A description of the resin at the point in curing when the liquid first forms a jelly-like solid.

**GELATION** – The formation of a gel.

**GEL COAT** – Clear or pigmented resin which becomes an integral part of the finished laminate as the outer surface to give visual impact and protect the laminate from the environment.

**GEL TIME** – Period of time from initial mixing of liquid reactants (resin & catalyst or part A and part B) to the point when gelation occurs.

**GLASS FIBRE** – Reinforcing fibre made by drawing molten glass through bushings.

**GLASS RESIN RATIO** – The amount of glass by weight compared to the amount of resin by weight in a laminate.

**GLASS RICH** – An area of moulded part that has an overabundance of glass reinforcement. The reinforcement may appear dry and un-wet within the resin.

**GLASS TRANSITION TEMPERATURE** – The temperature above which a hard/glassy polymer becomes rubbery due to increased molecular mobility with heat.

**GRAPHITE FIBRES** – Fibres containing greater than 95% carbon. The term graphite fibrosis often used interchangeably with carbon fibres. Carbon fibres contain  $\leq 95\%$  carbon.

**GREEN** – A description of a low state of cure also called green strength, the earliest time that a laminate, or part, can be handled.

**GFRP** – Glass Fibre Reinforced Plastics.

**GRP** – Glass Reinforced Plastic.

**HAND LAY-UP** – A composites fabrication method in which reinforcement layers are placed in the mould by hand, saturated with resin, consolidated then cured.

**HARDENER** – It is the substance that reacts with resin to enable curing, also called Part B.

**HEAT DISTORTION TEMPERATURE (HDT)** – It is the temperature at which a test bar deflects a certain amount under specified temperature and load.

**HONEYCOMB** – A low density sheet material formed into hexagonal shaped cells nested together. Used as a core material in composites.

**HOOP** – Ply laid onto a mandrel at a 90° angle.

**HOOP STRESS** – It is the circumferential stress in a cylindrical part.

**HUMIDITY** – Moisture content of air.

**HYBRID COMPOSITE** – A composite made with two or more types of reinforcing fibres.

## I – Q



**IMPACT STRENGTH** – Material's ability to withstand shock impact loading as measured by fracturing a sample

**IMPREGNATE** – To saturate the voids and interstices of a reinforcement with resin.

**INCLUSION** – Foreign matter that is either encapsulated or embedded in the laminate.

**INHIBITOR** – Chemical that is added to the resin to slow curing. This allows a longer shelf life of uncatalysed resin and can be used to slow gel and cure time during fabrication.

**INITIATOR** – Chemical which initiates or speeds up the chemical curing reaction of resin and is consumed in the process.

**INTERFACE** – Surface between two materials. In glass fibres, the area at which the glass and sizing meet. In a laminate the area at which the reinforcement and resin meet.

**INTERLAMINAR** – Between two or more adjacent laminae.

**INTERLAMINAR SHEAR** – Shearing force that produces displacement between two laminae along the plane of their interface.

**ISO** – It is the abbreviation of isophthalic type resins and gelcoats.

**ISOPHTHALIC** – A polyester resin based on isophthalic acid.

**ISOTROPIC** – Fibre directionality with the same properties in all directions. An arrangement of reinforcing materials in a random manner, resulting in equal strength in all directions.

## JACKSTRAWING

1. Prominence or white appearance of glass strands in the laminate. Formed by the glass separating from the resin due to excessive exothermic heat, usually associated with thick, resin rich laminates.

2. Can also be the binder on the glass becoming insoluble in the resin as gel takes place. Quite common in vinyl ester, and some types of polyester laminates where it is a cosmetic effect and does not affect composite strength

**KEVLAR** – Trademark of DuPont for strong, lightweight aramid fibre, used as a reinforcing fibre in composites.

**KNITTED FABRIC** – A textile material made by inter-looping yarns.

**LAMINATE** – The structure produced by bonding multiple plies of reinforcing fibre or fabric with resin.

**LAMINATE PLY** – One layer of reinforcement and resin in a laminate

**LAP JOINT** – A joint made by placing one material over the other so that the joint consists of two layers of material.

