

## Glossary General Composites Inc.

The following definitions for commonly used terms pertaining to the composites industry have been compiled from the Composite Material Handbook (MIL-HDBK-17). A more specific glossary of terms related to composite testing and material property generation is also available.

**A-Basis (or A-Value)** -- A statistically-based material property; a 95% lower confidence bound on the first percentile of a specified population of measurements. Also a 95% lower tolerance bound for the upper 99% of a specified population.

**A-Stage** -- An early stage in the reaction of thermosetting resins in which the material is still soluble in certain liquids and may be liquid or capable of becoming liquid upon heating. (Sometimes referred to as resol.)

**Absorption** -- A process in which one material (the absorbent) takes in or absorbs another (the absorbate).

**Accelerator** -- A material which, when mixed with a catalyzed resin, will speed up the chemical reaction between the catalyst and the resin.

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

**Adhesive** -- A substance capable of holding two materials together by surface attachment. In the handbook, the term is used specifically to designate structural adhesives, those which produce attachments capable of transmitting significant structural loads.

**Aging** -- The effect, on materials, of exposure to an environment for a period of time; the process of exposing materials to an environment for an interval of time.

**Ambient** -- The surrounding environmental conditions such as pressure or temperature.

**Angleply** -- Same as Crossply.

**Anisotropic** -- Not isotropic; having mechanical and/or physical properties which vary with direction relative to natural reference axes inherent in the material.

**Aramid** -- A manufactured fiber in which the fiber-forming substance consisting of a long-chain synthetic aromatic polyamide in which at least 85% of the amide (-CONH-) linkages are attached directly to two aromatic rings.

**Areal Weight of Fiber** -- The weight of fiber per unit area of prepreg. This is often expressed as grams per square meter.

**Artificial Weathering** -- Exposure to laboratory conditions which may be cyclic, involving changes in temperature, relative humidity, radiant energy and any other elements found in the atmosphere in various geographical areas.

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

**Autoclave Molding** -- A process similar to the pressure bag technique. The lay-up is covered by a pressure bag, and the entire assembly is placed in an autoclave capable of providing heat and pressure for curing the part. The pressure bag is normally vented to the outside.

**B-Basis (or B-Value)** -- A statistically-based material property; a 95% lower confidence bound on the tenth percentile of a specified population of measurements. Also a 95% lower tolerance bound for the upper 90% of a specified population.

**B-Stage** -- An intermediate stage in the reaction of a thermosetting resin in which the material softens when heated and swells when in contact with certain liquids but does not entirely fuse or dissolve. Materials are usually precured to this stage to facilitate handling and processing prior to final cure. (Sometimes referred to as resitol.)

**Bag Molding** -- A method of molding or laminating which involves the application of fluid pressure to a flexible material which transmits the pressure to the material being molded or bonded. Fluid pressure usually is applied by means of air, steam, water or vacuum.

**Balanced Laminate** -- A composite laminate in which all laminae at angles other than 0 degrees and 90 degrees occur only in  $\pm$  pairs (not necessarily adjacent).

**Batch (or Lot)** -- For fibers and resins, a quantity of material formed during the same process and having identical characteristics throughout. For prepregs, laminae, and laminates, material made from one batch of fiber and one batch of resin.

**Bearing Area** -- The product of the pin diameter and the specimen thickness.

**Bearing Load** -- A compressive load on an interface.

**Bearing Yield Strength** -- The bearing stress at which a material exhibits a specified limiting deviation from the proportionality of bearing stress to bearing strain.

**Bend Test** -- A test of ductility by bending or folding, usually with steadily applied forces. In some instances the test may involve blows to a specimen having a cross section that is essentially uniform over a length several times as great as the largest dimension of the cross section.

**Binder** -- A bonding resin used to hold strands together in a mat or preform during manufacture of a molded object.

**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 and is not part of the final composite.

**Bond** -- The adhesion of one surface to another, with or without the use of an adhesive as a bonding agent.

**Braid** -- A system of three or more yarns which are interwoven in such a way that no two yarns are twisted around each other.

