



- 1) A-glass: corrosive-resistant boron-free glass.
- 2) Ablative Plastic: material that absorbs heat (with low material loss and char rate) through a decomposition process (pyrolysis) that takes place at or near the surface exposed to the heat.
- 3) Abrasion: wearing away by friction. Glass is highly resistant to abrasion by other materials, but can be damaged through contact with itself.
- 4) Accelerated test: procedure in which conditions are increased in magnitude to reduce the time required to obtain a result. To reproduce in a short time the deteriorating effect obtained under normal service conditions.
- 5) Accelerator: material that, when mixed with a catalyst or a resin, will speed the chemical reaction between the catalyst and the resin. Also called promoter.
- 6) Acetone: ketone group solvent that is used to dissolve polyester resins. Used to a large extent for clean up of tools in fiberglass operations.
- 7) Acoustic emission: measure of integrity of a material, as determined by sound emission when a material is stressed. Ideally, emissions can be correlated with defects and/or incipient failure.
- 8) Acrylic: thermoplastic polymer made by the polymerization of esters of acrylic acid and its derivatives.
- 9) Activator: see Accelerator.
- 10) Addition polymerization: chemical reaction in which simple molecules (monomers) are added to each other to form long-chain molecules (polymers) without forming by-products.
- 11) Additive: any number of materials used to modify the properties of polymer resins, such as plasticizers, initiators, light stabilizers and flame retardants.

12) Adhesive: substance capable of holding two materials together by surface attachment. Adhesive can be in film, liquid, or paste form.

13) Admixture: addition and homogeneous dispersion of discrete components, before cure.

14) Afterbake: see Postcure.

15) Aggregate: hard, coarse material usually of mineral origins in composite tools. Also used in flooring or as a surface medium.

16) Aging: effect on materials of exposure to the environment. The process of exposing materials to an environment for an interval of time.

17) Air-bubble: void air entrapment within and between plies of reinforcement or within a bondline or encapsulated area; localized, noninterconnected, spherical in shape.

18) Air vent: small outlet to prevent entrapment of gases in a molding or tooling fixture.

19) Alligatoring: visible cosmetic defect in exposed gel coat which looks like wrinkled or alligator skin.

20) Alloy: in plastics, a blend of polymers or copolymers with other polymers or elastomers under selected conditions.

21) Ambient: surrounding environmental conditions, such as pressure, temperature, or relative humidity.

22) Angle-ply laminate: laminate having fibers of adjacent plies oriented at alternating angles.

23) Anisotropic: exhibiting different properties when tested along axes in different directions. see also Anisotropic laminate and Isotropic.

24) Anisotropic laminate: one in which the properties are different in different directions.

25) Antioxidant: substance that, when added in small quantities to resin, prevents oxidative degradation and contributes to the maintenance of its properties.

26) Antistatic agents: agents that, when added to a molding material or applied to the surface of a molded object, make it more conducting, thus hindering the fixation of dust or the buildup of electrical charge.

- 27) Aramid: type of highly oriented organic material derived from polyamide but incorporating aromatic ring structure. Used primarily as a high-strength, high-modulus fiber. Kevlar and Nomex are example of aramids.
- 28) Arc resistance: ability to withstand exposure to an electric voltage. The total time in seconds that an intermittent arc may play across a plastic surface without rendering the surface conductive.
- 29) Ash content: proportion of the solid residue remaining after a reinforcing substance has been incinerated (charred or intensely heated).
- 30) Aspect ratio: ratio of length to diameter of a fiber.
- 31) A-Stage: early stage in the polymerization reaction of certain thermosetting resins (especially phenolic) in which the material, after application to the reinforcement, is still soluble in certain liquids and is fusible. Also called resole. see also B-Stage and C-Stage.
- 32) Autoclave: closed vessel for conducting and completing a chemical reaction or other operation, under pressure and heat.
- 33) Autoclave Molding: process in which, after lay-up, winding, or wrapping, and entire assembly is placed in a heated autoclave, usually 50 to 200 psi. Additional pressure permits higher density and improved removal of volatiles from the resin. Lay-up usually vacuum bagged with a bleeder and release cloth.
- 34) Axial Winding: in filament-wound reinforced plastics, a winding with the filaments parallel or at a small angle to the axis (0° helix angle).
- 35) Bagging: applying an impermeable layer of film over an uncured part and sealing the edges so that a vacuum can be drawn.
- 36) Bag Molding: process in which the consolidation of the material in the mold is affected by the application of fluid or gas pressure through a flexible membrane.
- 37) 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.
- 38) Balanced Laminate: composite laminate in which all laminae at angles of 0° and 90° occur only in + or - pairs (not necessarily adjacent) and are symmetrical around the centerline.
- 39) Band width: in filament winding, the width of the reinforcement as it is applied to the mandrel.

40) Barcol-Shore Rockwell Hardness: property of material which describes its ability to be indented. The Rockwell method for measuring hardness forces a steel point into the material and then measures the penetration of the point. The different letters in the Rockwell reading describe the shape of the point and the load applied during the test. Units - Rockwell units with the appropriate suffix letter. The letter and number cannot be separated. Higher numbers with the same letter indicate harder materials. Harder materials have more resistance to penetration by another substance. The hardness value is often used as a measure of the degree of cure of a plastic.

41) Bare Glass: glass as it flows from the bushing in fiber form, before a binder or sizing is applied.

42) 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.

43) Batt: felted fabrics. Structures built by the interlocking action of compressing fibers, without spinning, weaving, or knitting.

44) Bearing Strength: maximum bearing stress that can be sustained. Also, the bearing stress at that point on the stress-strain curve where the tangent is equal to the bearing stress divided by $n\%$ of the bearing hole diameter.