**LAY UP** – The process of placing reinforcement into the mould and applying resin. Also used to describe the finished laminate itself.

**LOFT** – The height of the glass layer either dry or wet (with resin before consolidation).

**LOW PROFILE** – Resins formulated for low or zero shrinkage during moulding.

**MANDREL** – Mould, usually cylindrical, around which resin-impregnated fibre or tape is to produce a composite part.

**MAT** – A form of reinforcement composed of chopped filaments (for chopped-strand mat) or swirled filaments (for continuous-strand mat) with a binder applied or stitching to maintain form.

**MATCHED METAL MOULDING** – A composite fabrication method which uses matching male and a female metal moulds mounted in a hydraulic press. Matched die moulding is the same process using non-metal moulds.

**MATRIX** – Binder in which the reinforcing fibre of a composite is embedded. The general “Composites” terms usually assumes the matrix is a thermosetting resin.

**MEKP** – Methyl Ethyl Ketone Peroxide. A chemical which acts as an initiator (catalyst) in composite processing.

**MEK SOLVENT** – Methyl Ethyl Ketone. A colourless, flammable liquid which acts as solvent and is used in cleaning.

**MIL** – Unit of measure. 1 mil = 0.001 inch

**MILLED FIBRE** – Very short glass or carbon fibres formed by hammer milling.

**MODULUS** – Measurement of stiffness of a material. Ratio of applied load (stress) to the resultant deformation of a material (strain). High modulus indicates a stiff material.

**MONOMER** – A single molecule that can react with itself or other molecules to form a polymer

**MOULD** – The tool into/onto which resin and reinforcement is placed to form a composite part.

**MOULD RELEASE AGENT** – Substance or chemical use to coat the mould to provide easy release of the part.

**MOULDING** – The forming of composite parts over a mould. A term sometimes used to refer to the finished part.

**MSDS** – Material Safety Data Sheet. A sheet which must be provided by suppliers, providing information on identification, health hazard, precautions for use, safe handling and other information on the chemical.

**MULTIFILAMENT** – A yarn consisting of many continuous filaments.

**NONWOVEN ROVING** – A reinforcement composed of continuous fibre strands loosely gathered together.

**NPG** – Neopentyl Glycol. A component in the manufacture of some types of polyester resin.

**ONE PART RESIN SYSTEM** – A resin system (often used in resin transfer moulding) in which the neat resin and initiator (catalyst) are mixed together by the supplier. These systems generally require heat, or UV, to cure.

**ORANGE PEEL** – Backside of the gel coated surface that has the rough wavy texture of an orange peel often from spray pattern.

**ORTHO** – Abbreviation for orthophthalic type resins and gelcoats.

**ORTHOPHTHALIC** – A polyester resin based on orthophthalic acid or anhydride.

**OUTGASSING** – Release of solvents, dissolved air and moisture from composite parts under a vacuum.

**OUT-TIME** – Period of time in which a prepreg retains acceptable handling and other properties outside a specified storage environment (e.g. freezer).

**PAN** – Polyacrylonitrile. Base material in the manufacture of some carbon fibres.

**PATTERN** – The original model for making fibreglass moulds.

**PEEL PLY** – A layer of fabric that is applied to a laminate surface to give a clean, resin rich surface ready for bonding. The fabric is removed from the cured laminate so as to not form part of the final composite.

**PEEL STRENGTH** – Strength of an adhesive bond obtained by stress applied in a peeling mode.

**PHENOLIC RESIN** – Thermosetting resin produced by condensation polymerisation of an aromatic alcohol (phenol) with an aldehyde (formaldehyde). These are usually specified for their fire retardant properties.

**PINHOLES** – Small air bubbles or holes in the gel coat. Generally larger in size than porosity.

**PITCH** – A residual petroleum product used in the manufacture of some carbon fibres.

**PLUG** – The pattern or tool used to build moulds for the manufacture of composites. Also called master.

**PLY** – One of the layers that makes up a laminate. Also the number of single yarns twisted together to form a plied yarn.