**Braid Angle** -- The acute angle measured from the axis of braiding.

**Braid, Two-Dimensional** -- Braided fabric with no braiding yarns in the through thickness direction.

**Braid, Three-Dimensional** -- Braided fabric with one or more braiding yarns in the through thickness direction.

**Braid, Triaxial** -- A biaxial braided fabric with laid in yarns running in the axis of braiding.

**Braiding** -- A textile process where two or more strands, yarns or tapes are intertwined in the bias direction to form an integrated structure.

**Broadgoods** -- A term loosely applied to prepreg material greater than about 12 inches in width, usually furnished by suppliers in continuous rolls. The term is currently used to designate both collimated uniaxial tape and woven fabric prepreps.

**Buckling (Composite)** -- A mode of structural response characterized by an out-of-plane material deflection due to compressive action on the structural element involved. In advanced composites, buckling may take the form not only of conventional general instability and local instability but also a micro-instability of individual fibers.

**Bundle** -- A general term for a collection of essentially parallel filaments or fibers.

**C-Stage** -- The final stage of the curing reaction of a thermosetting resin in which the material has become practically infusible and insoluble. (Normally considered fully cured and sometimes referred to as resite.)

**Carbon Fibers** -- Fibers produced by the pyrolysis of organic precursor fibers such as rayon, polyacrylonitrile (PAN), and pitch in an inert atmosphere. The term is often used interchangeably with "graphite"; however, carbon fibers and graphite fibers differ in the temperature at which the fibers are made and heat-treated, and the amount of carbon produced. Carbon fibers typically are carbonized at about 2400°F (1300°C) and assay at 93 to 95% carbon, while graphite fibers are graphitized at 3450 to 5450°F (1900 to 3000°C) and assay at more than 99% elemental carbon.

**Caul Plates** -- Smooth metal plates, free of surface defects, the same size and shape as a composite lay-up, used immediately in contact with the lay-up during the curing process to transmit normal pressure and to provide a smooth surface on the finished laminate.

**Chain-Growth Polymerization** -- One of the two principal polymerization mechanisms. In chain-growth polymerization, the reactive groups are continuously regenerated during the growth process. Once started, the polymer molecule grows rapidly by a chain of reactions emanating from a particular reactive initiator which may be a free radical, cation or anion.

**Chromatogram** -- A plot of detector response against peak volume of solution (eluate) emerging from the system for each of the constituents which have been separated.

**Cocuring** -- The act of curing a composite laminate and simultaneously bonding it to some other prepared surface during the same cure cycle (see Secondary Bonding).

**Coefficient of Linear Thermal Expansion** -- The change in length per unit length resulting from a one-degree rise in temperature.

**Coefficient of Variation** -- The ratio of the population (or sample) standard deviation to the population (or sample) mean.

**Collimated** -- Rendered parallel.

**Compatible** -- The ability of different resin systems to be processed in contact with each other without degradation of end product properties.

**Composite Class** -- A major subdivision of composite construction in which the class is defined by the fiber system and the matrix class, e.g., organic-matrix filamentary laminate.

**Composite Material** -- Composites are considered to be combinations of materials differing in composition or form on a macroscale. The constituents retain their identities in the composite; that is, they do not dissolve or otherwise merge completely into each other although they act in concert. Normally, the components can be physically identified and exhibit an interface between one another.

**Compound** -- An intimate mixture of polymer or polymers with all the materials necessary for the finished product.

**Condensation Polymerization** -- This is a special type of step-growth polymerization characterized by the formation of water or other simple molecules during the stepwise addition of reactive groups.

**Constituent** -- In general, an element of a larger grouping. In advanced composites, the principal constituents are the fibers and the matrix.

**Continuous Filament** -- A yarn or strand in which the individual filaments are substantially the same length as the strand.

**Crazing** -- Apparent fine cracks at or under the surface of an organic matrix.

**Creep** -- The time dependent part of strain resulting from an applied stress.

**Creep, Rate Of** -- The slope of the creep-time curve at a given time.

**Crossply** -- Any filamentary laminate which is not uniaxial. Same as Angleply. In some references, the term crossply is used to designate only those laminates in which the laminae are at right angles to one another, while the term angle ply is used for all others.