45) Bearing Stress: applied load in pounds divided by the bearing area. Maximum bearing stress is the maximum load in pounds sustained by the specimen during the test, divided by the original bearing area.

46) Bias Fabric: warp and fill fibers at an angle to the length of the fabric.

47) Biaxial Load: loading condition in which a laminate is stressed in two different directions in its plane. A loading condition of a pressure vessel under internal pressure and with unrestrained ends.

48) Biaxial Winding: in filament winding, a type of winding in which the helical band is laid in sequence, side by side, with crossover of the fibers eliminated.

49) Bi-Directional: reinforcing fibers that are arranged in two directions, usually at right angles.

50) Bi-Directional Laminate: a reinforced plastic laminate with the fibers oriented in two directions in its plane. A cross laminate.

51) Binder: 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. Schmelzer Industries currently offers five distinct binders for varying uses in the composites industry.

52) Bismaleimide (BMI): type of polyimide that cures by an addition rather than a condensation reaction, thus avoiding problems with volatiles formation, and which is produced by a vinyl-type polymerization of a pre-polymer terminated with two maleimide groups. Intermediate in temperature capability between epoxy and polyimide.

53) Blanket: fiber or fabric plies that have been laid up in a complete assembly and placed on or in the mold all at one time (flexible bag process). Also, the form of bag in which the edges are sealed against the mold.

54) Bleeder Cloth: woven or non-woven 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.

55) Blister: flaw either between layers of laminate or between the gel coat film and laminate.

56) BMC: Bulk Molding Compound (Thermoset).

57) Bond Strength: 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.

58) Boron Fiber: fiber produced by vapor deposition of elemental boron, usually onto a tungsten filament core, to impart strength and stiffness.

59) Braiding: weaving a fiber into a tubular shape instead of a flat fabric, as for graphite fiber reinforced golf club shafts.

60) Breathing: opening and closing of a mold to allow gas to escape early in the molding cycle. Also called "degassing"; sometimes called "bumping" in phenolic molding.

61) Bridging: condition in which fibers do not move into or conform to radii and corner during molding, resulting in voids and dimensional control problems.

62) B-Stage: intermediate stage in the reaction of certain thermosetting resins in which the material softens when heated and is plastic and fusible but may not entirely dissolve or fuse. Also called "resistol" or "resitol." The resin in an uncured prepreg or premix is usually in this stage.

63) Buckling (Composite): mode of failure generally characterized by an unstable lateral material deflection due to compressive action on the structural element involved.

64) Bulk Molding Composite (BMC): thermosetting resin mixed with short strand reinforcement, filler, and so on, into a viscous compound for compression or injection molding.

- 65) Bundle: general term for a collection of essentially parallel filaments or fibers.
- 66) Bushing: plate with holes through which molten glass is pulled to produce glass fibers.
- 67) Bushing Tip: small tapered protrusions on the bottom of bushings each containing an orifice through which molted glass flows, from which continuous filaments are drawn.
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- 68) Carbon: element that provides the backbone for all organic polymers. Graphite is a more ordered form of carbon. Diamond is the densest crystalline form of carbon.
- 69) Carbon-Carbon: composite material consisting of carbon or graphite fibers in a carbon or graphite matrix.
- 70) Carbon Fiber: fiber produced by the pyrolysis of organic precursor fibers, such as rayon, polyacrylonitrile (PAN), and pitch, in an inert environment.
- 71) Casting: process of pouring a mixture of resin, fillers and/or fibers into a mold as opposed to building up layers through lamination. This technique produces different physical properties from laminating.
- 72) Catalyst: 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. For this industry, used synonymously with initiator. See also Initiator, Accelerator, Curing Agent, Hardener, and Promoter.
- 73) Catastrophic Failures: totally unpredictable failures of a mechanical, thermal, or electrical nature.
- 74) 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 temperature, and to provide a smooth surface on the finished laminate.
- 75) Cavity: space inside a mold in which a resin or molding compound is poured or injected. The female portion of the 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 a single cavity or multiple cavity.
- 76) Centrifugal Casting: production technique for fabricating cylindrical composites, such as pipe, in which composite material is positioned inside a hollow mandrel designed to be heated and rotated as resin is cured.
- 77) C-glass: glass with a soda-lime-borosilicate composition.

- 78) Chalking: surface phenomenon indicating degradation of a cosmetic surface. Chalking is a powdery film which appears lighter than the original color.
- 79) Chemical Size: surface finish applied to a fiber that contains some chemical constituents other than water.
- 80) Chopped Strand Mat: fiberglass reinforcement consisting of short strands of fiber arranged in a random pattern and held together with a binder.
- 81) Clamping Pressure: in injection molding and transfer molding, the pressure that is applied to the mold to keep it closed in opposition to the fluid pressure of the compressed molding material.
- 82) Cloth: fiberglass reinforcement made by weaving strands of glass fiber yarns.
- 83) Coefficient of Elasticity: reciprocal of Young's modulus in a tension test.
- 84) Coefficient of Thermal Expansion (CTE): how much a material shape will change for each degree of temperature change.
- 85) 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.
- 86) Cold Flow: the distortion that takes place in materials under continuous load at temperatures within the working range of the material without a phase or chemical change.
- 87) Compaction: the application of a temporary vacuum bag and vacuum to remove trapped air and compact the lay-up; also in SMC machines for removal of air prior to roll-up.
- 88) Compatibility: the ability of two or more substances combined with one another to form a homogeneous composition of useful plastic properties; for example, the suitability of a sizing or finish for use with certain general resin types.
- 89) Composite: chemical or mechanical bonding of dissimilar materials such as glass fiber and polyester resin, whose cumulative properties are superior to the individual materials.
- 90) Composite Material: a combination of two or more materials (reinforcing elements, fillers, and composite matrix binder). The constituents retain their identities; that is, they do not dissolve or merge completely into one another although they act in concert. Normally, the components can be physically identified and exhibit an interface between one another.

