



## A Glossary of Terms in Composites

**ADDITIVE** - Any substance added to another substance, usually to improve properties, such as plasticizers, initiators, light stabilizers, and flame retardants. See also filler.

**ADHEREND** - A body that is held to another body, usually by an adhesive. A detail or part prepared for bonding.

**ADHESION** - The state in which two surfaces are held together at an interface by mechanical or chemical forces or interlocking action or both.

**ADHESION PROMOTER** - A coating applied to a substrate before it is coated with an adhesive, to improve the adhesion of the plastic. Also called primer.

**ADHESIVE** - A substance capable of holding two materials together by surface attachment. Adhesive can be in film, liquid, or paste form.

**ADHESIVE FAILURE** - Rupture of an adhesive bond such that the separation appears to be at the adhesive-adherend interface.

**ADHESIVE FILM** - A synthetic resin adhesive, with or without a film carrier fabric, usually of the thermosetting type, in the form of a thin film of resin, used under heat and pressure as an interleaf in the production of bonded structures.

**ADHESIVE JOINT** - The location at which two adherends or substrates are held together with a layer of adhesive. The general area of contact for a bonded structure.

**ADHESIVE STRENGTH** - Strength of the bond between an adhesive and an adherend.

**AIR-BUBBLE VOID** - Air entrapment within and between the plies of reinforcement or within a bondline or encapsulated area; localized, noninterconnected, spherical in shape.

**AREAL WEIGHT** - The weight of fiber per unit area (width x length) of tape or fabric.

**ASSEMBLY TIME** - The time interval between the spreading of the adhesive on the adherend and the application of pressure and/or heat to the assembly.

**ARAMID** - Aromatic polyamide fibers characterized by excellent high-temperature, flame-resistance, and electrical properties.

**A-STAGE** - An early stage in the reaction of a thermosetting resin in which the material is still soluble and fusible.

**AUTOCLAVE** - A closed vessel for producing an environment of fluid pressure, with or without heat, to an enclosed object while undergoing a chemical reaction or other operation.

**BAGGING** - Applying an impermeable layer of film over an uncured part and sealing the edges so that a vacuum can be drawn.

**BAG MOLDING** - A process in which the consolidation of the material in the mold is effected by the application of fluid or gas pressure through a flexible membrane.

**BAG SIDE** - The side of the part that is cured against the vacuum bag.

**BALANCED CONSTRUCTION** - Equal parts of warp and fill in fiber fabric. Construction in which reactions to tension and compression loads result in extension or compression deformations only and in which flexural loads produce pure bending of equal magnitude in axial and lateral directions.

**BALANCED LAMINATE** - A composite laminate in which all laminate at angles other than 0° and 90° occur only in + pairs (not necessarily adjacent) and are symmetrical around the centerline.

**BARCOL HARDNESS** - A hardness value obtained by measuring the resistance to penetration of a sharp steel point under a spring load. The instrument, called the Barcol impressor, gives a direct reading on a 0 to 100 scale. The hardness value is often used as a measure of the degree of cure of a plastic.

**BATCH** - In general, a quantity of material formed during the same process or in one continuous process and having identical characteristics throughout. Also called a lot.

**BIAS FABRIC** - A fabric in which warp and fill fibers are at an angle to the length.

**BINDER** - The resin or cementing constituent (of a plastic compound) that holds the other components together. The agent applied to fiber mat or preforms to bond the fibers before laminating or molding.

**BLADDER** - An elastomeric lining for the containment of hydroproof or hydroburst pressurization medium in filament-wound structures.

**BLEEDER CLOTH** - A nonstructural layer of material used in the manufacture of composite parts to allow the escape of excess gas and resin during cure. The bleeder cloth is removed after the curing process is complete and is not part of the final composite.

**BLEEDOUT** - The excess liquid resin appearing at the surface primarily occurring during filament winding.

**BOND STRENGTH** - The amount of adhesion between bonded surfaces. The stress required to separate a layer of material from the base to which it is bonded, as measured by load/bond area. See also peel strength.

**BREATHER** - A loosely woven material, such as glass fabric, which serves as a continuous vacuum path over a part but does not come in contact with the resin. The breather is removed after the curing process is complete and is not part of the final composite.

**BRIDGING** - Condition in which fibers do not move into or conform to radii and corners during molding, resulting in voids and dimensional control problems.