**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 may occur also by addition, such as occurs with anhydride cures for epoxy resin systems.

**Cure Cycle** -- The schedule of time periods at specified conditions to which a reacting thermosetting material is subjected in order to reach a specified property level.

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

**Debond** -- A deliberate separation of a bonded joint or interface, usually for repair or rework purposes. (See Disbond, Unbond).

**Deformation** -- The change in shape of a specimen caused by the application of a load or force.

**Degradation** -- A deleterious change in chemical structure, physical properties or appearance.

**Delamination** -- The separation of the layers of material in a laminate. This may be local or may cover a large area of the laminate. It may occur at any time in the cure or subsequent life of the laminate and may arise from a wide variety of causes.

**Density** -- The mass per unit volume.

**Desorption** -- A process in which an absorbed or adsorbed material is released from another material. Desorption is the reverse of absorption, adsorption, or both.

**Deviation** -- Variation from a specified dimension or requirement, usually defining the upper and lower limits.

**Dielectric Constant** -- The ratio of the capacity of a condenser having a dielectric constant between the plates to that of the same condenser when the dielectric is replaced by a vacuum; a measure of the electrical charge stored per unit volume at unit potential.

**Dielectric Strength** -- The average potential per unit thickness at which failure of the dielectric material occurs.

**Disbond** -- An area within a bonded interface between two adherends in which an adhesion failure or separation has occurred. It may occur at any time during the life of the structure and may arise from a wide variety of causes. Also, colloquially, an area of separation between two laminae in the finished laminate (in this case the term "delamination" is normally preferred.) (See Debond, Unbond, Delamination.)

**Distribution** -- A formula which gives the probability that a value will fall within prescribed limits.

**Dry** -- a material condition of moisture equilibrium with a surrounding environment at 5% or lower relative humidity.

**Dry Fiber Area** -- Area of fiber not totally encapsulated by resin.

**Ductility** -- The ability of a material to deform plastically before fracturing.

**Elasticity** -- The property of a material which allows it to recover its original size and shape immediately after removal of the force causing deformation.

**Elongation** -- The increase in gage length or extension of a specimen during a tension test, usually expressed as a percentage of the original gage length.

**End** -- A single fiber, strand, roving or yarn being or already incorporated into a product. An end may be an individual warp yarn or cord in a woven fabric. In referring to aramid and glass fibers, an end is usually an untwisted bundle of continuous filaments.

**Epoxy Equivalent Weight** -- The number of grams of resin which contain one chemical equivalent of the epoxy group.

**Epoxy Resin** -- Resins which may be of widely different structures but are characterized by the presence of the epoxy group. (The epoxy or epoxide group is usually present as a glycidyl ether, glycidyl amine, or as part of an aliphatic ring system. The aromatic type epoxy resins are normally used in composites.)

**Extensometer** -- A device for measuring linear strain.

**Fabric, Nonwoven** -- A textile structure produced by bonding or interlocking of fibers, or both, accomplished by mechanical, chemical, thermal, or solvent means, and combinations thereof.

**Fabric, Woven** -- A generic material construction consisting of interlaced yarns or fibers, usually a planar structure. Specifically, a cloth woven in an established weave pattern from advanced fiber yarns and used as the fibrous constituent in an advanced composite lamina. In a fabric lamina, the warp direction is considered the longitudinal direction, analogous to the filament direction in a filamentary lamina.

**Fiber** -- A general term used to refer to filamentary materials. Often, fiber is used synonymously with filament. It is a general term for a filament of finite length. A unit of matter, either natural or manmade, which forms the basic element of fabrics and other textile structures.

**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 System** -- The type and arrangement of fibrous material which comprises the fiber constituent of an advanced composite. Examples of fiber systems are collimated filaments or filament yarns, woven fabric, randomly oriented short-fiber ribbons, random fiber mats, whiskers, etc.