91) Compound: the intimate admixture of a polymer with other ingredients, such as fillers, softeners, plasticizers, reinforcement, catalysts, pigments, or dyes. A thermoset compound usually contains all the ingredients necessary for the finished product, while a thermoplastic compound may require subsequent addition of pigments, blowing agents, and so forth.

92) Compression molding: a process where a mold is open when the material is introduced and shapes the material by the pressure of closing and by heat. All Schmelzer Industries veils are appropriate for use in compression molding.

93) Compressive modulus: ratio of compressive stress to compressive strain below the proportional limit. Theoretically equal to Young's modulus determined from tensile experiments.

94) Compressive strength: the ability of a material to resist a force that tends to crush or buckle.

The maximum compressive load sustained by a specimen divided by the original cross-sectional area of the specimen.

95) Condensation polymerization: a chemical reaction in which two or more molecules combine, with the separation of water or some other simple substance.

96) Conductivity: reciprocal of volume resistivity. The electrical or thermal conductance of a unit cube of any material (conductivity per unit volume).

97) Conformability: Ability of the mat to conform to difficult shapes without causing wrinkles or leaving excessively resin-rich or glass-rich radii, which may craze. Schmelzer Industries offers fiberglass veils with excellent conformability.

98) Contact molding: Refers to the use of a single or open mold onto which layers of polymer and reinforcement materials can be applied. Contact molding is characterized by one finished cosmetic side. Cure is either at room temperature using a catalyst-promoter system or by heating in an oven, without additional pressure.

99) Continuous Filament Yarn: yarn formed by twisting and or plying two or more continuous filaments into a single continuous strand.

100) Continuous Laminating: process for forming panels and sheeting in which fabric or mat is passed through a resin bath, brought together between covering sheets, and passed through a heating zone for cure. Squeeze rolls control thickness and resin content as the various plies are brought together.

101) Continuous Strand: fiberglass mat of very long individual fibers with a regular crossed pattern loosely held together with a binder.

102) Copolymer: a long-chain molecule formed by the reaction of two or more dissimilar monomers.

103) Core: A low density material used between two FRP skins. Examples of core materials are end-grain balsa wood, urethane foam, PVC foam and various honeycomb materials. The central member, usually foam or honeycomb, of a sandwich construction to which the faces of the sandwich are attached or bonded. The central member of a plywood assembly. A channel in a mold for circulation of heat transfer media. A device on which prepreg is wound.

104) Corrosion resistance: the ability of a material to withstand contact with ambient natural factors or those of a particular artificially created atmosphere, without degradation or change in properties. For metals, this could be pitting or rusting; for organic materials, it could be crazing. Schmelzer Industries uses corrosion resistant "A" glass to prevent corrosive substances from marring your composite.

105) Coupling agent: any chemical substance designed to react with both the reinforcement and matrix phases of a composite material to form or promote a stronger bond at the interface.

106) Crazing: cracking of gel coat or resin due to stress. Region of ultra-fine cracks, which may extend in a network on or under the surface of a resin or plastic material. May appear as a white band. Often found in a filament-wound pressure vessel or bottle.

107) Creel: a device for holding the required number of roving balls (spools) or supply packages of reinforcement in desired position for unwinding onto the next processing step, that is, weaving, braiding, or filament winding.

108) Creep: the change in dimension of a material under load over a period of time, not including the initial instantaneous elastic deformation. The time-dependent part of strain resulting from an applied load.

109) Creep, rate of: rate of the slope of the creep-time curve at a given time. Deflection with time under a given static load.

110) Cross-Linking: setting up of chemical bonds between molecule chains which occurs in all thermosetting resins during cure. Styrene monomer is a cross-linking agent in polyester resins.

111) C-Stage: the final stage in the reaction of certain thermosetting resins in which the material is practically insoluble and infusible.

112) CTE: see Coefficient of Thermal Expansion.

113) Cure: completion of the cross-linking process during which a composite develops its full strength. Cure may be accomplished by addition of curing (cross-linking) agents, with or without heat and pressure.

114) Cure cycle: the time/temperature/pressure cycle used to cure a thermosetting resin system or prepreg.

115) Cure Time: period between introduction of the catalyst to a polymer and final cure.

116) Curing agent: a catalytic or reactive agent that, when added to a resin, causes polymerization. Also called hardener.

117) Damping: the decay with time of the amplitude of free vibrations of a specimen.

118) Daylight: the distance, in the open position, between the moving and fixed tables or the platens of a hydraulic press. In the case of a multi-platen press, daylight is the distance between adjacent platens. Day-light provides space for removal of the molded part from the mold.

119) Deflashing: a finishing technique used to remove the excess, unwanted material (flashing) on a plastic molding.

120) Delamination: separation of composite layers, either local or covering a wide area. Can occur in the cure or subsequent life.

121) Denier: a yarn and filament numbering system in which the yarn number is numerically equal to the weight in grams of 9000 meters.

122) Density: comparison of weight per volume, measured in pounds per cubic foot.

123) Dielectric: a nonconductor of electricity. The ability of a material to resist the flow of an electrical current.

124) Dielectric constant: the ratio of the capacitance of an assembly of two electrodes separated solely by a plastic insulating material to its capacitance when the electrodes are separated by air.

125) Dielectric heating: the heating of materials by dielectric loss in a high-frequency electrostatic field.

126) Dielectric strength: value of a material as an electrical insulator or the resistance to the flow of electric current.

