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Film Extrusion Manual: Process, Materials, Properties

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Chapter 26

Plastics Glossary

by Mike Koyich

This glossary provides brief definitions of terms and concepts used daily in the plastics industry, and is to be used as a quick reference and spelling checker. The information was compiled from numerous previously printed sources, but no single source contained all the terms that are being used in our industry. Additional terms and descriptions were contributed by personnel at Novacor Technical Centre.

A

ABS ACRYLONITRILE - BUTADIENE-STYRENE A terpolymer manufactured from acrylonitrile and styrene liquids and butadiene gas. Resin can be produced by polymerization, grafting, physical mixture, or combinations.

ABRASION RESISTANCE Ability of a plastic to withstand mechanical action that tends to wear material from its surface.

ABSORPTION Penetration of one material into the mass of another by molecular or chemical action.

ACCUMULATOR An auxiliary ram used to provide fast delivery of plasticated melt. Used on injection and blow molding operations. A cylinder is filled with plasticated melt between shots by an extruder. This cylinder then stores the melt for the next shot. Mostly used for large pan molding. In injection molding, the accumulator is a nitrogen-filled bag inside a hydraulic cylinder and is used to produce higher injection speeds.

ACETAL Rigid thermoplastic produced by the reaction of purified formaldehyde. Molecular structure is linear acetal with unbranched polyoxymethylene chains.

ACETATE A derivative of acetic acid.

ACRYLIC A synthetic resin of acrylic or methacrylic esters. Methacrylates are usually methyl, ethyl, butyl, lauryl, or stearyl. Acrylics are widely known for their clarity properties.

ACTUATORS Device that controls the movement or mechanical action of a machine indirectly, usually accomplished by means of pneumatic or hydraulic cylinders.

ADAPTER A long, heated cylindrical pipe used to convey molten resin from an extruder into an extrusion die.

ADAPTER PLATE A plate which holds the mold to a platen in injection molding.

ADDITIVE Any substance compounded into resin to modify its properties. Additives can be antioxidants, colorants, pigments, light stabilizers, etc.

ADIABATIC A process condition in which no heat is deliberately added or removed. Used to describe extrusion methods where heat is derived from mechanical action of the screw to an extent that sufficient heat is generated to melt the resin.

ADSORPTION Adhesion of the molecules of one material to the surface of the solid or liquid with which they are in contact.

AIR RING In blown film extrusion, a circular manifold mounted above the extrusion die used to distribute an even flow of air against a blown film bubble.

ALLOY Terms in plastics used to describe a blend of polymers with other polymers or copolymers, usually where the properties of the alloy exceed those of the constituents (see Synergism).

AMORPHOUS Having no crystallinity. At processing temperatures, most plastics are amorphous.

ANISOTROPY The tendency of a material to have properties that differ according to the direction of measurement.

ANNEALING The process in which a molded plastic part is heated to a predetermined temperature, maintained at this temperature for a predetermined time and slowly cooled at a predetermined rate to relieve stresses.

ANTIBLOCK AGENT Additive incorporated in film to prevent the adhesion (sticking) between touching layers of film during fabrication, storage, or use. For example, these additives can be diatomaceous earth, silica, and talc.

ANTIMONY OXIDE A white, odorless, fine powder widely used as a flame retardant in plastics.

ANTIOXIDANT An additive which inhibits the degradation and oxidation of a material when exposed to ambient air during processing and subsequently in the end product form.

ANTISTATIC AGENT Additive which imparts a slight degree of electrical conductivity to plastics, permitting the dissipation of static electricity.

ARTIFICIAL WEATHERING Process of exposing plastics to environmental conditions developed by laboratory methods designed to simulate actual outdoor exposure. Laboratory conditions are usually intensified in comparison to actual outdoor conditions.

ASH CONTENT Solid residue left after a polymer has been incinerated at high temperatures sufficient to drive off all combustibles.

ATACTIC POLYMER Polymers with a random arrangement of radical groups above and below a molecular chain, usually used in reference to polypropylene resins.

AVERAGE MOLECULAR WEIGHT Molecular weight of polymers is determined by viscosity of the material in solution at a specific temperature. This results in an average molecular weight of the molecular chains independent of specific chain length. The value obtained falls between weight and number average molecular weight.

B

BACKING PLATE In injection molding, a plate used as a support for cavity blocks, guide pins, bushings, etc. Sometimes referred to as support plate.