**Filament** -- The smallest unit of a fibrous material. The basic units formed during spinning and which are gathered into strands of fiber, (for use in composites). Filaments usually are of extreme length and of very small diameter. Filaments normally are not used individually. Some textile filaments can function as a yarn when they are of sufficient strength and flexibility.

**Filamentary Composites** -- A major form of advanced composites in which the fiber constituent consists of continuous filaments. Specifically, a filamentary composite is a laminate comprised of a number of laminae, each of which consists of a nonwoven, parallel, uniaxial, planar array of filaments (or filament yarns) embedded in the selected matrix material. Individual laminae are directionally oriented and combined into specific multiaxial laminates for application to specific envelopes of strength and stiffness requirements.

**Filament Winding** -- A reinforced-plastics process that employs a series of continuous, resin-impregnated fibers applied to a mandrel in a predetermined geometrical relationship under controlled tension.

**Filament Wound** -- Pertaining to an object created by the filament winding method of fabrication.

**Fill (Filling)** -- In a woven fabric, the yarn running from selvage to selvage at right angles to the warp.

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

**Finish (or Size System)** -- A material, with which filaments are treated, which contains a coupling agent to improve the bond between the filament surface and the resin matrix in a composite material. In addition, finishes often contain ingredients which provide lubricity to the filament surface, preventing

abrasive damage during handling, and a binder which promotes strand integrity and facilitates packing of the filaments.

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

**Fracture Ductility** -- The true plastic strain at fracture.

**Gel** -- The initial jelly-like solid phase that develops during formation of a resin from a liquid. Also, a semi-solid system consisting of a network of solid aggregates in which liquid is held.

**Gel Coat** -- A quick-setting resin used in molding processes to provide an improved surface for the composite; it is the first resin applied to the mold after the mold-release agent.

**Gel Point** -- The stage at which a liquid begins to exhibit pseudo-elastic properties. (This can be seen from the inflection point on a viscosity-time plot.)

**Gel Time** -- The period of time from a pre-determined starting point to the onset of gelation (gel point) as defined by a specific test method.

**Glass** -- An inorganic product of fusion which has cooled to a rigid condition without crystallizing.

**Glass Cloth** -- Conventionally-woven glass fiber material (see Scrim).

**Glass Fibers** -- A fiber spun from an inorganic product of fusion which has cooled to a rigid condition without crystallizing.

**Glass Transition** -- The reversible change in an amorphous polymer or in amorphous regions of a partially crystalline polymer from (or to) a viscous or rubbery condition to (or from) a hard and relatively brittle one.

**Glass Transition Temperature** -- The approximate midpoint of the temperature range over which the glass transition takes place.

**Graphite Fibers** -- See Carbon Fibers.

**Hand Lay-up** -- A process in which components are applied either to a mold or a working surface, and the successive plies are built up and worked by hand.

**Heterogeneous** -- Descriptive term for a material consisting of dissimilar constituents separately identifiable; a medium consisting of regions of unlike properties separated by internal boundaries. (Note that all nonhomogeneous materials are not necessarily heterogeneous).

**Homogeneous** -- Descriptive term for a material of uniform composition throughout; a medium which has no internal physical boundaries; a material whose properties are constant at every point, in other words, constant with respect to spatial coordinates (but not necessarily with respect to directional coordinates).

**Horizontal Shear** -- Sometimes used to indicate interlaminar shear.

**Humidity, Relative** -- The ratio of the pressure of water vapor present to the pressure of saturated water vapor at the same temperature.

**Hybrid** -- A composite laminate comprised of laminae of two or more composite material systems. Or, a combination of two or more different fibers such as carbon and glass or carbon and aramid into a structure (tapes, fabrics and other forms may be combined).

**Inclusion** -- A physical and mechanical discontinuity occurring within a material or part, usually consisting of solid, encapsulated foreign material. Inclusions are often capable of transmitting some structural stresses and energy fields, but in a noticeably different manner from the parent material.