**BROAD GOODS** - Fiber woven to form fabric up to 1270 mm (50 in.) wide. It may or may not be impregnated with resin and is usually furnished in rolls of 25 to 140 kg. (50 to 300 lb).

**B-STAGE** - An intermediate stage in the reaction of a thermosetting resin in which the material melts when heated and dissolves in certain solvents. Materials are usually precured to this stage to facilitate handling and processing prior to final cure.

**BULK FACTOR** - The ratio of the volume of a raw molding compound or powdered plastic to the volume of the finished solid piece produced therefrom. The ratio of the density of the solid plastic object to the apparent or bulk density of the loose molding powder.

**BULK MOLDING COMPOUND (BMC)** - Thermosetting resin mixed with strand reinforcement, fillers, and so on, into a viscous compound for compression or injection molding. See also sheet molding compound.

**CARBON FIBERS** - Fibers produced from pyrolytic degradation of synthetic organic fibers, polyacrylonitrile (PAN) or rayon, which contain about 92-99% carbon content and typically have modulus values up to  $75 \times 10^6$  psi.

**CATALYST** - A substance that changes the rate of a chemical reaction without itself undergoing permanent change in composition or becoming a part of the molecular structure of the product. A substance that markedly speeds up the cure of a compound when added in minor quantity as compared to the amounts of primary reactants.

**CAUL PLATES** - Smooth metal, plastic, or rubber plates free of surface defects. A caul plate must be the appropriate size and shape for the composite lay-up with which it will be used. It is used in immediate contact with the lay-up during the curing process to transmit normal pressure and provide a smooth surface on the finished part.

**CAVITY** - The space inside a mold in which a resin or molding compound is poured or injected. The female portion of a mold. That portion of the mold that encloses the molded article (often referred to as the die). Depending on the number of such depressions, molds are designated as single cavity or multiple cavity.

**CELL** - In honeycomb core, a cell is a single honeycomb unit, usually in a hexagonal shape.

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

**COEFFICIENT OF THERMAL EXPANSION** - The fractional change in length of a material for each unit change in temperature.

**COHESION** - The propensity of a single substance to adhere to itself. The internal attraction of molecular particles toward each other. The ability to resist partition of itself. The force holding a single substance together.

**COHESIVE FAILURE** - Failure of an adhesive joint occurring primarily in an adhesive layer.

**COIN TAP TEST** - Using a coin to tap a laminate in different spots, listening for a change in sound, which would indicate the presence of a defect. A surprisingly accurate test in the hands of experienced personnel.

**COMPACTION** - The application of a temporary vacuum bag and vacuum to remove trapped air and compact the lay-up.

**COMPOSITE** - A material created from a fiber (or reinforcement) and an appropriate matrix material in order to maximize specific performance properties. The constituents do not dissolve or merge completely but retain their identities as they act in concert.

**COMPRESSION MOLDING** - A technique for molding thermoset plastics in which a part is shaped by placing the fiber and resin into an open mold cavity, closing the mold, and applying heat and pressure until the material has cured or achieved its final form.

**COMPRESSIVE MODULUS** - Ratio of compressive stress to compressive strain below the proportional limit. Theoretically equal to Young's modulus determined from tensile experiments.

**COMPRESSIVE STRENGTH** - A material's ability to resist a force that tends to crush or buckle; maximum compressive load a specimen sustains divided by the specimen's original cross sectional area.

**CONDITIONING** - Subjecting a material to a prescribed environmental and/or stress history before testing.

**CONTACT MOLDING** - A molding technique in which reinforcement and resin are placed in a mold, with cure taking place at room temperature with a catalyst/promoter system or in a heated oven. No additional pressure is used.

**CORE** - The central component of a sandwich construction to which the sandwich faces or skins are attached; also, part of a complex mold that forms undercut parts.

**CORE CRUSH** - A collapse, distortion, or compression of the core.

**COUNT** - For fabric, number of warp and filling yarns per inch in woven cloth. For yarn, size based on relation of length and weight.

**COUPON** - Usually, a specimen for a specific test, as a tensile coupon.

**CREEP** - The dimensional change in a material under physical load over time beyond instantaneous elastic deformation.

**CROSS LAMINATED** - Material laminated so that some of the layers are oriented at various angles to the other with respect to the laminate grain. A cross-ply laminate usually has plies oriented only at 0/90 degrees.

