

Glossary of Raw Materials Terms

A

Acid. A species that reacts in liquid water to generate hydrogen ions. See **Acid groups**.

Acid equivalent weight. The weight of resin that contains one equivalent of carboxylic acid functionality.

Acid functional acrylic. An acrylic resin that has carboxylic acid functional groups for curing.

Acid groups. Also, carboxylic acid, organic acid that possesses one or more carboxyl groups. The simplest member of the series is formic acid HCOOH. See **Acid**.

Acid number. A measure of acidity, typically resulting from carboxylic acid functional groups on the polyester. Usually reported as milligrams potassium hydroxide per gram resin (mg KOH/g).

Adduct. (1) A chemical compound that forms from chemical addition of two species, for example, reaction of butadiene with styrene forms an adduct, 4-phenyl-1-cyclohexene; (2) the complex compound formed by association of an inclusion complex.

Aliphatic esters. Nonaromaticity-containing esters (see **Aromatic monomers**) typically used to produce improved exterior-durable polyester resins.

Allyl. Compounds whose functional groups are based on $\text{CH}_2 = \text{CRH}$ where R may be a hydrogen or other alkyl group.

Amines. Any group of organic compounds of nitrogen—used as a curing agent when combined with epoxy resin—contains the NH_2 group.

Anhydride. A reactive chemical compound that combines with water to yield two acid functional groups or with hydroxyls to yield an acid and an ester chemical link.

Aromatic monomers. Monomers used to make relatively inexpensive polyesters. The composition is such (aromaticity) that the polyester derived from it has only limited exterior durability.

B

Backbone chain. Base chemical used to polymerize a chemical compound or resin. Examples of epoxy resins are epichlorohydrin and bisphenol-A.

Benzoin. An additive used in some powder coating formulations as a degassing agent. Air or other gases expelled during cure from the substrate or the powder coating can become trapped below the surface of the finish, causing blisters, bubbles, or small holes—such as microcraters or pinholes. Benzoin prevents these film defects and promotes flow and leveling of the powder finish.

Binder. The powder coating component that binds to the pigments and fillers and provides adhesion to the substrate.

Bisphenol A. Aromaticity-containing monomer (see **Aromatic monomers**) typically used in epoxy resins for powder and other coatings.

Blocked isocyanate curative. A group of urethane curing agents with isocyanate groups bonded (blocked) to a blocking agent (most often **E-caprolactam**, see next page) to render them chemically inert at ambient temperatures. At elevated temperatures, generally more than 250°F (121°C), the curative deblocks and the resulting isocyanate groups react with the hydroxyl groups of the resin or resins.

Blocking. The tendency of some powder coating resins to agglomerate or stick together during storage; also called *sintering* or *fusing*.

C

Carboxyl group. $-\text{COOH}$ The functional group of carboxylic acid. Also known as carboxy group.

Carboxylic acid. The $-\text{COOH}$ chemical unit. It provides acidity, reacts with hydroxyls to make esters, and is commonly used as the polyester resin functional group that reacts with epoxide resins and TGIC during coating cure conditions to yield durable coatings.

Cation. Specifically, for cationic polymerization is a process in which the active end of the growing polymer molecule is a positive ion.

Cresol. One of three poisonous, colorless isomeric methyl phenols, o-cresol, m-cresol, p-cresol; used in the production of phenolic resins, tricresyl phosphate, disinfectants, and solvents.

Crosslink. A generic term for chemical bonds that link polymer chains to each other, or the process of linking polymer chains to each other. Provides enhanced solvent resistance and durability. Often synonymous with curing.

D

Dicyandiamide. A typical representative among the aliphatic solid amines used as curing agents in the production of epoxy powder coatings.

Dodecanedioic acid (DDA). Crosslinker for glycidyl methacrylate (GMA) acrylic resins. It contains two carboxylic acid groups, enabling it to react, or cure, with the epoxy group of the GMA resin.

Dry blending. Two final powder coatings are mixed together rather than extruded together.