BACK PRESSURE In extrusion, the resistance of molten polymer to flow forward, caused by a pressure difference between two points along the path of flow. In molding, the resistance provided by the hydraulic system to the screw to retard its screw back time.

BALANCED RUNNER A runner system in injection molding which designs all cavities in equal distance from the sprue.

BANBURY MIXER A compounding apparatus consisting of two contra-rotating spiral-shaped blades encased in intersecting cylindrical housings so as to leave a ridge between blades.

BAND HEATER Electrical heating units fitted to extruder barrels, adapters, dies, nozzles, etc. utilized for heating the polymer to a desired temperature.

BARREL The tubular portion of the extruder or injection molding machine in which the extruder screw is placed and rotates.

BARRIER RESINS Polymers which have very low permeability to gases.

BETA GAUGE A thickness measuring device used for sheeting or extruded pans. The device operates by beta radiation being emitted on one side of the pan and a detector placed on the opposite side. When a pan is passed through the beam, some of the beta radiation is absorbed, which is indicative of the pan thickness.

BIAXIAL ORIENTATION The process of stretching a hot plastic film or other article in two directions under conditions resulting in molecular orientation in two directions.

BIODEGRADATION The degradation of plastics by microorganisms when buried in the soil. Some plastics can be modified to become biodegradable by the incorporation of a biodegradable additive such as corn starch.

BLANKING DIE The cutting of a flat sheet to shape by striking it sharply with a metal punch while supporting it on a mating die.

BLEND The mixing of polymers with other polymers or copolymers, usually where the mixture results in the desired physical properties.

BLISTER A defect on an injection molded part caused by trapped gases within the pan.

BLISTER PACKAGING A method of packaging in thermoformed pouches shaped to fit the contours of the article. The product

is placed in the pouch and a panel board or plastic backing is sealed to the formed sheet to enclose the product.

BLOCKING An undesirable adhesion between layers of film or sheeting which may have developed during processing or storage. Blocking can be prevented by adding antiblock agents to the resin.

BLOOM A thin, greasy film on the surface of a plastic film or pan usually caused by the exudation of an additive. Slip additives are designed to migrate or bloom to the surface of films.

BLOWING AGENT A substance which, alone or in conjunction with other substances, is capable of producing a cellular structure in a plastic mass.

BLOW HOLE Blow-outs or loss of internal air from a blown film bubble usually due to a rupture caused by fisheyes, gels, or contamination.

BLOW MOLDING A method of processing in which a parison (hollow tube) is forced into the shape of the mold cavity by internal air pressure.

- a) **EXTRUSION BLOW MOLDING**
Extruder is operated continuously and the output either feeds an accumulator or flows through the die as an endless parison, pinching it off, with air then introduced into the cavity.
- b) **INJECTION BLOW MOLDING**
Plastic melt is injected as a parison into a preform cavity forming the preform around a core rod. A completely finished injection molded neck is formed at this station. The preform is then transferred

to a blow station where it is blown through an opening in the core rod and into the final shape.

- c) **REHEAT BLOW MOLDING** In reheat blow molding, parisons are stretched axially by an external gripper or an internal stretch rod, and then stretched radially by blow air to form the finished product. This process orients the molecules biaxially resulting in improved barrier properties.

BLOW PRESSURE Air pressure used to expand the parison within a blow mold.

BLOWN FILM TOWER Apparatus for handling film in blown film extrusion between the extruder die and take-up equipment. The blown film tube passes through the tower where it is cooled, sized, and gauged. Nip rolls are located at the top where the inflated tube is collapsed prior to winding.

BLOW-UP RATIO The ratio of the final tube diameter to the die diameter in blown film extrusion. In blow molding, it is the ratio between the mold cavity diameter and the parison diameter.

BOSS A small projection provided on an article to add strength or facilitate alignment with another part during assembly. May also be used to attach one part to another.

BRANCHED POLYMER A polymer in which side chains are attached to the backbone of the molecular chain.

BREAKER PLATE A perforated plate located at the rear end of an extruder head or die adapter serving to support the screen pack. The breaker plate also helps to generate back pressure in extrusion.

BULK DENSITY The density (mass per unit of volume) of a resin in solid form (granular, nodular, pellet, powder, etc.) expressed in g/cc or lb/ft³.