**CROSS-LINKING** - Applied to polymer molecules, the setting-up of chemical links between the molecular chains. When extensive, as in most thermosetting resins, cross-linking makes one infusible supermolecule of all the chains.

**C-STAGE** - The final stage of the curing of a thermosetting resin in which the material has become infusible and insoluble in common solvents.

**CURE** - To change the properties of a thermosetting resin irreversibly by chemical reaction, i.e., condensation, ring closure, or addition. Cure may be accomplished by addition of curing (cross-linking) agents, with or without catalyst, and with or without heat.

**CURE CYCLE** - The time/temperature/pressure cycle used to cure a thermosetting resin system of prepreg.

**CURE STRESS** - A residual internal stress produced during the curing cycle of composite structures. Normally, these stresses originate when different components of a wet lay-up have different thermal coefficients of expansion.

**CURING AGENT** - A catalytic or reactive agent that brings about polymerization when it is added to a resin.

**DEBOND** - A deliberate separation of a bonded joint or interface, usually for repair or rework purposes. Also, an unbonded or nonadhered region; a separation at the fiber-matrix interface due to strain incompatibility. In the United Kingdom, the term often refers to accidental damage. See also delamination.

**DEBULKING** - Compacting of a thick laminate under moderate heat and pressure and/or vacuum to remove most of the air, to ensure seating on the tool, and to prevent wrinkles.

**DELAMINATION** - The separation of a laminated plastic material along the plane of its layers.

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

**DRAFT ANGLE** - The angle of a taper on a mandrel or mold that facilitates removal of the finished part.

**DRAPE** - The ability of a fabric or prepreg to conform to a contoured surface.

**DRY LAMINATE** - A laminate containing insufficient resin for complete bonding of the reinforcement. See also resin starved.

**DRY LAY-UP** - Construction of a laminate by the layering of preimpregnated reinforcement (partly cured resin) in a female mold or on a male mold, usually followed by bag molding or autoclave molding.

**E-GLASS** - "Electrical glass"; the borosilicate glass most often used for the glass fibers in conventional reinforced plastics.

**ELASTICITY** - That property of materials by virtue of which they tend to recover their original size and shape after removal of a force causing deformation.

**ELONGATION** - Deformation caused by stretching. The fractional increase in length of a material stressed in tension. (When expressed as percentage of the original gage length, it is called percentage elongation.)

**END** - A strand of roving consisting of a given number of filaments gathered together. The group of filaments is considered an "end" or strand before twisting, a "yarn" after twist has been applied. An individual warp yarn, thread, fiber, or roving.

**EPOXY PLASTIC** - A polymerizable thermoset polymer containing one or more epoxide groups and curable by reaction with amines, alcohols, phenols, carboxylic acids, acid anhydrides, and mercaptans. An important matrix resin in composites and structural adhesive.

**EXOTHERM** - The liberation or evolution of heat during the curing of a plastic product.

**FATIGUE** - The failure or decay of mechanical properties after repeated applications of stress. Fatigue tests give information on the ability of a material to resist the development of cracks, which eventually bring about failure as a result of a large number of cycles.

**FATIGUE STRENGTH** - The maximum cyclical stress a material can withstand for a given number of cycles before failure occurs. The residual strength after being subjected to fatigue.

**FAYING SURFACE** - The surfaces of materials in contact with each other and joined or about to be joined together.

**FIBER CONTENT** - The amount of fiber present in a composite. This is usually expressed as a percentage volume fraction or weight fraction of the composite.

**FIBER COUNT** - The number of fibers per unit width of ply present in a specified section of a composite.

**FIBER DIRECTION** - The orientation or alignment of the longitudinal axis of the fiber with respect to a stated reference axis.

**FIBER ORIENTATION** - The fiber alignment in a nonwoven or a mat laminate in which most of the fibers are in the same direction, thereby affording higher strength in that direction.

**FIBER-REINFORCED PLASTIC (FRP)** - A general term for a composite that is reinforced with cloth, mat, strands, or any other fiber form.

**FILAMENT** - The smallest unit of a fibrous material. The basic units formed during drawing and spinning, which are gathered into strands of fiber for use in composites. Filaments usually are of extreme length and very small diameter, usually less than 25  $\mu\text{m}$  (1 mil). Normally filaments are not used individually. Some textile filaments can function as yarn when they are of sufficient strength and flexibility.