E

E-caprolactam, or E-cap. A widely used blocking agent for isocyanate curatives. During cure, up to 80 percent of the E-cap evaporates from the powder finish. The rest is retained in the film. E-cap is biodegradable.

E-caprolactam-blocked isophorone diisocyanate (IPDI). One of the widely used crosslinkers for urethane powder coatings (see **E-caprolactam** and **Blocked isocyanate curative**).

EMMAQUA. Accelerated exterior-durable test method in which natural sunlight amplified by mirrors is directed to painted panels.

Epoxide. A reactive group in which an oxygen atom is joined to each of two carbon atoms that are already bonded.

Epoxy. A reactive group commonly present in resins (epoxy resins, GMA resins) or crosslinkers (triglycidyl isocyanurate, or TGIC).

Epoxy equivalent weight (EEW). The weight of the resin containing 1 gram equivalent of epoxide; also called *weight per epoxide group (WPE)* and *epoxy molecular mass (EMM)*.

Epoxy groups. Functional groups with the structure:



Epoxy resin. A polymeric product characterized by possessing epoxy functional groups (three-member, cyclic ring with two carbon atoms and one oxygen atom) that are capable of reacting with other functional groups such as carboxylic acids to form new chemical bonds.

Equivalent weight. The weight of a polymer per functional group, for example, 450 grams per hydroxyl group.

Ester. The compound formed by the elimination of water and the bonding of an alcohol and an organic acid.

Esterification. A reaction that produces ester linkage.

F

Flow agent. Substance added to a powder to increase flow characteristics during the curing process.

Free radical. A highly reactive electron-deficient molecule.

Functionality. Ability of a compound to form covalent bonds; compounds may be mono-, di-, tri-, or polyfunctional; that is, one, two, three, or many functional groups may participate in a reaction.

Fusion. See *Sintering*.

G

Gel time. Amount of time it takes for a resin to set (stop flowing) at a given temperature.

Glass transition temperature. The temperature at which polymer molecules are able to move fairly freely even in the solid state. Rubber is elastic because the molecules at room temperature are above their glass transition temperature and can be easily stretched out of position.

Glycidyl methacrylate (GMA) acrylic. An acrylic resin that has an epoxy group for curing.

Glycol. A chemical compound characterized by having two hydroxyl (-OH) functional groups bonded to the same molecule. Is also commonly referred to as a *diol*.

Glycoluril. A chemical compound derived from urea-formaldehyde reaction products. Reacts with hydroxyl functional polyesters at conventional cure oven temperatures.

H

Hardener. Curing agent; promoter; catalyst.

Homopolymerize. A polymer made up of similar repeat units.

Hybrid coating. A powder coating based on a blend of polyester and epoxy resins reacting during the cure cycle to yield the binder.

Hydroxyalkylamides (HAA). Chemical compounds that have a specific spatial arrangement of the hydroxyl functionality and amide chemical bonds that provides internal catalysis to the reaction of the hydroxyl with carboxylic acids.

Hydroxyl. Reactive group commonly present in resins for urethane coatings, either polyester or acrylic.

Hydroxyl equivalent weight. The weight of a resin that contains one equivalent of hydroxyl functionality.

Hydroxyl functional acrylic. An acrylic resin that has hydroxyl functional groups for curing.

Hydroxyl number. A measure of hydroxyl (-OH) functionality in a resin. Usually reported at milligrams potassium hydroxide per gram resin (mg KOH/g).

I

Isocyanate. Chemical functionality that reacts with hydroxyl functionality to yield a urethane chemical bond.

M

Maleic functional. A polymer containing functional groups derived from reacted maleic acid or anhydride.

Masterbatch. A plastic, rubber, or elastomer mixture in which there is a high additives concentration, such as plastic with color pigment; used to proportion additives accurately into large bulks of plastic, rubber, or elastomer.

(Meth)acrylate ester. CH₂:C(CH₃)COOR Methacrylic acid ester in which R can be methyl, ethyl, isobutyl, or any other of many alkyl groups.

Methanol-blocked melamine. A crosslinker for hydroxyl- or carboxylic-acid-containing resins. The reactive sites are blocked with methanol, which releases during cure.

