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Standard Terminology Relating to Reinforced Plastic Pultruded Products[1]

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1. Scope

1.1 These definitions cover terms used in the reinforced plastics pultrusion industry. In some cases the terms may be identical to those employed in other standards.

NOTE 1—There is no known ISO equivalent to this standard.

2. Terminology

barcol hardness—a measurement of the surface hardness using a Barber Colman impresser.

NOTE 2—The Barcol hardness is a relative measure of cure and the nominal value can differ on a fully cured part with the use of different additives.

blister—a rounded elevation of the pultruded surface with boundaries that may be more or less sharply defined. A blister may be a small percentage or large percentage of the pultruded part surface.

NOTE 3—The rounded elevation somewhat resembles a blister on the surface of human skin. Blisters may exist within the pultrusion as a hollow area (usually gas-filled) under a raised portion of the surface.

blooming, fiber—a pultrusion surface condition exhibiting a fiber prominence or fiber show that usually has a white or bleached color on parts without a surfacing veil.

NOTE 4—The surface generally feels rough when touched by the fingers and is of superficial thickness easily removed by buffing or light sanding. There is not a structural issue.

blooming, undercure—a dull and bleached surface color that is evident in pultruded material not exposed to the weather.

NOTE 5—This condition is usually the result of insufficient surface cure.

bow—See *camber* and *straightness*.

camber—the deviation of the edge or surface of a pultruded shape from a reference straight line.

chips—minor damage to the pultruded surface that removes material but does not cause a crack or craze. Typically caused by minor impact damage closed shape-a pultruded shape that has a hollow component.

crack—a visual separation that occurs internally or penetrates down from the pultruded surface to the equivalent of one full ply or more of reinforcement (at least 0.019 in. or 0.48 mm).

crater—a small, shallow pultrusion surface imperfection.

craze—multiple fine cracks at or under the pultruded surface.

craze, hairline—multiple fine pultrusion surface separation cracks that exceed ¼ in. (6.4 mm) in length and do not penetrate in depth to the equivalent of full ply of reinforcement.

craze, resin—multiple fine separation cracks at the pultruded surface not penetrating into the reinforcement.

NOTE 6—This condition is usually due to resin shrinkage during cure in resin-rich areas.

delamination—the separation of two or more layers or plies of reinforcing material within a pultrusion, which increases the localized part thickness by more than 0.13 mm (0.005 in.).

die-parting line—a lengthwise flash or depression on the surface of a pultruded plastic part.

NOTE 7—The die-parting line is associated with the area where separate pieces of the die join together to form the cavity.

die struck dimension—a dimension that is controlled exclusively by the dimensions of the steel die and not by processing.

discoloration—a streak or other pattern on the surface that causes a noticeable change of color from the rest of the pultruded surface.

dry fiber—a condition in which fibers are not fully encapsulated by resin during pultrusion.

dullness—a lack of normal pultruded surface gloss or shine.

NOTE 8—This condition can be caused by insufficient cure locally or in large areas end cut angularity-The squareness of the end cut on a pultruded shape measured in reference to a flat surface on the pultruded part which is parallel to the direction of pull.

dwarf width—a condition in which the crosswise (of the direction of pultrusion) dimension of a flat surface of the part is less than that the die normally would yield for a particular composite.

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NOTE 9—This condition is usually caused by a partial blockage of the pultrusion die cavity caused by "build-up" or particles of the composite adhering to the cavity surface. This condition is commonly called a "lost edge" when the flat surface has a free edge that is altered by the build-up.

exposed underlayer—the underlying layer of mat or roving not covered by surface mat in a pultrusion.

NOTE 10—This condition can be caused by reinforcement shifting, too narrow surface mat, too wide underlying mat, uneven slitting of surface mat, or necking down of surface mat or excessive tension in pulling the mat off the spindle.

fiber bridging—reinforcing fiber material that is found bridging across on an inside radius of a pultruded product.

fiber prominence—a visible and measurable pattern of the reinforcing material on the surface of a pultruded plastic part.

NOTE 11—Typically not a structural issue.

flatness—a localized curvature in the pultruded surface measure perpendicular to the direction of pull.

folded reinforcement—an unintentional or unspecified misalignment of mat or fabric reinforcing material in relation to the contour of a pultruded section.