BUTENE A class of hydrocarbons having four carbon atoms and a double bond comprising 1-butene, cis-2-butene, trans-2-butene, and iso-butylene. Has numerous applications in plastics including acting as monomers with styrene, acrylics, olefins, and vinyls. 1-butene is a comonomer used in the production of linear low-density polyethylene.

C

CADMIUM PIGMENTS Inorganic pigments based on cadmium sulphide and cadmium sulphoselenides used widely in polyethylenes. Includes cadmium maroon, orange, red, and yellow.

CALCIUM CARBONATE A filler and extender used in thermoplastics. It occurs naturally in the form of minerals such as calcite, chalk, limestone, marble, and whiting.

CALENDERING Process in which film and sheet material is produced by squeezing heated, viscous material between two or more counter-rotating rolls. The gap between the last pair of heated rollers determines the thickness of the sheet. Subsequent cold rollers cool the sheet.

CALORIMETER A device used for measuring the heat transferred during thermal reactions.

CAPILLARY RHEOMETER An instrument for measuring the shear flow properties of polymer melts. The data obtained is usually presented as graphs of shear stress against shear rate at a constant temperature.

CARBON BLACK A multifunctional pigment used in plastics as a conductor of electricity, a pigment, a filler extender, and as a UV stabilizer.

CARTRIDGE HEATER Cylindrical-bodied, electrical heater for providing heat for injection, compression and transfer molds, injection nozzles, runnerless mold systems, hot stamping dies, sealing, etc.

CAST FILM Film extruded from a flat die onto chill rolls. Benefits are extremely high line speeds (2000 fpm) and clarity. Drawbacks include high capital costs and film orientation is predominantly in the machine direction.

CATALYST A substance which causes or accelerates a chemical reaction when added to the reactants in minor amount without being permanently affected by the reaction.

CAVITY A depression in plastic forming which forms the outer surfaces of the cast or molded articles.

CELLULOSE ACETATE An acetic acid ester of cellulose which forms a tough, transparent thermo-plastic material when compounded with plasticizers.

CENTER GATED MOLD In injection molding, a mold in which each cavity is fed through an orifice at the center of the cavity. This type of gating is employed for items such as cups, bowls, and lids.

CHAIN LENGTH The number of monomeric or structural units in a linear polymer.

CHANNEL DEPTH RATIO In an extruder screw, the ratio of the depth of the first channel at the hopper end to the depth of the last channel in the metering section.

CHARGE Precise, weighed amount of material placed in a open mold. Also determined by volumetric measurement.

CHILL ROLL A cored roll, usually temperature controlled with circulating water, which cools a molten polymer web on contact before winding.

CHROMATOGRAPHY The process used for analysis and separation of mixtures of two or more substances, and for determining many characteristics in research work.

CHROME PIGMENTS Pigments based on basic lead chromate. Included are chrome yellow and orange. They have intense colors, good acid resistance, and heat stability.

CLAMPING AREA Largest molding area an injected molding machine can hold closed under full pressure.

CLAMPING PRESSURE Pressure which is applied to an injection or transfer mold to hold it closed.

CLAMP TONNAGE Rated clamping capacity of an injection or transfer molding machine.

COATING WEIGHT Weight of coating per unit area.

COEFFICIENT OF FRICTION

Resistance to movement of sliding or rolling surfaces of solid bodies in contact with each other.

COEFFICIENT OF THERMAL EXPANSION Change in dimension of a material per unit change in temperature.

COEXTRUSION The technique of extruding two or more materials through a single die being fed by separate extruders.

COINJECTION The technique of injecting two materials into a single mold from two plasticating cylinders, either simultaneously or in sequence.

COLORANT Dyes or pigments which impart color to plastics. The dyes are synthetic or natural compounds of submicroscopic size, soluble in common solutions, yielding transparent colors. Pigments are organic and inorganic substances with larger particle sizes and are usually insoluble in common solvents.

COLOR CONCENTRATE A plastics compound which contains a high percentage of pigment to be blended into base resins. The term masterbatch is sometimes used for color concentrate as well as for concentration of other additives.

COLORIMETER An instrument for measuring and matching colors.

COMPATIBILITY The ability of two or more substances to mix together without separation.

COMONOMER A monomer which copolymerizes with another monomer.

COMPOUNDING The process of mixing a polymer with all the materials necessary for the finished resin to be shipped to the processor.