**Integral Composite Structure** -- Composite structure in which several structural elements, which would conventionally be assembled by bonding or with mechanical fasteners after separate fabrication, are instead laid up and cured as a single, complex, continuous structure; e.g., spars, ribs, and one stiffened cover of a wing box fabricated as a single integral part. The term is sometimes applied more loosely to any composite structure not assembled by mechanical fasteners.

**Interface** -- The boundary between the individual, physically distinguishable constituents of a composite.

**Interlaminar** -- Descriptive term pertaining to some object (e.g., voids), event (e.g., fracture), or potential field (e.g., shear stress) referenced as existing or occurring between two or more adjacent laminae.

**Intralaminar** -- Descriptive term pertaining to some object (e.g., voids), event (e.g., fracture), or potential field (e.g., temperature gradient) existing entirely within a single lamina without reference to any adjacent laminae.

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

**Knitting** -- A method of constructing fabric by interlocking series of loops of one or more yarns.

**Lamina** -- A single ply or layer in a laminate made up of a series of layers.

**Laminae** -- Plural of lamina.

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

**Laminate Orientation** -- The configuration of a crossplied composite laminate with regard to the angles of crossplying, the number of laminae at each angle, and the exact sequence of the lamina lay-up.

**Lay-up** -- A process of fabrication involving the assembly of successive layers of resin-impregnated material.

**Macro** -- In relation to composites, denotes the gross properties of a composite as a structural element but does not consider the individual properties or identity of the constituents.

**Mandrel** -- A form fixture or male mold used for the base in the production of a part by lay-up, filament winding or braiding.

**Mat** -- A fibrous material consisting of randomly oriented chopped or swirled filaments loosely held together with a binder.

**Material Acceptance** -- The testing of incoming material to ensure that it meets requirements.



**Material Qualification** -- The procedures used to accept a material by a company or organization for production use.

**Material System** -- A specific composite material made from specifically identified constituents in specific geometric proportions and arrangements and possessed of numerically defined properties.

**Material System Class** -- A group consisting of material systems categorized by the same generic constituent materials, but without defining the constituents uniquely; e.g., the carbon/epoxy class.

**Material Variability** -- A source of variability due to the spatial and consistency variations of the material itself and due to variation in its processing.

**Matrix** -- The essentially homogeneous material in which the fiber system of a composite is embedded.

**Mechanical Properties** -- The properties of a material that are associated with elastic and inelastic reaction when force is applied, or the properties involving the relationship between stress and strain.

**Micro** -- In relation to composites, denotes the properties of the constituents, i.e., matrix and reinforcement and interface only, as well as their effects on the composite properties.

**Modulus, Chord** -- The slope of the chord drawn between any two specified points on the stress-strain curve.

**Modulus, initial** -- The slope of the initial straight portion of a stress-strain curve.

**Modulus, Young's** -- The ratio of change in stress to change in strain below the elastic limit of a material. (Applicable to tension and compression).

**Moisture Content** -- The amount of moisture in a material determined under prescribed condition and expressed as a percentage of the mass of the moist specimen, i.e., the mass of the dry substance plus the moisture present.

**Moisture Equilibrium** -- The condition reached by a sample when it no longer takes up moisture from, or gives up moisture to, the surrounding environment.

**Mold Release Agent** -- A lubricant applied to mold surfaces to facilitate release of the molded article.

**Molded Edge** -- An edge which is not physically altered after molding for use in final form and particularly one which does not have fiber ends along its length.

**Molding** -- The forming of a polymer or composite into a solid mass of prescribed shape and size by the application of pressure and heat.

**Monolayer** -- The basic laminate unit from which crossplied or other laminates are constructed.

**Monomer** -- A compound consisting of molecules each of which can provide one or more constitutional units.

**NDE** -- Nondestructive evaluation. Broadly considered synonymous with NDI.

**NDI** -- Nondestructive inspection. A process or procedure for determining the quality or characteristics of a material, part, or assembly without permanently altering the subject or its properties.

**NDT** -- Nondestructive testing. Broadly considered synonymous with NDI.

**Nominal Specimen Thickness** -- The nominal ply thickness multiplied by the number of plies.

**Nominal Value** -- A value assigned for the purpose of a convenient designation. A nominal value exists in name only.

**Normalization** -- A mathematical procedure for adjusting raw test values for fiber-dominated properties to a single (specified) fiber volume content.