**PLY SCHEDULE** – A description of the arrangement of individual plies in a laminate.

**POLYESTER** – A polymer containing the ester group. In composites unsaturated polyester resins are used. These are made by the reaction between dihydroxy alcohols and dibasic acids, one of which is unsaturated to permit crosslinking. A monomer such as styrene is then added.

**POLYMER** – A large molecule formed by combining many smaller molecules called monomers, in a regular pattern.

**POLYMERIZATION** – The chemical reaction that links monomers together to form polymers.

**POROSITY** – Small air bubbles or holes in the gel coat film. Smaller than pinholes.

**POST CURE** – Exposure of the cured resin to higher temperatures than used during curing. This additional processing step, often performed in an oven, gives a composite a more complete cure and higher mechanical properties.

**POT LIFE** – Length of time before a catalysed resin has gelled to an unworkable state. Same as gel time.



**PREFORM** – A pre-shaped fibrous reinforcement.

**PREMIX** – A mix of reinforcement, resin and usually pigment, filler and catalyst.

**PRE-RELEASE** – Premature release of the gelcoat or laminate from the mould.

**PRINT THROUGH** – Appearance of the image/form of the reinforcement through the gelcoat.

**PRIMER** – A coating applied as the first coat to a surface, which improves the adhesion performance or load-carrying ability of the bond.

**PROMOTER** – A chemical which, when mixed with a catalysed resin, reacts with the catalyst initiating the cross linking of the resin. Promoters can speed up or slow this chemical reaction. Also called an activator or promoter.

**PREPREG** – Reinforcement impregnated with resin in flat form that can be stored for later use. The resin is often partially cured to B stage.

**PROFILE RETENTION** – A measure of the ability of composite sheeting (usually corrugated) to retain its shape after being subjected to elevated temperatures.

**PULTRUSION** – An automated, continuous process for fabricating composite shapes of constant cross section. Roving and other reinforcements are saturated with resin and continuously pulled through a heated die, where the part is formed then cured and cut to length.

**QUASI-ISOTROPIC** – Approximating isotropy by orienting plies in several directions.

## R – Z



**RAMPING** – Gradual increase/decrease in temperature or pressure to control cure or cooling of composite parts

**REINFORCEMENT** – Material combined with resin to provide improved properties such as strength and stiffness. Forms include short fibres, continuous fibres and fabrics.

**RELEASE AGENT** – Chemical used to prevent laminate from sticking to the tool.

**RELEASE FILM** – An impermeable film layer that does not bond to the composite during cure.

**RESIN** – Polymer, the matrix component in a composite which binds the reinforcement together and protects the part from the environment.

**RESIN CONTENT** – The amount of resin in a laminate expressed as either a percentage of total weight or volume

**RESIN RICH** – Area with excess resin relative to reinforcement.

**RESIN STARVED** – An area lacking sufficient resin for fibre wet-out. The area can be identified by low gloss, dry spots or fibre show.

**RESIN TRANSFER MOULDING (RTM)** – A composite fabrication process where catalysed resin is injected into a two sided, matched mould in which fibrous reinforcement has been placed. Heat may be used.

**RESIN TEARING** – A gelcoat surface defect produced by a separation of gelcoat solids leaving resin filled voids. Usually seen as black wavy lines.

**ROLL OUT** – A process used in hand lay-up and spray-up where the resin and reinforcement are consolidated to a uniform height with a roller.

**ROVING** – A collection of continuous filaments in a parallel bundle with little or no twist.

**RUNS** – Draining of the gel coat or laminating resin.

**SAGS** – Slumping of the gel coat or laminating resin.

**SANDWICH CONSTRUCTION** – A laminate composed of a core with a relatively thin skin of reinforcement and resin adhered to either side.

**SECONDARY BONDING** – The joining together, by the process of adhesive bonding, of two or more already cured composite parts.