COMPRESSION RATIO In an extruder screw, the ratio of the volume of the channel at the first flight of the screw to the volume at the last flight in the metering section.

COMPRESSIVE STRENGTH Load at which compressive failure occurs in a specimen divided by the original cross-sectional area of the specimen.

CONTINUOUS POLYMERIZATION A type of polymerization in which the monomer is continuously fed to a reactor and the polymer is continuously removed.

CONVERTOR A term used in the packaging industry. Convertors buy plastic film or sheeting in the form of roll stock and convert it to useful forms by slitting, die cutting, heat sealing, etc. for resale to packaging firms

COOLING CHANNELS Passageways provided in molds or platens for circulating water or other cooling media, in order to control the surface temperature of the cavities and remove heat from the polymer. Operating cycles in injection and blow molding are made shorter by means of such cooling.

COPOLYMER A polymer resulting from the polymerization reaction of two chemically different monomers.

CORE Male part of a mold which shapes the inside of a molded part.

CORE PIN In injection molding, a pin inserted in a mold to produce a hole. May also be used to activate the movement of a sliding core.

CORONA DISCHARGE A method of rendering the surface of inert plastics, such as polyethylene, more receptive to inks, adhesives, or coatings by subjecting their surfaces to an electrical discharge. Typical method is to pass film over a grounded metal cylinder above which a high voltage electrode is spaced to leave a small air gap. The corona discharge oxidizes the film leading to the formation of polar groups. The surface now becomes receptive to the coatings.

CREEP Creep is the permanent deformation resulting from prolonged application of a stress below the material's yield point.

CROSSLINKING The establishment of chemical bonds between the molecular chains in polymers. Crosslinking can be accomplished by chemical reaction, vulcanization, degradation, and radiation.

CRYSTALLINITY The state of molecular structure in some resins denoting uniformity and compactness of the molecular chain.

CYCLE One full sequence in a molding operation, from a point in the process to the same point in the next sequence.

CYCLOHEXANE A colorless liquid derived from the catalytic hydrogenation of benzene, used as a solvent in percent extractables testing.

D

DANCER ROLL A roller used as a tension maintenance device in the production of films and sheeting.

DAYLIGHT OPENING The maximum distance that can be obtained between the stationary platen and the moving platen in a mold clamping system when the actuating mechanism is fully retracted without ejector box and/or spacers.

DECKLE A rod or plate attached to each end of a cast film or extrusion coating die which is used to adjust the length of the die opening.

DEFLECTION TEMPERATURE The temperature at which a standard ASTM D-648 test bar deflects 0.010 inch under a load of 264 psi.

DEFLASHING The process of removal of flash or rind left on molded plastic articles.

DEFORMATION Any change of form or shape in a body; the linear change of a dimension of a body in a given direction produced by the action of external forces.

DEGRADATION A deleterious change in the chemical structure, physical properties, or appearance of a plastic caused by exposure to heat, light, oxygen, or weathering.

DEGREE OF POLYMERIZATION The average number of monomer units per polymer molecule, a measure of molecular weight between the layers.

DELAMINATION The separation of one or more layers in a laminate caused by the failing of the adhesive bond.

DENSITY Weight per unit volume of a substance usually reported in g/cc or lb/ft³.

DIAPHRAGM GATE In injection and transfer molding, a type of gate used for annular or tubular articles.

DIE A steel block containing an orifice through which plastic is extruded, shaping the extrudate to the desired form.

DIE ADAPTER The part of an extrusion die which holds the die block.

DIE CUTTING (BLANKING) The process of cutting shapes from sheets of plastic by pressing a shaped knife edge into one or several layers of sheeting.

DIE GAP Distance between the metal faces forming the die opening.

DIE LAND (See Land).

DIE LINES Vertical or horizontal marks on the extrudate and in the finished product caused by damaged die elements or by contamination held up in the die land.

DIE (EXTRUDATE) SWELL In extrusion, the increase in diameter of the extrudate over that of the die opening through which it is extruded.

DIE (EXTRUDATE) SWELL RATIO In extrusion, particularly for blow molding, the ratio of the outer parison diameter (or parison thickness) to the outer diameter of the extrusion die (or die gap).

DIFFERENTIAL SCANNING CALORIMETRY (DSC) Method used to determine thermal histories of polymers such as melting points and glass transition points.