127) Dimensional stability: ability of a plastic part to retain the precise shape to which it was molded, cast, or otherwise fabricated.

128) Distortion: change in shape from that which is intended. Symptomatic of laminating difficulties, curing problems, tooling problems or resin shrinkage.

129) Doctor blade or bar: a straight piece of material used to spread resin, as in application of a thin film of resin for use in hot melt prepreg or for use as an adhesive film. Also called paste metering blade.

130) Draft: the taper or slope of the vertical surfaces of a which allow removal of molded parts.

131) 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.

132) Dwell: a pause in the application of pressure or temperature to a mold, made just before it is completely closed, to allow the escape of gas from the molding material.

133) E-Glass: a family of glasses with a calcium alumina borosilicate composition and a maximum alkali content of 2.0%. Originally formulated for use in electric circuitry.

134) 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.

135) Elastic limit: the greatest stress a material is capable of sustaining without permanent strain remaining after the complete release of the stress. A material is said to have passed its elastic limit when the load is sufficient to initiate plastic, or nonrecoverable, deformation.

136) Elastomer: a material that substantially recovers its original shape and size at room temperature after removal of a deforming force.

137) Elongation at break: standard measure for the amount a sample can stretch as a percentage of original length before it fails or breaks.

138) Encapsulating: completely surrounding an object with resin or a fiber resin composite. Sometimes used specifically in reference to the enclosure of capacitors or circuit board modules.

139) 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.

140) End count: an exact number of ends supplied on a ball of roving.

141) Environment: the aggregate of all conditions (such as contamination, temperature, humidity, radiation, magnetic and electric fields, shock, and vibration) that externally influence the performance of an item.

142) Epoxy: 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. Epoxies generally have higher physical properties than polyester resins. They are also more costly and difficult to process, and less able to withstand sunlight. Schmelzer Industries produces epoxy-compatible veils and mats.

143) Even tension: the process whereby each end of roving is kept in the same degree of tension as the other ends making up the ball of roving.

144) Exotherm: the liberation or evolution of heat during curing of a plastic product.

145) Extend: to add fillers or low-cost materials in an economy producing endeavor. To add inert materials to improve void-filling characteristics and reduce crazing.

146) Extenders: low-cost materials used to dilute or extend high-cost resins without extensive lessening of properties.

147) Fabricator: manufacturer of reinforced plastic products.

148) 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.

149) Fatigue life: the number of cycles of deformation required to bring about failures of the test specimen under a given set of oscillating conditions (stresses and strains).

150) Fatigue limit: the stress level below which a material can be stress cyclically for an infinite number of times without failure.

151) 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.

152) Fiber: reinforcement material which is a major component in a composite matrix. Often, fiber is used synonymously with filament.

153) 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.

154) Fiber diameter: the measurement (expressed in hundred thousandths of an inch) of the diameter of individual filaments.

155) Fiber direction: the orientation or alignment of the longitudinal axis of the fiber with respect to a stated reference axis.

156) Fiberglass: Glass which has been extruded into extremely fine filaments. These filaments vary in diameter, and are measured in microns. Glass filaments are treated with special binders and processed similar to textile fibers. These fibers come in many forms such as roving, woven roving, mat and continuous strands. All Schmelzer Industries products are made of fiberglass.

157) Fiberglass reinforcement: major material used to reinforce plastic. Available as mat, roving, fabric, and so forth, it is incorporated into both thermosets and thermoplastics.

158) Fiber pattern: visible fibers on the surface laminates or molding. The thread size and weave of glass cloth.

159) Fiber Reinforced Plastic (FRP): a general term for a composite that is reinforced with cloth, mat, strands, or any other fiber form.

160) Filament: single thread-like fiber of extruded glass. The smallest single unit of a fibrous material.

161) Filament winding: process which involves winding a resin-saturated strand of glass filament around a rotating mandrel.

162) Fill: yarn oriented at right angles to the warp in a woven fabric.

163) Filler: Usually inert organic or inorganic materials which are added to plastics, resins or gel coats to vary the properties, extend volume, or lower the cost of the article being produced.

164) Finish: a mixture of materials for treating glass or other fibers. It contains a coupling agent to improve the bond of resin to the fiber.

165) Fire retardants: certain chemicals that are used to reduce the tendency of a resin to burn.

166) Fish Eye: effect of surface contamination which causes a circular separation of a paint or gel coat.

167) Flammability: measure of the extent to which a material will support combustion. How fast a material will burn under controlled conditions.

168) Flash: that portion of the charge which flows from or is extruded from the mold cavity during the molding. Extra plastic attached to a molding along the parting line, which must be removed before the part is considered finished.

169) Flash Point: lowest temperature at which a substance gives off enough vapors to form a flammable mixture.

170) Flexible molds: molds made of rubber or elastomeric plastics, used for casting plastics. They can be stretched to remove cured pieces with undercuts.

171) Flexural modulus: determines how much a sample will bend when a given load is applied. 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.

172) Flexural strength: also known as bending 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. It describes how much of a non-moving load can be applied before a bar yields or breaks. Units are normally thousands of pounds per square inch. (103 psi) - Mega Pascals (MPa). Higher numbers mean that material is stronger and can withstand a heavier load.

173) Flow: the movement of resin under pressure, allowing it to fill all parts of a mold. The gradual but continuous distortion of a material under continued load, usually at high temperatures; also called creep.

174) Flow line: a mark on a molded piece made by the meeting of two flow fronts during molding. Also called striae, weld mark, or weld line.

175) Flow marks: wavy surface appearance of an object molded from thermoplastic resins, caused by improper flow of the resin into the mold.

176) Foam: lightweight, cellular plastic material containing glass-filled voids. Typical foams include urethane, PVC, and polyester.