**FILAMENT WINDING** - A process for fabricating a composite structure in which continuous reinforcements (filament, wire, yarn, tape, or other), either previously impregnated with a matrix material or impregnated during the winding, are placed over a rotating and removable form or mandrel in a prescribed way to meet certain stress conditions. Generally the shape is a surface of revolution and may or may not include end closures. When the required number of layers is applied, the wound form is cured and the mandrel removed.

**FILL** - Yarn oriented at right angles to the warp in a woven fabric.

**FILLER** - A relatively inert substance added to a material to alter its physical, mechanical, thermal, electrical, and other properties or to lower cost or density. Sometimes the term is used specifically to mean particulate additives.

**FILM ADHESIVE** - An adhesive in the form of a thin, dry, resin film with or without a carrier, commonly used for adhesion between layers of laminates.

**FINISH** - Material applied to fibers, after sizing is removed, to improve matrix-to-fiber coupling.

**FLASH** - Excess material which forms at the parting line of a mold or die, or which is extruded from a closed mold.

**FLEXURAL MODULUS** - The ratio, within the elastic limit, of the applied stress on a test specimen in flexure to the corresponding strain in the outermost fibers of the specimen.

**FLEXURAL STRENGTH** - The maximum stress that can be borne by the surface fibers in a beam in bending. The flexural strength is the unit resistance to the maximum load before failure by bending, usually expressed in force per unit area.

**FRACTURE** - A rupture of the surface of a laminate because of external or internal forces, with or without complete separation.

**GEL** - The initial jellylike solid phase that develops during the formation of a resin from a liquid. A semisolid system consisting of a network of solid aggregates in which liquid is held.

**GEL COAT** - A quick setting resin applied to the surface of a mold and gelled before lay-up. The gel coat becomes an integral part of the finished laminate, and is usually used to improve surface appearance and bonding.

**GEL TIME** - The time required for a liquid material to form a gel under specified conditions of temperature as measured by a specific test.

**GLASS CLOTH** - Conventionally woven glass fiber material; certain lightweight glass fabrics are also called scrim.

**GLASS TRANSITION TEMPERATURE ( $T_g$ )** - The approximate midpoint of the temperature range over which the glass transition takes place; glass and silica fiber exhibit a phase change at approximately 955  $^{\circ}\text{C}$  (1750  $^{\circ}\text{F}$ ) and carbon/graphite fibers at 2205 to 2760  $^{\circ}\text{C}$  (4000 to 5000  $^{\circ}\text{F}$ ). The temperature at which increased molecular mobility results in significant changes in the properties of a cured resin system. Also, the inflection point on a plot of modulus versus temperature. The measured value of  $T_g$  depends to some extent on the method of test.

**GRAPHITE FIBERS** - A group of carbon fibers which have a carbon content of about 99% and also have high modulus values. This term is used interchangeably with "carbon fibers" throughout the industry.

**HAND LAYUP** - A fabrication method in which reinforcement layers, preimpregnated or coated afterwards, are placed in a mold by hand, then cured to the formed shape.

**HARDENER** - A substance used to promote or control curing action by taking part in it; as opposed to catalyst.

**HARDNESS** - The resistance to surface indentation usually measured by the depth of penetration (or arbitrary units related to the depth of penetration) of a blunt point under a given load using a particular instrument according to a prescribed procedure.

**HEAT DISTORTION POINT** - The temperature at which a standard test bar deflects a specified amount under a stated load. Now called deflection temperature.

**HEAT RESISTANCE** - The property or ability of plastics and elastomers to resist the deteriorating effects of elevated temperatures.

**HEAT SINK** - A contrivance for the absorption or transfer of heat away from a critical element or part. Bulk graphite is often used as a heat sink.

**HONEYCOMB** - Resin-impregnated material manufactured in, usually, hexagonal cells that serves as a core material in sandwich constructions. Honeycomb may also be metallic or polymer materials in a rigid, open-cell structure.

**HYBRID** - A composite laminate comprised of laminae of two or more composite material systems, e.g., graphite and glass. It also applies to woven fabrics having more than one type of fiber.

**IMPACT STRENGTH** - A material's ability to withstand shock loading as measured by the work done in fracturing a specimen.