**Oligomer** -- A polymer consisting of only a few monomer units such as a dimer, trimer, etc., or their mixtures.

**Orthotropic** -- Having three mutually perpendicular planes of elastic symmetry.

**Oven Dry** -- The condition of a material that has been heated under prescribed conditions of temperature and humidity until there is no further significant change in its mass.

**PAN Fibers** -- Reinforcement fiber derived from the controlled pyrolysis of poly(acrylonitrile) fiber.

**Peel Ply** -- A layer of resin free material used to protect a laminate for later secondary bonding.

**pH** -- A measure of acidity or alkalinity of a solution, with neutrality represented by a value of 7, with increasing acidity corresponding to progressively smaller values, and increasing alkalinity corresponding to progressively higher values.

**Pitch Fibers** -- Reinforcement fiber derived from petroleum or coal tar pitch.

**Plastic** -- A material that contains one or more organic polymers of large molecular weight, is solid in its finished state, and, at some state in its manufacture or processing into finished articles, can be shaped by flow.

**Plasticizer** -- A material of lower molecular weight added to a polymer to separate the molecular chains. This results in a depression of the glass transition temperature, reduced stiffness and brittleness, and improved processability. (Note, many polymeric materials do not need a plasticizer.)

**Polymer** -- An organic material composed of molecules characterized by the repetition of one or more types of monomeric units.

**Polymerization** -- A chemical reaction in which the molecules of monomers are linked together to form polymers via two principal reaction mechanisms. Addition polymerizations proceed by chain growth and most condensation polymerizations through step growth.

**Porosity** -- A condition of trapped pockets of air, gas, or vacuum within a solid material, usually expressed as a percentage of the total nonsolid volume to the total volume (solid plus nonsolid) of a unit quantity of material.

**Postcure** -- Additional elevated temperature cure, usually without pressure, to increase the glass transition temperature, to improve final properties, or to complete the cure.

**Pot Life** -- The period of time during which a reacting thermosetting composition remains suitable for its intended processing after mixing with a reaction initiating agent.

**Precursor (for Carbon or Graphite Fiber)** -- Either the PAN or pitch fibers from which carbon and graphite fibers are derived.

**Preform** -- An assembly of dry fabric and fibers which has been prepared for one of several different wet resin injection processes. A preform may be stitched or stabilized in some other way to hold its shape. A commingled preform may contain thermoplastic fibers and may be consolidated by elevated temperature and pressure without resin injection.

**Preply** -- Layers of prepreg material, which have been assembled according to a user specified stacking sequence.

**Prepreg** -- Ready to mold or cure material in sheet form which may be tow, tape, cloth, or mat impregnated with resin. It may be stored before use.

**Pressure** -- The force or load per unit area.

**Quasi-Isotropic Laminate** -- A laminate approximating isotropy by orientation of plies in several or more directions.

**Reinforced Plastic** -- A plastic with relatively high stiffness or very high strength fibers embedded in the composition. This improves some mechanical properties over that of the base resin.

**Release Agent** -- See Mold Release Agent.

**Resilience** -- A property of a material which is able to do work against restraining forces during return from a deformed condition.

**Resin** -- An organic polymer or prepolymer used as a matrix to contain the fibrous reinforcement in a composite material or as an adhesive. This organic matrix may be a thermoset or a thermoplastic, and may contain a wide variety of components or additives to influence; handleability, processing behavior and ultimate properties.

**Resin Content** -- The amount of matrix present in a composite either by percent weight or percent volume.

**Resin Starved Area** -- Area of composite part where the resin has a non-continuous smooth coverage of the fiber.

**Resin System** -- A mixture of resin, with ingredients such as catalyst, initiator, diluents, etc. required for the intended processing and final product.