177) Force: the male half of the mold that enters the cavity, exerting pressure on the resin and causing it to flow. Also called punch.

178) Fracture: the separation of a body. Defined both as rupture of the surface without complete separation of laminate and as complete separation of a body because of external or internal forces.

179) Fracture stress: the true, normal stress on the minimum cross-sectional area at the beginning of fracture.

180) Fracture toughness: a measure of the damage tolerance of a material containing initial flaws or cracks. Used in aircraft structural design and analysis.

181) FRP: see Fiber Reinforced Plastic.

182) Gel: the initial jelly-like 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.

183) Gelation: the point in a resin cure when the resin viscosity has increased to a point such that it barely moves when probed with a sharp instrument.

184) Gel coat: surface coat of a specialized, quick-setting polyester resin, either colored or clear, providing a cosmetic enhancement and weatherability to a fiberglass laminate. The gel coat becomes an integral part of the finished laminate. Veils can reduce the need for gel coats and help the gel coat to bond to the reinforcement layers.

185) Gel point: the stage at which a liquid begins to exhibit pseudo-elastic properties. This stage may be conveniently observed from the inflection point on a viscosity time plot.

186) GRP: glass-reinforced plastic, polymer or polyester. This derivation is commonly used in Europe.

187) GFRP: glass fiber-reinforced plastic, polymer or polyester.

188) Glass Fiber Wet-Process: process of forming a glass mat on modified papermaking equipment.

189) Glass Transition: reversible change in the 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.

190) Glass transition temperature (T_g): the appropriate midpoint of the temperature range over which glass transition takes place.

191) Good Side: side of a molding in contact with a mold surface.

192) Graphite fiber: a fiber made from a precursor by oxidation, carbonization, and graphitization process (which provides a graphitic structure).

193) Green: resin which has not completely cured and is still rather soft and rubbery.

194) Green strength: that ability of the material, while not completely cured, to undergo removal from the mold and handling without tearing or permanent distortion.

195) Hand: the softness of a piece of fabric, as determined by the touch (individual judgment).

196) Hand lay-up: the process of placing (and working) successive plies of reinforcing material or resin-impregnated reinforcement in position on a mold by hand. Method of molding room temperature curing thermosetting polymers, mainly epoxies and polyesters, in association with glass, mineral, or fiber reinforcements. Catalyzed resin mixtures are sprayed, brushed, or spatulated on a mold. A precut reinforcing layer is laid on the wet resin. After the resin soaks into the reinforcement, subsequent layers are built up to the required thickness and are cured, removed from the mold and trimmed. Some variations of hand lay-up techniques are bag molding, drape molding, vacuum molding and spray-up molding. Typical parts are custom auto bodies and boat hulls.

197) Hardener: a substance or mixture added to a plastic composition to promote or control the curing action by taking part in it.

198) 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.

199) Heat distortion point: temperature at which the strength of a material begins to degrade. Now called deflection temperature.

200) Heat resistance: the property or ability of plastics and elastomers to resist the deteriorating effect of elevated temperatures.

201) 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.

202) Helical winding: in filament wound items, a winding in which a filament band advances along a helical path, not necessarily at a constant angle except in the case of a cylinder.

203) Het-Acid Resin: polyester resin with exceptional fire qualities.

204) High-pressure laminates: laminates molded and cured at pressures not lower than 6.9 MP (1.0 ksi), and more commonly in the range of 8.3 to 13.9 Mpa (1.2 to 2.0 ksi).

205) Homogeneous: descriptive term for a material of uniform composition throughout.

206) Honeycomb: manufactured product of resin-impregnated sheet material (paper, glass, fabric, and so on) or metal foil, formed into hexagonal-shaped cells. Used as a core material in sandwich construction.

207) Hoop stress: the circumferential stress in a material of cylindrical form subjected to internal or external pressure.

208) Hybrid: a composite laminate consisting of laminae of two or more composite material systems. A combination of two or more different fibers, such as carbon and glass or carbon and aramid, into a structure.

209) Hydraulic press: a press in which the molding force is created by the pressure exerted by a fluid.

210) Hysteresis: the energy absorbed in a complete cycle of loading and unloading. This energy is converted from mechanical to friction energy (heat).

211) Ignition loss: the difference in weight before and after burning. As with glass, the burning off of the binder or size.

212) Impact strength: the ability of a material to withstand shock loading.

213) Impact test: measure of the energy necessary to fracture a standard sample by an impulse load.

214) Impregnate: in reinforced plastics, to saturate a reinforcement, especially fiberglass, with a resin.

215) Inhibitor: a substance that retards a chemical reaction. Also used in certain types of monomers and resins to prolong storage life.

216) Initiator: peroxides used as sources of free radicals. They are used in free-radical polymerization, for curing thermosetting resins, as cross-linking agents for elastomers and polyethylene, and for polymer modification.

217) Injection molding: method of forming a plastic to the desired shape by forcing the heat-softened thermoplastic polymer into a relatively cool cavity under pressure or thermosetting polymer into a heated mold. All Schmelzer Industries veils can be used in injection molding.

218) Inorganic pigments: natural or synthetic metallic oxides, sulfides, and other salts that impart heat and light stability, weathering resistance, color, or migration resistance to plastics.

219) Insert: an integral part of plastic molding consisting of metal or other material that may be molded into the part or pressed into position after the molding is completed.

220) In-Situ: in place. In the position which it will finally occupy, e.g. molding or forming foam.

221) Interface: the boundary or surface between two different, physically distinguishable materials. On fibers, the contact area between fibers and sizing or finish. In a laminate, the contact area between the reinforcement and the laminating resin.