DIFFERENTIAL THERMAL ANALYSIS (DTA) An analytical method similar to thermo-gravimetric analysis, except that the specimen is heated simultaneously with an inert material as a control, each having its own temperature-sensing and recording apparatus. The curve shows the weight losses of both materials under the same rates of heating.

DIMENSIONAL STABILITY The ability of a plastic part to retain the precise shape in which it was molded, fabricated, or cast.

DIP COATING Method by which an object is coated by dipping into a plastisol or organosol.

DISC GATE Mold gate having the same cross section as the mold runner.

DISCOLORATION Any change from an initial color possessed by a plastic; a lack of uniformity in color where color should be uniform over the whole area of a plastic object.

DISPERSION Fine division of particles of a resin or solid in suspension in another material.

DOCTOR BAR (Blade) A flat bar used for regulating the amount of liquid material on the rollers of a coating machine, or to control the thickness of a coating after it is applied to a substrate.

DOUBLE-SHOT MOLDING A process for production of two-color parts by means of successive molding operations.

DOWEL (Pin) A pin used to maintain alignment between two or more parts of a mold.

DRAFT The tapered design of a mold wall which facilitates removal of a molded part.

DRAG FLOW In the metering section of an extruder screw, drag flow is the component of the total material flow caused by the relative motion between the screw and the cylinder.

DRAWDOWN In extrusion, the process of pulling the extrudate away from the die at a linear speed higher than that at which the melt is emerging from the die, thus reducing the cross-sectional dimensions of the extrudate.

DROOLING Leakage of resin from a nozzle or around the nozzle area during the injection step in injection molding or around the screen-pack during extrusion.

DUCTILITY Amount of strain a material can withstand before it fractures.

DWELL TIME A pause in the application of pressure to a mold, made just before the mold is completely closed, to allow for the escape of gas.

E

EJECTOR PIN A pin or thin plate that is driven into a mold cavity from the rear as the mold opens, forcing out the finished piece.

EJECTOR PLATE A plate which backs up the ejector pins and holds the ejector assembly together.

EJECTOR RETURN PINS Projections that push back the ejector assembly as the mold closes.

ELASTIC DEFORMATION The portion of deformation of an object under load which can be recovered after the load is removed.

ELASTICITY The property (of plastic materials) of recovering original size and shape after deformation.

ELASTOMER A material which, at room temperature, can be stretched under low stress to at least twice its original length and, upon immediate release of the stress, will return with force to its approximate original length.

ELONGATION Deformation caused by stretching; the fractional increase in length of a material stressed in tension.

EMBOSSING Technique providing a textured surface to roll goods. It is used in-line with extruders and calenders or off-line in an unwind, emboss, and rewind operation. The focal point of the equipment is the textured roll which imparts the impression.

ENDOTHERMIC REACTION A reaction which is accompanied by the absorption of heat.

ENTRANCE ANGLE In extrusion, the maximum angle at which the molten material enters the land area of the die, measured from the center line of the mandrel.

ENVIRONMENTAL STRESS

CRACKING The susceptibility of a thermoplastic resin to crack or craze when stressed in the presence of surface active agents or other environments.

EPOXY RESINS Thermosetting resins which, in the uncured form, contain one or more reactive epoxide or oxirane groups. These groups serve as crosslinking points in the subsequent curing hardener. Epoxy resins are used in protective coatings, bonding adhesives, in building and construction, and electrical uses.

ERUCAMIDE A fatty acid-based slip additive used in polyolefin resins.

ETHYLENE A colorless, flammable gas derived by cracking of petroleum and natural gas fractions. Also serves as a monomer for polyethylene.

ETHYLENE VINYL ACETATE (EVA) Copolymeric member of the polyolefin family derived from random copolymerization of vinyl acetate and ethylene.

EXOTHERM The temperature vs. time curve of a chemical reaction and the amount of heat given off. Maximum temperature occurs at peak exotherm.

EXOTHERMIC REACTION A reaction in which heat is given off.

EXTENSIBILITY The ability of a material to extend or elongate upon application of sufficient force, expressed as a percent of the original length.

EXTRUDATE The film, wire coating, pipe or other product of the extrusion process.

EXTRUDATE SWELL See Die Swell.

EXTRUDATE SWELL RATIO See Die Swell Ratio.