**Room Temperature Ambient (RTA)** -- 1) an environmental condition of  $73\pm 5\text{ }^{\circ}\text{F}$  ( $23\pm 3\text{ }^{\circ}\text{C}$ ) at ambient laboratory relative humidity; 2) a material condition where, immediately following consolidation/cure, the material is stored at  $73\pm 5\text{ }^{\circ}\text{F}$  ( $23\pm 3\text{ }^{\circ}\text{C}$ ) and at a maximum relative humidity of 60%.

**Roving** -- A number of strands, tows, or ends collected into a parallel bundle with little or no twist. In spun yarn production, an intermediate state between sliver and yarn.

**S-Basis (or S-Value)** -- The mechanical property value which is usually the specified minimum value of the appropriate government specification or SAE Aerospace Material Specification for this material.

**Sample** -- A small portion of a material or product intended to be representative of the whole. Statistically, a sample is the collection of measurements taken from a specified population.

**Sandwich Construction** -- A structural panel concept consisting in its simplest form of two relatively thin, parallel sheets of structural material bonded to, and separated by, a relatively thick, light-weight core.

**Saturation** -- An equilibrium condition in which the net rate of absorption under prescribed conditions falls essentially to zero.

**Scrim (also called Glass Cloth, Carrier)** -- A low cost fabric woven into an open mesh construction, used in the processing of tape or other B-stage material to facilitate handling.

**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.

**Selvage or Selvedge** -- The woven edge portion of a fabric parallel to the warp.

**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.

**Size System** -- See Finish.

**Sizing** -- A generic term for compounds which are applied to yarns to bind the fiber together and stiffen the yarn to provide abrasion-resistance during weaving. Starch, gelatin, oil, wax, and man-made polymers such as polyvinyl alcohol, polystyrene, polyacrylic acid, and polyacetates are employed.

**Sleeving** -- A common name for tubular braided fabric.

**Solute** -- The dissolved material.

**Specific Gravity** -- The ratio of the weight of any volume of a substance to the weight of an equal volume of another substance taken as standard at a constant or stated temperature. Solids and liquids are usually compared with water at 39°F (4°C).

**Specific Heat** -- The quantity of heat required to raise the temperature of a unit mass of a substance one degree under specified conditions.

**Specimen** -- A piece or portion of a sample or other material taken to be tested. Specimens normally are prepared to conform with the applicable test method.

**Staple** -- Either naturally occurring fibers or lengths cut from filaments.

**Strain** -- the per unit change, due to force, in the size or shape of a body referred to its original size or shape. Strain is a nondimensional quantity, but it is frequently expressed in inches per inch, meters per meter, or percent.

**Strand** -- Normally an untwisted bundle or assembly of continuous filaments used as a unit, including slivers, tow, ends, yarn, etc. Sometimes a single fiber or filament is called a strand.

**Strength** -- the maximum stress which a material is capable of sustaining.

**Stress** -- The intensity at a point in a body of the forces or components of forces that act on a given plane through the point. Stress is expressed in force per unit area (pounds-force per square inch, megapascals, etc.).

**Stress-Strain Curve (Diagram)** -- A graphical representation showing the relationship between the change in dimension of the specimen in the direction of the externally applied stress and the magnitude of the applied stress. Values of stress usually are plotted as ordinates (vertically) and strain values as abscissa (horizontally).

**Structural Element** -- a generic element of a more complex structural member (for example, skin, stringer, shear panels, sandwich panels, joints, or splices).

**Surfacing Mat** -- A thin mat of fine fibers used primarily to produce a smooth surface on an organic matrix composite.

**Symmetrical Laminate** -- A composite laminate in which the sequence of plies below the laminate midplane is a mirror image of the stacking sequence above the midplane.

**Tack** -- Stickiness of the prepreg.

**Tape** -- Prepreg fabricated in widths up to 12 inches wide for carbon and 3 inches for boron. Cross stitched carbon tapes up to 60 inches wide are available commercially in some cases.

**Thermal Conductivity** -- Ability of a material to conduct heat. The physical constant for quantity of heat that passes through unit cube of a substance in unit time when the difference in temperature of two faces is one degree.

**Thermoplastic** -- A plastic that repeatedly can be softened by heating and hardened by cooling through a temperature range characteristic of the plastic, and when in the softened stage, can be shaped by flow into articles by molding or extrusion.