**S-GLASS** – "Structural Glass". Magnesia-alumina-silicate glass reinforcement which has very high tensile strength.

**SHEAR** – An applied stress which tends to cause two adjacent parts of a body to slide relative to each other in a direction parallel to their plane of contact. In interlaminar shear the plane of contact is composed of resin only.

**SHEAR STRENGTH** – The maximum shear stress that a material can sustain

**SHEET MOULDING COMPOUND (SMC)** – A ready to mould mix of glass fibre reinforcement and resin primarily used in compression moulding.

**SHELF LIFE** – The length of time an un-catalysed resin or other chemical remains workable while stored under specified conditions in a tightly sealed container.

**SHRINKAGE** – Reduction in volume which occurs upon the curing of liquid resin to a solid product.

**SINK MARK** – A shallow depression on the surface of an injection moulded part due to collapsing of the surface following local internal shrinkage

**SIZING** – A proprietary soluble solution of chemical additives used to coat filaments used for reinforcement purposes. Acts as a binder which protects the fine, brittle filaments during processing. Imparts characteristics such as abrasion resistance, static reduction, dispersion, conformability, wet-out rate etc. to the final reinforcement. Components of the sizing determine the compatibility of the reinforcement with the laminate matrix, and contribute significantly to an effective reinforcement: laminate interface.

**SKIN** – A layer of relatively dense material used on top of the core in a sandwich structure.

**SKIN COAT** – The first layer of laminate next to the gelcoat. Generally a thin laminate layer to minimise exotherm, and utilising fine, lightweight reinforcement to avoid fibre show/print through on the laminate surface.

**SOLVENT** – A substance in which another material will dissolve. e.g. acetone is a solvent for polyester resin

**SPECIFIC GRAVITY** – Density (mass per unit volume) of a material divided by that of water at a standard temperature.

**SPLICE** – The joining together of two ends of yarn by intertwining them.

**SPLIT MOULD** – A mould in which the cavity is formed of two or more components held together by an outer case.

**SPRAY PATTERN** – The width and uniformity of the fan of resin and glass when it leaves the gun in the spray-up process.

**SPRAY-UP** – A composite fabrication process in which chopped glass fibres, resin and catalyst are simultaneously deposited in a mould by the use of a spray gun.

**SPRING-BACK** – Reinforcement filaments straightening over convex curves in the laminate.

**STORAGE LIFE** – The length of time a material can be stored and retain specific properties.

**STRAND** – A bundle of continuous filaments combined in a single compact unit without twist.

**STRAIN** – The change in dimension per unit length of a member when it is subject to a stress.

**STRESS** – Internal resistance to change in size or shape, expressed in force per unit area.

**STRESS CONCENTRATION** – The magnification of applied load in the region of a notch, void, hole or inclusion

**STRESS CORROSION** – Preferential attack of areas under stress in a corrosive environment, where such an environment alone would not have caused corrosion.

**STRESS CRACK** – External and/or internal cracks in a composite caused by tensile stresses.

**STRUCTURAL ADHESIVE** – An adhesive used to transfer loads between two or more adherents.

**STYRENE MONOMER** – A type of liquid monomer used to thin polyester resins and act as the crosslinking agent.

**SURFACE VEIL/TISSUE** – A thin lightweight reinforcing mat made of fibres. This is used to give a resin rich surface layer for laminates, assisting in resistance to corrosive liquid or fumes. It is also used to block out the fibre pattern of the underlying reinforcement, providing an improved surface finish

**TACKY** – Sticky.

**TENSILE STRENGTH** – Maximum stress sustained by a composite specimen before it fails in a tension test.

**TEX** – A unit of linear density. Mass in grams per 1000 metres of yarn, fibre or other strand. Also known as Bundle Tex or Strand Tex.

**THERMAL CONDUCTIVITY** – Ability to transfer heat.

**THERMOPLASTIC** – A polymer based material that will repeatedly soften when heated and harden when cooled.

**THERMOSET** – A polymer based material that will undergo or has undergone a chemical cross linking reaction by the action of heat, catalyst, ultraviolet light etc, leading to a solid state which cannot be reversed.