EXTRUDER A machine for producing more or less continuous lengths of plastic sections such as rods, sheets, tubes, profiles, and cable coatings by melting and pumping resin through a forming die.

EXTRUDER, COMPOUNDING The basic functions of a compounding extruder are to melt the polymer and evenly disperse and distribute additives or fillers to meet the specifications of the end product. Large-scale compounding is done on either single- or twin-screw extruders. Single screws are used for basic operations where little variation in material formulation and viscosity is expected. Twin-screw compounders offer better mixing characteristics.

EXTRUDER, SINGLE SCREW Basic machine consists of a screw, barrel, drive mechanism, resin feed arrangement and controls. The constantly turning screw augers the resin through the heated barrel where it is heated to proper temperature and blended into a homogeneous melt. Before the melt can leave the barrel, it must pass through a breaker plate and screen pack. The melt is then extruded through the die into the desired shape.

EXTRUDER, TWIN SCREW Two screws, side by side, are placed within the extruder barrel, either co-rotating or counter-rotating. Counter-rotating twin screw extruders are used primarily for processing PVC products such as pipe, siding, sheet, pellets, and film. The co-rotating units are used for compounding materials where thorough mixing and high output rates are

important. The twin-screw unit resembles a positive displacement screw pump. It conveys the material at low speeds with controlled shear. The positive action assures that all portions of the material experience a uniform residence time.

EXTRUDER, VENTED An extruder provided with a vent hole, usually in the metering zone where the material has attained a molten condition, for the withdrawal of gases and air.

EXTRUDER SIZE The nominal inside diameter of the extruder barrel.

EXTRUSION Compacting and melting a plastic material and forcing it through an orifice in a continuous fashion. In the extrusion process, the material is conveyed through the heated machine barrel by a helical screw where it is heated and mixed to a homogeneous state and then forced through a die of the shape required for the finished product.

Blown Film Process involves extruding a continuous thin walled tube of plastic and inflating it immediately after it leaves the die. The pressure is such that the tube stretches, increasing its diameter and reducing its wall thickness to desired gauge. Air is trapped within the blow tube (bubble) between the die and collapsing rolls which convert it to layflat film to facilitate winding onto a roll.

Cast Film Process by which a polymer is extruded from a slot die onto the surface of a water-cooled roll. Film is clearer and has more sparkle than blown film.

Coating Coating of a substrate by extruding a thin film of molten polymer and pressing it onto the substrate.

Foam Process for producing plastic sheet or molded article with a cellular construction. Either a chemical or gaseous blowing agent is introduced into the polymer melt while the melt is being prepared in the extruder barrel. As the plastic melt exits the die, it expands a predetermined amount forming a cellular wall.

Pipe and Profile Extrusion process by which heavywall continuous profiles are produced. Die design determines shape of extrudate and designs range from a simple circular shape to complex window channels and moldings.

EXTRUSION PLASTOMETER A type of viscometer used for determining flow rates of a polymer under specified temperatures and loads, more commonly known as a melt indexer.

EXUDATION Migration of additives from the interior to the surface of a plastic part to the melting zone.

F

FAN GATE Opening between the runner and the cavity which has the shape of a fan. This shape reduces stress concentrations in the gate area by spreading the opening over a wider area.

FATIGUE STRENGTH The maximum cyclic stress a material can withstand for a given number of cycles before failure occurs.

FEED SECTION First section or zone of an extruder screw which is fed from the hopper and conveys solids

FILAMENT Fiber of extreme length, used in yarns and other compositions.

FILL In injection molding, packing of a cavity or cavities to produce complete parts.

FILLER A material which is added to plastics to make it less costly. Filler can be inert or can alter various properties of the plastic.

FILM Sheet material having a nominal thickness not greater than 10 mil.

FISHEYE Small globular mass which has not blended completely into the surrounding material resulting as a fault in film or sheet.

FLAME RETARDANT Reactive compounds and additive compounds to render a polymer fire resistant. Reactive compounds become an integral part of the polymer.

FLAME TREATING A method of rendering the surface of inert thermoplastics or other substitutes, particularly polyolefins, receptive to inks, lacquers, paints, adhesives, and the like by bathing the surface of the article in a highly oxidizing flame. This treatment oxidizes the surface layer of the article, making it receptive to coating.