Moiety. A part, portion, or share.

Molecular weight. A measure of the size or length of a polymer chain. Usually reported as an average mass unit. Higher molecular weights tend to lead to higher melt viscosity.

Monomer. A primary molecule, or building block, in a polymer product, such as ethylene (in polyethylene) and glycols (in polyesters).

Multifunctional resins. See *Upgraded resins*.

N

Novolac resin. Any of the thermoplastic phenol-formaldehyde resins made with an excess of phenol in the reaction; used in varnishes.

O

Oxime-blocked isocyanate. An isocyanate crosslinker in which the reactive isocyanates are blocked by an oxime group.

Oximes. A large family of chemical compounds; some can be used as a blocking agent for isocyanate.

P

Pendant groups. Part of the (meth)acrylic monomer that gives each monomer its specific set of properties.

Phenolic resins. A particular group of film formers. Resins made from phenols and aldehydes.

Photoinitiator. A compound that initiates a reaction after irradiation with intense light.

Polyester. A polymer characterized by having multiple ester chemical links in its backbone structure and formed by the reaction of glycols or polyols with di-, tri-, or polycarboxylic acids at high temperatures.

Polymer. A chemical compound characterized by having a large molecular mass and produced by chemically linking smaller molecules together. Main component of the binder.

Polyols. Resin—acrylic or polyester—that contains hydroxyl functional reactive groups (alcohols).

Q

QUV. Accelerated weathering test in which painted panels are exposed to ultraviolet light.

R

Reactive diluent. A viscosity reducer for coatings that has low volatility and will become a permanent part of the coating through chemical reaction.

Reactivity. The relative capacity of an atom, molecule, or radical to combine chemically with another atom, molecule, or radical.

Resin. Film former; material (natural or synthetic) contained in varnishes, lacquers, and paints. See also **Polymer**.

S

Sintering/blocking. The process by which a free-flowing powder softens and agglomerates.

Specific gravity. An expression of the density of a material. The ratio of the weight of a given volume of liquid or solid to the weight of an equal volume of water.

T

Theoretical coverage. The amount of area that can be covered with a given amount of powder coating at a defined average film thickness (often calculated for 1 mil, or 25 microns, and expressed as square feet per pound per mil). It can be determined through a mathematical formula containing a numerical constant, the specific gravity of the powder, and the average intended film thickness (often 1 mil). Terms such as mileage and theoretical mileage also are used.

Thixotropes. Additives used to impart thixotropy to a coating. See **Thixotropy**.

Thixotropy. Flow behavior in which viscosity is reduced by touch (agitation, stirring). Thixotropy is time dependent. With a thixotropic material, viscosity decreases with time at a given shear rate, then rebuilds with time when the shearing stops. See **Thixotropes**.

U

Ultraviolet-light-curable (UV curable). Ultraviolet light, not heat, is used to cause the chemical curing process.

Upgraded resins. Resins that contain more than two epoxide groups; also called multifunctional resins.

V

Vinyl group. A group of atoms derived when one hydrogen atom is removed from ethylene.

Viscosity. A measure of how much or how well a material flows under a specific set of test conditions. Reported in poise or pascal seconds for the polyesters. Higher value represents higher viscosity and lower flow.

Definitions are a compilation from glossaries published with the following articles in *Powder Coating*:

"Polyester resins—versatility leads to winning performance," by Carl J. Sullivan and Clayton C. Crawford, vol. 8, no. 5 (August 1997), p. 22.

"A review of ultraviolet-curable powder coatings," by Shelby F. Thames and James W. Rawlins, vol. 7, no. 8 (November 1996), p. 21.

"Thin-film powder coatings: Advantages to consider," by Bruno Fawer, vol. 7, no. 1 (February 1996), p. 43.

"Acrylic resins for powder coatings: Current generations and future trends," by Jos M.J. Verlaak, vol. 5, no. 3 (June 1994), p. 16.

"Epoxy resins: A few facts will get you the finish you need," by Robert Miller, vol. 4, no. 3 (June 1993), p. 24.

Definitions in the preceding articles are from the authors and the following sources:

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