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

**INJECTION MOLDING** - Method of forming a plastic to the desired shape by forcing the heat softened plastic into a relatively cool cavity under pressure.

**INTERFACE** - The boundary or surface between two different, physically distinguishable media. On fibers, the contact area between fibers and sizing or finish. In a laminate, the contact area between the reinforcement and the laminating resin.

**INTERLAMINAR** - Existing or occurring between two or more adjacent laminae.

**INTERLAMINAR SHEAR** - A shearing force tending to produce a relative displacement between two laminae along the plane of their interface.

**ISOTROPIC** - Having uniform properties in all directions. The measured properties of an isotropic material are independent of the axis of testing.

**KEVLAR®** - Registered trademark of E.I. DuPont de Nemours, Inc. for a strong organic fibers similar to fiberglass but having a higher strength-to-weight ratio. When woven into cloth and impregnated with a thermosetting epoxy resin, it produces a material having high impact resistance and low radio frequency attenuation. Generic term: aramid.

**LAMINATE** - A product made by bonding together two or more layers of material or materials.

**LAMINATE ORIENTATION** - The configuration of a cross-plyed composite laminate with regard to the angles of cross-plying, the number of laminae at each angle, and the exact sequence of the lamina lay-up.

**LAY-UP** - The reinforcing material placed in position in the mold. The process of placing the reinforcing material in position in the mold. The resin-impregnated reinforcement. A description of the component materials, geometry, and so forth, of a laminate.

**LOT** - A specific amount of material produced at one time using the same process and the same conditions of manufacture, and offered for sale as a unit quantity.

**MANDREL** - The core tool around which resin-impregnated paper, fabric, or fiber is wound to form pipes, tubes, or structural shell shapes.

**MAT** - A fibrous reinforcing material comprised of chopped filaments (for chopped-strand mat) or swirled filaments (for continuous-strand mat) with a binder to maintain form; available in blankets of various widths, weights, and lengths.

**MATRIX** - A material in which the fiber of a composite is imbedded; it can be plastic, metal, ceramic, or glass.

**MIL** - The unit used in measuring the diameter of glass fiber strands, wire, and so forth (1 mil = 0.001 in.).

**MILLED FIBER** - Continuous glass strands hammer milled into very short glass fibers. Useful as inexpensive filler or anticrazing reinforcing fillers for adhesives.

**MODULUS** - A measure of the ratio of load (stress) applied to the resultant deformation of a material, such as elasticity or shear.

**MOISTURE CONTENT** - The amount of moisture in a material determined under prescribed conditions and expressed as a percentage of the mass of the moist specimen, that is, the mass of the dry substance plus the moisture present.

**MOLD** - The cavity or matrix into or on which the plastic composition is placed and from which it takes form. To shape plastic parts or finished articles by heat and pressure. The assembly of all the parts that function collectively in the molding process.

**MOLDING** - The forming of a polymer or composite into a solid mass of prescribed shape and size by the application of pressure and heat for given times. Sometimes used to denote the finished part.

**MOLDING PRESSURE** - The pressure applied to the ram of an injection machine or compression or transfer press to force the softened plastic to fill the mold cavities completely.

**MOLD-RELEASE AGENT** - A lubricant, liquid, or powder (often silicone oils and waxes), used to prevent sticking of molded articles in the cavity.

**MOLD SURFACE** - The side of a laminate that faced the mold (tool) during cure in an autoclave or hydroclave.

**NOMINAL VALUE** - A value assigned for the purpose of a convenient designation. A nominal value exists in name only. It is often an average number with a tolerance so as to fit together with adjacent parts.

**NONDESTRUCTIVE TESTING (NDT)** - Broadly considered synonymous with non-destructive inspection (NDI).

**ORANGE PEEL** - An uneven surface somewhat resembling that of an orange peel; said of injection moldings that have unintentionally ragged surfaces.

**OUT TIME** - The time a prepreg is exposed to ambient temperature, namely, the total amount of time the prepreg is out of the freezer. The primary effects of our time are to decrease the drape and tack of the prepreg while also allowing it to absorb moisture from the air.

**PARTING LINE** - A mark on a molded piece where the sections of a mold have met in closing.

**PEEL PLY** - Layer of material applied to a prepreg layup surface that is removed from the cured laminate prior to bonding operations and leaves a clean resin-rich surface ready for bonding.