222) Interlaminar: descriptive term pertaining to an object (for example, voids), event (for example, fracture), or potential field (for example, shear stress) referenced as existing or occurring between two or more adjacent laminae.

223) Interlaminar shear: shearing force tending to produce a relative displacement between two laminae in a laminate along the plane of the interface.

224) Intumescent: fire-retardant technology which causes an otherwise flammable material to foam, forming an insulating barrier when exposed to heat.

225) Irreversible: not capable of redissolving or remelting. Chemical reactions that proceed in a single direction and are not capable of reversal (as applied to thermosetting resins).

226) Isocyanate plastics: plastics based on resins made by the reaction of organic isocyanates with other compounds.

227) Isophthalic: polyester resin based on isophthalic acid, generally higher in properties than a general purpose or orthophthalic polyester resin.

228) Isotropic: having uniform properties in all directions.

229) Izod impact test: a test for shock loading in which a notched specimen bar is held at one end and broken by striking, and the energy absorbed is measured.

230) Jackstrawing: visual effect of glass fiber turning white in a cured laminate. It may not effect the strength of a laminate, but could indicate air entrapment or water contamination.

231) Kevlar: An organic polymer composed of aromatic polyamides having a para-type orientation (parallel chain extending bonds from each aromatic nucleus).

232) Laminant: composite material system made with layers of fiber reinforcement in a resin. Sometimes used as a general reference for composites, regardless of how made.

233) Laminate: to unite layers with a bonding material, usually with pressure and heat (normally used with reference to flat sheets, but also rods and tubes).

234) Layer: a single ply of lay-up or laminate.

235) Lay-up: act of building up successive layers of polymer and reinforcement. Layers of catalyzed resin and fiberglass or other reinforcements are applied to a mold in order to make a part. 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.

236) Liquid-crystal polymer: a newer thermoplastic polymer that is melt processable and develops high orientation in molding, with resultant tensile strength and high-temperature capability.

237) Load-deflection curve: a curve in which the increasing tension, compression, or flexural load are plotted on the ordinate axis and the deflections caused by those loads are plotted on an abscissa axis.

238) Loss on ignition: weight loss, usually expressed as percent of total, after burning off an organic sizing from glass fibers, or an organic resin from a glass fiber laminate.

239) Low-Pressure Laminates: laminated, molded, and cured using pressures from 400 psi down to and including the pressure obtained by mere contact of the plies.

240) Lubricant: a material added to most sizing to improve the handling and processing properties of textile strands.

241) Mandrel: the core tool around which resin-impregnated paper, fabric, or fiber is wound to form pipes, tubes, or structural shell shapes.

242) Mat: a fibrous material for reinforced plastic. Schmelzer Industries produces non-woven mats for foam reinforcement.

243) Matched metal molding: a reinforced plastics manufacturing process in which matching male and female metal molds are used (also called compression molding) to form the part, with time, pressure, and heat.

244) Matrix: the resin component of a polymer composite. Both thermoplastic and thermoset resins may be used, as well as metals, ceramics, and glasses. The plural is matrices.

245) Mat Strength: ability of the mat to resist being pulled apart under tension during impregnation and molding.

246) Mechanical properties: the properties of a material, such as compressive and tensile strengths, and modulus, that are associated with elastic and inelastic reaction when force is applied. The individual relationship between stress and strain.

247) Metallic fiber: manufactured fiber composed of metal, plastic-coated metal, metal-coated plastic, or core completely covered by metal.

248) Microballoons: microscopic bubbles of glass, ceramic or phenolic, used as a filler or to create syntactic foam or putty mixtures.

- 249) Microcracking: crack formed in composites when thermal stresses locally exceed the strength of the matrix.
- 250) Mil: the unit used in measuring the diameter of glass fiber strands (1 mil = 0.001 in.). Schmelzer Industries products are available in a range from 3 to approximately 50 mils.
- 251) Milled fiber: continuous glass strands hammer milled into very short glass fibers. Useful as inexpensive filler or anticrazing reinforcing filler for adhesives.
- 252) Modulus, initial: the slope of the initial straight portion of a stress strain or load-elongation curve.
- 253) Modulus of elasticity: describes a material's ability to bend without losing its ability to return to its original physical properties.
- 254) 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.
- 255) Mold: the cavity or matrix into or on which the plastic composition is placed and from which it takes form. The tool used to fabricate the desired part shape.
- 256) Molded edge: an edge that is not physically altered after molding for use in final form, and particularly on that does not have fiber ends along its length.
- 257) Molding: the forming of a polymer or composite into a solid mass of prescribed shape and size.
- 258) Molding cycle: the period of time required for the complete sequence of operations on a molding press to produce one set of moldings.
- 259) 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.
- 260) Mold-release agent: a lubricant, liquid, or powder (often silicone oils and waxes), used to prevent sticking of molded articles in the cavity.
- 261) Non-Air-Inhibited Resin: resin in which the surface cure will not be inhibited or stopped by the presence of air.
- 262) Non-Woven Fabric: textile structure produced by bonding or interlocking of fibers, or both, accomplished by mechanical, chemical, thermal, or solvent means and combinations thereof. All Schmelzer Industries veils and mats are non-woven.