**THIXOTROPIC** – Materials which are gel-like at rest but flow easily when agitated. These materials have a high static shear strength and a low dynamic shear strength.

**THIXOTROPIC INDEX** – A measurement of thixotropic nature using a Brookfield viscometer, calculated as the low speed viscosity divided by the high speed viscosity.

**TISSUE** – An ultra-thin non-woven mat of reinforcing fibres. The tissue supports a resin rich layer in a laminate. It is also called veil.

**TOOL** – The mould, either open or closed, in or upon which composite materials re-formed.

**TOW** – An untwisted bundle of continuous filaments. Tow is usually written in the form of a number followed by K e.g. 16K, where K indicates multiplication by 1000 (16K tow has 16,000 filaments).

**TRACER** – A fibre, tow or yarn, usually a contrasting colour added to a fabric to verify fibre alignment.

**TRIBE** – Wrinkling of gelcoat caused by styrene attack of under-cured gelcoat when the backing resin is applied

**UNDERCUT** – Negative or reverse draft on the mould. Split moulds are necessary to shape parts that are undercut.

**UNIDIRECTIONAL (UD)** – Fabric, tape or laminate where the fibres are all oriented in the same direction (straight, parallel and continuous).

**VACUUM ASSISTED RESIN TRANSFER MOULDING (VARTM)** – A composite fabrication process using infusion. A vacuum draws resin into a one-sided (open) mould which has a rigid or flexible cover placed over the top to form a vacuum tight seal.

**VACUUM BAG MOULDING** – A composite fabrication process where the reinforcement and resin are applied by hand lay-up or spray-up and then a flexible bag is sealed over the part and a vacuum drawn whilst the part cures.

**VEIL** – An ultra-thin non-woven mat of reinforcing fibres. The veil supports a resin rich layer in a laminate. Also called tissue.

**VINYL ESTER RESIN** – A type of thermosetting resin that is usually derived from an epoxide, glycol and unsaturated acid, with styrene monomer added.

**VISCOSITY** – The tendency of a fluid to resist flow.

**VOID** – A pocket of entrapped gas that has been cured into a laminate.

**VOLATILE ORGANIC COMPOUNDS (VOCs)** – Carbon containing chemical compounds (e.g., solvents and styrene) that evaporate readily at ambient temperatures. Regulations often limit exposure to VOCs so that low VOC content is preferable.

**WARP** – The yarns running lengthwise in a woven fabric.

**WARPAGE** – Dimensional distortion in a composite part.

**WEAVE** – Pattern by which a fabric is formed from interlacing yarns.

**WEFT** – Yarns running perpendicular to the warp in a woven fabric. The yarns which run across the fabric from one edge to the other.

**WETTING AGENT** – A surface-active chemical that promotes wetting by decreasing the cohesion within a liquid

**WET-OUT** – Saturation of strands and filaments and all voids between these with resin.

**WET-OUT RATE** – The speed with which the reinforcement can be completely saturated with resin.

**WET-THROUGH** – The impregnation of resin through the reinforcement matrix

**WET WINDING** – Filament winding where fibre strands are impregnated with resin immediately before they contact the mandrel.

**WINDING PATTERN** – In filament winding, the regularly recurring pattern of the filament path after a certain number of mandrel revolutions

**WORKING LIFE** – The period of time between addition of catalyst or hardener to a resin and gelation. Also called gel-time.

**WOVEN ROVING** – Heavy, coarse fabric produced by weaving continuous rovings.

**WRINKLE** – Imperfection in the surface of a laminate that looks like a crease.

**X-AXIS** – The axis in the plane of the laminate used as a 0° reference.

**YARN** – An assembly of twisted fibres or strands which forms a continuous length.

**Y-AXIS** – The plane of the laminate perpendicular to the X axis.

**YOUNG'S MODULUS** – Ratio of normal stress to the corresponding strain for tensile or compressive stresses less than the proportional limit of the material.

**Z-Axis** – The axis perpendicular to the laminate plane.

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