**PEEL STRENGTH** - Adhesive bond strength, as in pounds per inch of width, obtained by a stress applied in a peeling mode.

**pH** - The measure of the acidity or alkalinity of a substance, neutrality being at pH 7. Acid solutions are less than 7, alkaline solutions are more than 7.

**PLAIN WEAVE** - A weaving pattern in which the warp and fill fibers alternate; that is, the repeat pattern is warp/fill/warp/fill, and so on. Both faces of a plain weave are identical. Properties are significantly reduced relative to a weaving pattern with fewer crossovers.

**PLATENS** - The mounting plates of a press, to which the entire mold assembly is bolted.

**PLY** - In general, fabrics or felts consisting of one or more layers (laminates, and so forth). The layers that make up a stack. Yarn resulting from twisting operations (three-ply yarn, and so forth). A single layer of prepreg. A single pass in filament winding (two plies forming one layer).

**POLYMER** - A very large molecule formed by combining a large number of smaller molecules, called monomers, in a regular pattern.

**POLYMERIZATION** - A chemical reaction in which the molecules of monomers are linked together to form polymers.

**POST CURE** - The exposure of certain resins to higher than normal curing temperatures after the initial cure cycle. This second stage is necessary to attain the complete cure and desired mechanical properties of the resins involved. The higher temperatures are used separately because they would result in an excessive reaction if applied throughout the entire cure.

**POT LIFE** - The length of time a catalyzed thermosetting resin system retains a viscosity low enough for it to be suitable for processing.

**PREFORM** - A preshaped fibrous reinforcement formed by distribution of chopped fibers or cloth by air, water flotation, or vacuum over the surface of a perforated screen to the approximate contour and thickness desired in the finished part. Also, a preshaped fibrous reinforcement of mat or cloth formed to the desired shape on a mandrel or mock-up before being placed in a mold press.

**PREPREG, PREIMPREGNATED** - A combination of mat, fabric, nonwoven material, or roving with resin, usually advanced to the B-stage, ready for curing.

**PRESSURE BAG MOLDING** - A process for molding reinforced plastics in which a tailored, flexible bag is placed over the contact lay-up on the mold, sealed, and clamped in place. Fluid pressure, usually provided by compressed air or water, is placed against the bag, and the part is cured.

**PRESSURE INTENSIFIER** - A layer of flexible material (usually a high-temperature rubber) used to ensure the application of sufficient pressure to a location, such as a radius, in a lay-up being cured.

**PRIMER** - A coating applied to a surface, before the application of an adhesive, lacquer, enamel, and so forth, to improve the adhesion performance or load-carrying ability of the bond.

**PROCESSING WINDOW** - The range of processing conditions, such as stock (melt) temperature, pressure, shear rate, and so on, within which a particular grade of plastic can be fabricated with optimum or acceptable properties by a particular fabricating process.

**PROTOTYPE** - A model suitable for use in complete evaluation of form, design, performance, and material processing.

**REINFORCEMENT** - A material added to the matrix to provide the required properties; ranges from short fibers through complex textile complex textile forms.

**RELEASE AGENTS** - Materials that are used to prevent cured matrix material from bonding to tooling.

**RELEASE FILM** - An impermeable layer of film that does not bond to the resin being cured. See also separator.

**RESIN** - A material, generally a polymer, that has an indefinite and often high molecular weight and a softening or melting range and exhibits a tendency to flow when it is subjected to stress. Resins are used as the matrices to bind together the reinforcement material in composites.

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

**RESIN-RICH** - Localized area filled with resin but lacking reinforcement fiber.

**RESIN-STARVED** - Localized area lacking sufficient resin for wetout of the fibers.

**RESIN-TRANSFER MOLDING (RTM)** - A molding process in which catalyzed resin is transferred into an enclosed mold into which the fiber reinforcement has been placed; cure normally is accomplished without external heat. RTM combines relatively low tooling and equipment costs with the ability to mold large structural parts.

**ROVING** - A number of yarns, strands, tows, or ends collected into a parallel bundle with little or no twist.

**RT** - Stands for ambient room temperature, usually between 70-77oF(21-25oC).

**SANDWICH CONSTRUCTION** - A composite composed of lightweight core material (usually honeycomb or foamed plastic) to which two relatively thin, dense, high strength, functional, or decorative skins (also called faces) are adhered.

