



Designation: D 3918 – 96

## Standard Terminology Relating to Reinforced Plastic Pultruded Products<sup>1</sup>

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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 or by other standards bodies.

NOTE 1—There is no similar or equivalent ISO standard.

### 2. Terminology Definitions

**black marking**—black smudges on the surface of the pultruded product that cannot be removed by cleaning or scrubbing or wiping with solvent.

NOTE 2—Black marking results from excessive pressures in the die when the pultrusion is rubbing against soft or unchromed die surfaces.

**blister**—a rounded elevation of the pultruded surface with boundaries that may be more or less sharply defined.

NOTE 3—The rounded elevation somewhat resembles in shape a blister on the surface of human skin. Blisters may exist within the pultrusion as a hollow delaminated 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 and a sparkling appearance.

NOTE 4—The surface generally feels rough when touched by the fingers and is of superficial thickness easily removed by buffing or light sanding.

**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**—a condition of longitudinal curvature in pultruded parts.

**burn**—a discoloration, distortion, or destruction of the pultruded surface as a result of thermal decomposition.

**chips**—minor damage to the pultruded surface that removes material but does not cause a crack or craze.

**concave surface**—a local concave curvature in the flat surfaces of pultruded plastic parts as measured transversely to their length.

**convex surface**—a local convex curvature in the flat surfaces of pultruded plastic parts as measured transversely to their length.

**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.

**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  $\frac{1}{4}$  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.

**craze, star**—multiple fine pultrusion surface separation cracks exceeding  $\frac{1}{4}$  in. (6.4 mm) in length but not penetrating in depth to the equivalent of a full ply of reinforcement, that appear to emanate from a central point.

NOTE 7—This condition is often caused by impact damage.

**delamination**—the separation of two or more layers or plies of reinforcing material within a pultrusion.

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

NOTE 8—The die-parting line is associated with the area where separate pieces of the die join together to form the cavity.

**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 9—This condition can be caused by insufficient cure locally or in large areas, resulting in the dull band created on a pultruded part within the die when the pultrusion process is interrupted briefly (see **stop mark**).

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**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.

NOTE 10—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 11—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 it off the spindle.

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

NOTE 12—This condition is caused by shrinkage stresses around such a radius during cure.

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

**fiber show**—strands or bundles of fibers that are not covered by resin and that are at or above the surface of a reinforced plastic pultrusion.

**fish-eye**—a small globular mass that has not blended completely into the surrounding pultruded material.

NOTE 13—This condition is particularly evident in a transparent or translucent material.

**flats**—a longitudinal flat area on a normally convex surface of a pultrusion.

NOTE 14—This condition may be caused by shifting in the reinforcement, lack of sufficient reinforcement, or local fouling of the die surface.

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

NOTE 15—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. Such reinforcement irregularities are usually due to shifting and crowding of the reinforcing material during pultrusion.

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

**glassiness**—a glassy, marbled, streaked appearance at the pultruded surface.

NOTE 16—This condition is visually evident, but reinforcement is in fact fully encapsulated with resin.

*gouges*—see **chips**.

**grooving**—long narrow grooves or depressions in a surface of a pultrusion parallel to its length.

NOTE 17—This condition is usually caused by die fouling or by a spot of resin build-up on the die surface, effectively changing the shape of the cross section.

**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 18—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.

**intermittent disfigurement**—disfigurement of the shape of the pultrusion for a limited length.

NOTE 19—This condition usually results from die fouling or from folded or crowded reinforcing material and is corrected after a short distance.

**internal shrinkage cracks**—longitudinal cracks in the pultrusion that are found within sections of roving reinforcement.

NOTE 20—This condition is caused by shrinkage strains during cure that show up in the roving portion of the pultrusion where transverse strength is low.

**lack of resin fillout**—a pultrusion condition where an area contains reinforcement not wetted with sufficient quantity of resin.

NOTE 21—This condition usually occurs at the edge of a pultrusion.

**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.

**pultrude, v**—to draw resin-impregnated reinforcement through a die.

**pultruded, adj**—made by pultrusion.

**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 wet-out 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.

NOTE 22—This condition usually causes noticeable changes in the local reinforcement content with crushing of the reinforcement or resin-richness in isolated areas.

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

NOTE 23—This usually occurs where mat or other reinforcement is folded, creased, or bunched in a portion of the cross section.

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

NOTE 24—The fiber pattern may not be visible.

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

NOTE 25—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.

NOTE 26—This condition is usually caused by cutting with a dull saw blade, cutting too slowly, or cutting a highly reinforced material with a diamond blade without water.

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

NOTE 27—Scales can often be readily removed, sometimes leaving surface voids or depressions.

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

NOTE 28—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 29—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 30—This condition is the result of an interruption in the normal continuous pulling operation.

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

NOTE 31—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**).

**wire brush surface**—a roughness due to fibers protruding above the surface of the pultruded part.

NOTE 32—This condition usually occurs at the edge of a reinforcing mat strip and is typically located at the edges or corners of the profile.

**wrap seam**—a depression or step in the surface finish caused by the lap of the flexible mold or carrier strip after it is removed from the cured pultrusion.

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

NOTE 33—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.

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