**Thermoset** -- A plastic that is substantially infusible and insoluble after having been cured by heat or other means.

**Tolerance** -- The total amount by which a quantity is allowed to vary.

**Tolerance Limit** -- A lower (upper) confidence limit on a specified percentile of a distribution. For example, the B-basis value is a 95% lower confidence limit on the tenth percentile of a distribution.

**Tolerance Limit Factor** -- The factor which is multiplied by the estimate of variability in computing the tolerance limit.

**Toughness** -- A measure of a material's ability to absorb work, or the actual work per unit volume or unit mass of material that is required to rupture it. Toughness is proportional to the area under the load-elongation curve from the origin to the breaking point.

**Tow** -- An untwisted bundle of continuous filaments. Commonly used in referring to man-made fibers, particularly carbon and graphite fibers, in the composites industry.

**Transversely Isotropic** -- Descriptive term for a material exhibiting a special case of orthotropy in which properties are identical in two orthotropic dimensions, but not the third; having identical properties in both transverse directions but not the longitudinal direction.

**Traveller** -- A small piece of the same product (panel, tube, etc.) as the test specimen, used for example to measure moisture content as a result of conditioning.

**Typical Basis** -- A typical property value is a sample mean. Note that the typical value is defined as the simple arithmetic mean which has a statistical connotation of 50% reliability with a 50% confidence.

**Unbond** -- An area within a bonded interface between two adherends in which the intended bonding action failed to take place. 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. (See Disbond, Debond).

**Unidirectional Laminate** -- A laminate with nonwoven reinforcements and all layers laid up in the same direction.

**Vacuum Bag Molding** -- A process in which the lay-up is cured under pressure generated by drawing a vacuum in the space between the lay-up and a flexible sheet placed over it and sealed at the edges.

**Variance** -- See Sample Variance.

**Viscosity** -- The property of resistance to flow exhibited within the body of a material.

**Void** -- A physical and mechanical discontinuity occurring within a material or part which may be two-dimensional (e.g., disbonds, delaminations) or three-dimensional (e.g., vacuum-, air-, or gas-filled pockets). Porosity is an aggregation of micro-voids. Voids are essentially incapable of transmitting structural stresses or nonradiative energy fields. (See Inclusion.)

**Warp** -- The longitudinally oriented yarn in a woven fabric (see Fill); a group of yarns in long lengths and approximately parallel.

**Wet Lay-up** -- A method of making a reinforced product by applying a liquid resin system while the reinforcement is put in place.

**Wet Strength** -- The strength of an organic matrix composite when the matrix resin is saturated with absorbed moisture. (See Saturation).

**Whisker** -- A short single crystal fiber or filament. Whisker diameters range from 1 to 25 microns, with aspect ratios between 100 and 15,000.

**Work Life** -- The period during which a compound, after mixing with a catalyst, solvent, or other compounding ingredient, remains suitable for its intended use.

**Woven Fabric Composite** -- A major form of advanced composites in which the fiber constituent consists of woven fabric. A woven fabric composite normally is a laminate comprised of a number of laminae, each of which consists of one layer of fabric embedded in the selected matrix material. Individual fabric laminae are directionally oriented and combined into specific multiaxial laminates for application to specific envelopes of strength and stiffness requirements.

**Yarn** -- A generic term for strands or bundles of continuous filaments or fibers, usually twisted and suitable for making textile fabric.

**Yield Strength** -- The stress at which a material exhibits a specified limiting deviation from the proportionality of stress to strain. (The deviation is expressed in terms of strain such as 0.2 percent for the Offset Method or 0.5 percent for the Total Extension Under Load Method.)

**X-Axis** -- In composite laminates, an axis in the plane of the laminate which is used as the 0 degree reference for designating the angle of a lamina.

**X-Y Plane** -- In composite laminates, the reference plane parallel to the plane of the laminate.

**Y-Axis** -- In composite laminates, the axis in the plane of the laminate which is perpendicular to the x-axis.

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

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