- 263) Orange Peel: gel coated or painted finish which is not smooth and is patterned similar to an orange's skin. Veils can reduce the occurrence of orange peel.
- 264) Organic: matter originating in plant or animal life or composed of chemicals of hydrocarbon origin, either natural or synthetic.
- 265) Orthophthalic Resin: polyester resin based on orthophthalic acid, also known as a general purpose resin (GP).
- 266) Overlay Sheet: a nonwoven fibrous mat (of glass, synthetic fiber, and so forth) used as the top layer in a cloth or mat lay-up, to provide a smoother finish, minimize the appearance of the fibrous pattern, or permit machining or grinding to a precise dimension. Also called surfacing mat.
- 267) Phenolic Resin: thermosetting resin produced by the condensation of an aromatic alcohol with an aldehyde, particularly of phenol with formaldehyde. Used in high-temperature applications with various fillers and reinforcements. Schmelzer Industries offers veils and mats with phenolic binders.
- 268) Pigment: A colorant added to gel coat or resin.
- 269) Pinholes: small holes on the exposed gel coated surface. They are about the diameter of common pins and may be easily counted. Veils can help reduce the appearance of pinholes.
- 270) Plastic: material that contains as an essential ingredient an organic polymer of large molecular weight, hardeners, fillers, reinforcements, and so forth; is solid in its finished state, and, at some stage in its manufacture or its processing into finished articles, can be shaped by flow. Made of plastic. A plastic may be either thermoplastic or thermoset.
- 271) Plasticizer: material incorporated in a plastic to increase its workability and flexibility. Normally used in thermoplastics. A lower molecular weight material added to an epoxy to reduce stiffness and brittleness, thereby resulting in a lower glass transition temperature for the polymer.
- 272) Plug: A composite industry name for a pattern or model.
- 273) Polyester (unsaturated): product of an acid-glycol reaction commonly blended with a monomer to create a polymer resin. In its thermosetting form it is the most common resin used in the FRP industry.
- 274) Polymer: chain molecule composed of many identical groups, commonly found in plastics.
- 275) Polymerization: chemical bonding of polymer molecules during the curing reaction.

276) Porosity: entrapped gas bubbles or voids in a gel coat film.

277) Prepreg: either ready-to-mold material in sheet form or ready-to-wind material in roving form, which may be cloth, mat, unidirectional fiber, or paper impregnated with resin and stored for use. The resin is partially cured to a B-stage and supplied to the fabricator, who lays up the finished shape and completes the cure with heat and pressure. The two distinct types of prepreg available are (1) commercial prepreps, where the roving is coated with a hot melt or solvent system to produce a specific product to meet specific customer requirements, and, (2) wet prepreg, where the basic resin is installed without solvents or preservatives but has limited room-temperature shelf life.

278) Pressure Bag: A membrane which conforms to the inside of a laminate laid up on a mold. The membrane or bag is then inflated applying pressure which consolidates and densifies the laminate.

279) Print Through: distortion in the surface of a part which allows the pattern of the core or fiberglass reinforcement to be visible through the surface. Also known as print out, telegraphing or read through.

280) Pultrusion: continuous process for manufacturing composites that have a constant cross-sectional shape. The process consists of pulling a fiber-reinforcing material through a resin impregnation bath and through a shaping die, where the resin is subsequently cured.

281) Putty: thickened mixture of resin made by adding fillers and reinforcing fibers.

282) Reaction Injection Molding (RIM): process for molding polyurethane, epoxy, and other liquid chemical systems. Mixing of two to four components in the proper chemical ratio is accomplished by a high-pressure impingement-type mixing head, from which the mixed material is delivered into the mold at low pressure, where it reacts (cures).

283) Reinforced Molding Compound: compound consisting of a polymer and a reinforcement fiber or filler supplied by raw material producer in the form of ready-to-use materials.

284) Reinforced Plastics: molded, formed, filament-wound, tape-wrapped, or shaped plastic parts consisting of resins to which reinforcing fibers, mats, fabrics, and so forth, have been added before the forming operation to provide some strength properties greatly superior to those of the base resin.

285) Reinforced Reaction Injection Molding (RRIM): a reaction injection molding with a reinforcement added. See also Reaction Injection Molding.

286) Reinforcement: strong material bonded into a matrix to improve its mechanical properties. Reinforcements are usually long fibers, chopped fibers, whiskers, particulates, and so forth. The term should not be used synonymously with filler.

- 287) Release Agent: compound used to reduce surface tension or adhesion between a mold and a part.
- 288) Resin: solid or pseudosolid organic material, usually of high molecular weight, that exhibits a tendency to flow when subjected to stress. Most resins are polymers. In reinforced plastics, the material used to bind together the reinforcement material. See also Matrix and Polymer.
- 289) Resin-Rich Area: localized area filled with resin and lacking reinforcing material.
- 290) Resin-Starved Area: localized area of insufficient resin, usually identified by low gloss, dry spots, or fiber showing on the surface.
- 291) Resin Tearing: separation of pigments in a gel coat affecting cosmetic appearance.
- 292) Resin Transfer Molding (RTM): A process whereby catalyzed resin is transferred or injected into an enclosed mold in which the fiberglass reinforcement has been placed.
- 293) RIM: see Reaction Injection Molding.
- 294) Roving: collection of bundles of continuous filaments in untwisted strands. Used in the spray-up (chopping) process.
- 295) RRIM: see Reinforced Reaction Injection Molding.
- 296) RTM: see Resin Transfer Molding.
- 297) Sandwich Constructions: panels composed of a lightweight core material, such as honeycomb or foamed plastic, to which two relatively thin, dense, high-strength or high-stiffness faces or skins are adhered.
- 298) Scrim: 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.
- 299) S Glass: family of magnesium-alumina-silicate glasses with a certified chemical composition which conforms to an applicable material specification and which produces high mechanical strength.
- 300) Shear: engineering term referring to forces applied normal to the surface of a given material. The movement between plies of a laminate is referred to as interlaminar shear.
- 301) Sheet Molding Compound (SMC): 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.