**SCRIM** - A low-cost reinforcing fabric made from continuous filament yarn in an open-mesh construction. Used in the processing of tape or other B-stage material to facilitate handling. Also used as a carrier of adhesive, to be used in secondary bonding.

**SECONDARY BONDING** - The joining together, by the process of adhesive bonding, of two or more already cured composite parts, during which the only chemical or thermal reaction occurring is the curing of the adhesive itself.

**SEPARATOR** - A permeable layer that also acts as a release film. Porous Teflon-coated fiberglass is an example. Often placed between lay-up and bleeder to facilitate bleeder system removal from laminate after cure.

**SET UP** - To harden, as in curing of a polymer resin.

**S-GLASS** - Structural glass; a magnesia/alumina/silicate glass reinforcement designed to provide very high tensile strength.

**SHEAR STRENGTH** - The maximum shear stress that a material is capable of sustaining. Shear strength is calculated from the maximum load during a shear or torsion test and is based on the original cross-sectional area of the specimen.

**SHEET MOLDING COMPOUND (SMC)** - A composite of fibers, usually a polyester resin, and pigments, fillers, and other additives that have been compounded and processed into sheet form to facilitate handling in the molding operation

**SHelf LIFE** - The length of time a material, substance, product, or reagent can be stored under specified environmental conditions and continue to meet all applicable specification requirements and/or remain suitable for its intended function.

**SHORE HARDNESS** - A measure of the resistance of material to indentation by a spring-loaded indenter. The higher the number, the greater the resistance. Normally used for rubber materials.

**SHORT BEAM SHEAR (SBS)** - A flexural test of a specimen having a low test span-to-thickness ratio (for example, 4:1), such that failure is primarily in shear.

**SHRINKAGE** - The relative change in dimension from the length measured on the mold when it is cold to the length of the molded object 24 hrs after it has been taken out of the mold.

**SIZE** - Any treatment consisting of starch, gelatin, oil, wax, or other suitable ingredient applied to yarn or fibers at the time of formation to protect the surface and aid the process of handling and fabrication or to control the fiber characteristics. The treatment contains ingredients that provide surface lubricity and binding action but, unlike a finish, contains no coupling agent. Before final fabrication into a composite, the size is usually removed by heat cleaning, and a finish is applied.

**SIZING CONTENT** - The percent of the total strand weight made up by the sizing; usually determined by burning off or dissolving the organic sizing; known as loss on ignition.

**SKIN** - A layer of relatively dense material used in a sandwich construction of the surface of the core.

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

**SPRAY-UP** - Technique in which a spray gun is used as an applicator tool. In reinforced plastics, for example, fibrous glass and resin can be simultaneously deposited in a mold. In essence, roving is fed through a chopper and ejected into a resin stream that is directed at the mold by either of two spray systems. In foamed plastics, fast-reacting urethane foams or epoxy foams are fed in liquid streams to the gun and sprayed on the surface. On contact, the liquid starts to foam.

**STACKING SEQUENCE** - A description of a laminate that details the ply orientations and their sequence in the laminate.

**STANDARD DEVIATION** - A measure of dispersion of data from the average. The root means square of the individual deviation from the average.

**STIFFNESS** - A measure of modulus. The relationship of load and deformation. The ratio between the applied stress and resulting strain. A term often used when the relationship of stress to strain does not conform to the definition of Young's modulus.

**STOPS** - Metal pieces inserted between die halves. Used to control the thickness of a press-molded part. Not a recommended practice, because the resin will receive less pressure, which can result in voids.

**STORAGE LIFE** - The period of time during which a liquid resin, packaged adhesive, or prepreg can be stored under specified temperature conditions and remain suitable for use. Also called shelf life.

**STRAND** - Normally an untwisted bundle or assembly of continuous filaments used as a unit, including slivers, tows, ends, yarn, and so forth. Sometimes a single fiber or filament is called a strand.

**STRUCTURAL ADHESIVE** - Adhesive used for transferring required loads between adherends exposed to service environments typical for the structure involved.

**STRUCTURAL BOND** - A bond that joins basic load-bearing parts of an assembly. The load may be either static or dynamic.

**SURFACE PREPARATION** - Physical and/or chemical preparation of an adherend to make it suitable for adhesive bonding.

**TACK** - The stickiness of a prepreg.

**TEMPLATE** - A pattern used as a guide for cutting and laying plies.

**TENSILE STRENGTH** - The maximum load or force per unit cross-sectional area, within the gage length, of the specimen. The pulling stress required to break a given specimen.