NOTE 12—Such folds may or may not affect the surface appearance of the pultrusion and are chiefly visible in a cut cross section of the product.

fracture—cracks, crazing, or delamination, or a combination thereof, resulting from physical damage to the pultrusion.

gouges—see **chips**.

grooving—long narrow grooves or depressions in a surface of a pultrusion parallel to the direction of pull.

inclusion—any foreign matter or particles that are either encapsulated or imbedded in the pultrusion.

insufficient cure—a pultrusion abnormality created by lack of, or incomplete, cross-linking of the resin.

NOTE 13—This condition can usually be detected by dull surface appearance, low Barcol hardness, and low physical properties. Thick sections, cured from the outside in, can reveal insufficient cure in the center of the section even though completely cured on the surface. This condition can be caused by insufficient die temperature, improper catalyst, or pulling too fast for the die temperature. Low Barcol hardness is relative to the normal Barcol hardness for the product.

internal shrinkage cracks—separations not extending to the surface in the pultrusion that are found within sections of heavy roving reinforcement between the mats. Internal shrinkage separations do not increase the part thickness by more than 0.005 in. (0.48 mm).

NOTE 14—This condition is caused by shrinkage strains during cure that are apparent in the heavy roving portion of the pultruded part.

open shape—a pultruded shape that is not enclosed by composite on all sides.

porosity: porosity, internal—the presence of numerous pits or pin holes beneath the pultruded surface; usually observable only in a cut cross section.

porosity, surface—the presence of numerous visible pits or pin holes at or near the pultruded surface.

pultrusion—(*1*) a process described as the reversed "extrusion" of resin-impregnated reinforcements in the manufacture of rods, tubes, sheets, and shapes of uniform cross section. The reinforcement, after being saturated by the resin-application system, is drawn through a die to form the desired cross section. (*2*) a term that is applied to the product of the above process. (*3*) a term used to show association with the above process.

reinforcement distortion—knotted, tangled, widely spaced, or otherwise abnormal but local irregularities in reinforcement distribution throughout the pultruded cross section.

reinforcement-rich area—an over-concentration of reinforcement in the pultruded cross section.

resin-rich area—an area of the pultrusion that lacks sufficient reinforcement.

NOTE 15—The fiber pattern may not be visible.

roving knot—a knotted or entangled section of roving found in a pultrusion.

NOTE 16—Such a knot may cause high fiber concentration locally and may or may not be visible as a white or light spot on the surface of the section.

saw burn—blackening or carbonization of a cut surface of a pultruded section.

scale—a condition wherein resin plates or particles are on the surface of a pultrusion.

NOTE 17—Scales can often be readily removed, sometimes leaving surface voids or depressions.

scuffing—long white scrape marks on the surface of the pultrusion.

NOTE 18—This condition usually results from mechanical scraping or scratching of the pultrusion in the machine or in handling it afterwards.

sluffing—a condition wherein scales peel off or become loose, either partially or entirely, from the pultrusion.

NOTE 19—This term is applied to an occurrence during the pultrusion process and is not to be confused with scraping, prying, or physically removing the scale from the pultrusion. "Sluffing" is sometimes spelled "sloughing".

stop mark—a band, either dull or glossy, on the surface, approximately ½ to 3 in. (12 to 76 mm) wide and extending around the periphery of a pultruded shape.

NOTE 20—This condition is the result of an interruption in the normal continuous pulling operation and typically does not cause a structural issue.

straightness—the vertical (upward) deviation of the pultruded shape when resting on a flat surface. This deviation is measured in the center of the shapes resting on a flat surface.

twist—a condition of longitudinal progressive rotation found in pultruded parts.

NOTE 21—This term describes a condition that can be easily detected for a noncircular cross section by placing the pultrusion on a plane surface, holding one end flat with the surface, and observing if one edge or side of the other end does not lie parallel with that surface.

void—any pocket of gas entrapment within or between the plies of reinforcement (see **blister** and **porosity**).

wet-out—the saturation of the reinforcement by the polymer.

wrinkle depression—an undulation or series of undulations or waves on the surface of the pultruded part.

NOTE 22—This condition can occur in either the lengthwise or crosswise direction of the pultrusion and is caused by reinforcement shifting and crowding (see **folded reinforcement**). Wrinkles affect the flatness of the surface. Wrinkles that occur in the flange tip and are approximately 45° to the direction of pull are known as "wavelike wrinkles."