- 302) Shelf Life: allowable storage time before a product must be used.
- 303) Size: treatment applied to the glass fiber to allow the resin and glass to adhere to one another. Also allows glass fiber to be conveniently handled.
- 304) Skin Coat: first layer of laminate next to the gel coat.
- 305) SMC: see Sheet Molding Compound.
- 306) 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.
- 307) 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.
- 308) Structural Reaction Injection Molding (S-RIM): evolution of two other plastic molding processes—RIM and RTM. S-RIM uses the fast polymerization reactions of RIM-type polymers, its intensive resin mixing procedures, and its rapid resin injection rates. S-RIM also employs preforms like RTM to obtain composite mechanical properties.
- 309) Styrene Monomer: A water-thin liquid monomer used to thin polyester resins and act as the crosslinking agent.
- 310) Surfacing Mat: very thin mat, usually 180 to 510 mm (7 to 20 mil) thick, used primarily to produce a smooth, resin-rich surface on a reinforced plastic laminate, or for precise machining or grinding. See also Veil.
- 311) Surfactant: chemicals used to modify or change the surface of a layer of resin or polymer. Usually used to form a film on a curing resin, producing a tack-free surface.
- 312) Tack: surface stickiness.
- 313) Tack Free: surface which is not sticky after cure.
- 314) Tangent Modulus: slope of the line at a predefined point on a static stress-strain curve, expressed in force per unit area per unit strain. This is the tangent modulus at that point in shear, tension, or compression, as the case may be. See also secant modulus.
- 315) Tape: narrow width reinforcing fabric or mat.
- 316) Tensile Elongation: engineering term referring to the amount of stretch a sample experiences during tensile strain.

- 317) Tensile Load: load applied away from and to opposite ends of a given sample.
- 318) Tensile Modulus: When a bar is pulled in tension, it has to get longer. The tensile modulus is used to calculate how much longer it will get when a certain load is applied to it. Units are normally millions of pounds per square inch. (10⁶ psi) - Giga Pascals (GPa). Higher numbers indicate materials which will not elongate as much as others when they are being compared under equal tensile loading conditions.
- 319) Tensile Strength: how large a non-moving load a bar can withstand before it breaks due to elongation. Units are normally thousands of pounds per square inch. (10³ psi) - Mega Pascals (MPa). Higher numbers indicate materials which can withstand a stronger pull before breaking.
- 320) Tensile Stress: normal stress caused by forces directed away from the plane on which they act.
- 321) Thermal Coefficient of Expansion: see Coefficient of Thermal Expansion.
- 322) Thermal Conductivity: measures the transfer of heat through a material.
- 323) Thermoplastic: capable of being repeatedly softened by an increase of temperature and hardened by a decrease 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.
- 324) Thermoplastic Polyesters: class of thermoplastic polymers in which the repeating units are joined by ester groups. The two important types are (1) polyethylene terephthalate (PET), which is widely used as film, fiber, and soda bottles; and (2) polybutylene terephthalate (PBT), primarily a molding compound.
- 325) Thermoset: plastic that, when cured by application of heat or chemical means, undergoes an irreversible change.
- 326) Thermosetting Polyesters: class of resins produced by dissolving unsaturated, generally linear, alkyd resins in a vinyl-type active monomer such as styrene, methyl styrene, or diallyl phthalate. Cure is effected through vinyl polymerization using peroxide catalysts and promoters or heat to accelerate the reaction. The two important commercial types are (1) liquid resins that are cross-linked with styrene and used either as impregnants for glass or carbon fiber reinforcements in laminates, filament-wound structures, and other built-up constructions, or as binders for chopped-fiber reinforcements in molding compounds, such as sheet molding compound (SMC), bulk molding compound (BMC), and thick molding compound (TMC); and (2) liquid or solid resins cross-linked with other esters in chopped-fiber and mineral-filled molding compounds, for example, alkyd and diallyl phthalate.
- 327) Tooling Gel Coat: gel coat formulated for mold surfaces.

328) Translucent: permits a percentage of light to pass but not optically clear like window glass.

329) Unidirectional: strength lying mainly in one direction. A glass reinforcement in which the fiber is oriented in one direction.

330) UV Stabilizer: chemical compound which improves resistance to degradation from ultraviolet radiation.

331) Vacuum Bag Molding: 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.

332) Veil: ultra thin mat similar to a surface mat. Veil allows for a resin rich surface without overloading your composite with too much resin. Too much resin in relation to your reinforcement can weaken the composite, adding weight without adding strength.

333) Vinyl Esters: class of thermosetting resins containing esters of acrylic and/or methacrylic acids, many of which have been made from epoxy resin. cure is accomplished as with unsaturated polyesters by copolymerization with other vinyl monomers, such as styrene. Schmelzer Industries offers veils and mats with vinyl binders.

334) Viscosity: liquid properties of a material. Resistance to flow.

335) Wet-Out: action of saturating a glass mat with resin. Also a measure of the speed at which a mat soaks up resin. Veils and mats made with the Modigliani process have rapid wet-out.

336) Woven Roving Fabric: heavy fabrics woven from continuous filament in roving form. Usually in weights between 18-30 oz. per square yard.

337) Wrinkle: 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.

338) Yarn: twisted strands of roving, used to weave textile reinforcements.

339) Yield Point: first stress in a material, less than the maximum attainable stress, at which the strain increases at a higher rate than the stress. The point at which permanent deformation of a stressed specimen begins to take place. Only materials that exhibit yielding have a yield point.

340) Yield Strength: stress at the yield point. The stress at which a material exhibits a specified limiting deviation from the proportionality of stress to strain. The lowest stress at which a material undergoes plastic deformation. Below this stress, the material is elastic; above it, the material is viscous. Often defined as the stress needed to produce a specified amount of plastic deformation (usually a 0.2% change in length).

341) Young's modulus: ratio of normal stress to corresponding strain for tensile or compressive stresses less than the proportional limit of the material.

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