**THERMAL CONDUCTIVITY** - The ability of a material to conduct heat.

**THERMOPLASTIC** - Capable of being repeatedly softened by an increase of temperature and hardened by an increase in temperature. Applicable to those materials whose change upon heating is substantially physical rather than chemical and that in the softened stage can be shaped by flow into articles by molding or extrusion.

**THERMOSET** - A plastic that, when cured by application of heat or chemical means, changes into a substantially infusible and insoluble material.

**THIXOTROPY** - The tendency of a material to cling to a vertical surface.

**THREAD COUNT** - The number of yarns (threads) per inch in either the lengthwise (warp) or crosswise (fill or weft) direction of woven fabrics.

**TOW** - An untwisted bundle of continuous filaments.

**TRACER** - A fiber, tow, or yarn added to a prepreg for verifying fiber alignment and, in the case of woven materials, for distinguishing warp fibers from fill fibers.

**ULTRASONIC TESTING** - A nondestructive test applied to materials for the purpose of locating internal flaws or structural discontinuities by the use of high-frequency reflection or attenuation (ultrasonic beam).

**UNBOUND** - An area within a bonded interface between two adherends in which the intended bonding action failed to take place, or where two layers of prepreg in a cured component do not adhere to each other. Also used to denote specific areas deliberately prevented from bonding in order to simulate a defective bond, such as in the generation of quality standards specimens.

**VACUUM BAG MOLDING** - A process in which a sheet of flexible transparent material plus bleeder cloth and release film are placed over the lay-up on the mold and sealed at the edges. A vacuum is applied between the sheet and the lay-up. The entrapped air is mechanically worked out of the lay-up and removed by the vacuum, and the part is cured with temperature, pressure, and time. Also called bag molding.

**VENT** - A small hole or shallow channel in a mold that allows air or gas to exit as the molding material enters.

**VISCOSITY** - The tendency of a material to resist flow.

**VOID CONTENT** - Volume percentage of voids, usually less than 1% in a properly cured composite. The experimental determination is indirect, that is, calculated from the measured density of a cured laminate and the "theoretical" density of the starting material.

**VOIDS** - Air or gas that has been trapped and cured into a laminate. Porosity is an aggregation of microvoids. Voids are essentially incapable of transmitting structural stresses or nonradiative energy fields.

**VOLATILES** - Materials, such as water and alcohol, in a sizing or a resin formulation, that are capable of being driven off as a vapor at room temperature or at a slightly elevated temperature.

**WARP** - The yarn running lengthwise in a woven fabric. A group of yarns in long lengths and approximately parallel. A change in dimension of a cured laminate from its original molded shape.

**WATER JET** - Water emitted from a nozzle under high pressure (70 to 410 MPa, or 10 to 60 ksi or higher). Useful for cutting organic composites.

**WEATHERING** - Exposure of plastics to the outdoor environment.

**WEAVE** - The particular manner in which a fabric is formed by interlacing yarns. Usually assigned a style number.

**WET LAY-UP** - A method of making a reinforced product by applying the resin system as a liquid when the reinforcement is put in place.

**WET-OUT** - The condition of an impregnated roving or yarn in which substantially all voids between the sized strands and filaments are filled with resin.

**WORKING LIFE** - The period of time during which a liquid resin or adhesive, after mixing with catalyst, solvent, or other compounding ingredients, remains usable.

**WRINKLE** - A surface imperfection in laminated plastics that has the appearance of a crease or fold in one or more outer sheets of the paper, fabric, or other base, which has been pressed in. Also occurs in vacuum bag molding when the bag is improperly placed, causing a crease.

**YARN** - An assemblage of twisted filaments, fibers, or strands, either natural or manufactured, to form a continuous length that is suitable for use in weaving or interweaving into textile materials.

**Y-AXIS** - In composite laminates, the axis in the plane of the laminate that is perpendicular to the x-axis. Contrast with x-axis.

**Z-AXIS** - In composite laminates, the reference axis normal to the plane of the laminate.

**ZERO BLEED** - A laminate fabrication procedure that does not allow loss of resin during cure. Also describes prepreg made with the amount of resin desired in the final part, such that no resin has to be removed during cure.