FLAMMABILITY The measure of the extent to which a material will support combustion. The test usually used is described in ASTM D-1433, the results being expressed in seconds required for specimen to burn over six inches of its length.

FLASH The thin, surplus web of material which is forced into crevices between mating mold surfaces during a molding operation, and which remains attached to the

molded article. It is usually removed by deflashing operations such as buffing, grinding, tumbling, or blasting.

FLASH GATE A long, shallow rectangular gate in an injection mold.

FLASH MOLD A mold designed to permit excess molding material.

FLEXURAL MODULUS Ratio of applied stress to strain in outer fibers of a plastic specimen during flexure.

FLEXURAL STRENGTH Resistance of a plastic material to cracking or breaking during bending.

FLIGHT The outer surface of the helical ridge of metal on an extrusion or injection molding screw.

FLOATING PLATEN Moveable platen(s) between the stationary platen and actuated platen on a vertically operating compression press.

FLOW During processing by injection, compression, or transfer molding, the flow of a plastic is a measurement of fluidity.

FLOW LINES Distinctive surface marks caused when two flow fronts meet and weld together during molding or film extrusion.

FLOW RATE The ASTM condition of 190°C and a load of 21.6 Kg used for determining the rate of flow of molten HDPE resins through a standard orifice. Also known as high load melt index.

FLUOROPLASTICS Polyolefin polymers in which fluorine, fluorinated alkyl groups, or other halogens replace hydrogen atoms in the carbon chain. This structure has

outstanding electrical properties, excellent resistance to chemical attack, low coefficient of friction, excellent fire resistance, exceptionally good performance at high and low temperatures, low moisture absorption, and outstanding weatherability.

FLUOROCARBON ELASTOMERS

Polyolefin containing fluorocarbons which are intended to be incorporated as a plastics modifier to aid in the extrusion of film, pipe, sheet, etc. Mostly used in construction with LLDPE, HDPE, HMW-HDPE, and UHMW-HDPE. Otherwise known as polymer process aid (PPA).

FRACTIONATION A method of determining the molecular weight distribution of polymers based on the fact that polymers of high molecular weight are less soluble than those of low molecular weight. Two basic methods in use are precipitation fractionation and extraction fractionation.

FREE RADICAL An atom or group of atoms having at least one unpaired electron. Most free radicals are short lived intermediates with high reactivity and high energy, difficult to isolate. They play a role in many polymerization processes.

FROSTLINE In the extrusion of blown film, a ring-shaped zone of frosty appearance located at the point where the resin solidifies, caused by a reduction in film temperature below the melting point of the resin.

G

GATE Opening through which the plastic enters the injection mold cavity.

GATE MARK Blemish on the molded part by the mold gate.

GAUGE Thickness of plastic film measured in decimal inches or mils.

GEL Small globular mass which has not blended completely into the surrounding material resulting in a fault in the film or sheet.

GEL PERMEATION

CHROMATOGRAPHY A developed column chromatography technique employing a stationary phase (gel) in the presence of a diluent which is a nonsolvent for the polymer. The polymer to be analyzed is introduced at the top of the column and then is diluted with a solvent. The polymer molecules diffuse through the gel at rates dependent on their molecular size. As they emerge from the bottom of the column, they are detected by a differential refractometer coupled to a recording chart, on which a molecular size distribution curve is plotted.

GLASS TRANSITION TEMPERATURE

The temperature at which a reversible change occurs in an amorphous polymer when it is heated to a certain temperature and undergoes a rather sudden transition from a hard, glassy, or brittle condition to a flexible or elastomeric condition.

GLOSS Brightness or luster of a plastic resulting from a smooth surface.

GRADIENT TUBE DENSITY A method for measuring densities of very small samples, often used in the plastics industry. A vertical glass tube (the gradient tube) is filled with a heterogeneous mixture of two or more liquids, the density of the mixture varying linearly or in other known fashion with the height. A drop or small particle of

the specimen is introduced in the tube and falls to a position of equilibrium which indicates its density by comparison with positions of known standard samples.

GRANULAR Composed of coarse particles. Often used in reference to Granular LLDPE.

GRAVURE PRINTING The depressions in an engraved printing cylinder or plate are filled with ink, the excess raised portions being wiped off by a doctor blade. Ink remaining in the depressions is deposited on the plastic film or other substrates as it passes between the gravure roll and resilient back-up roll.

GUIDE PINS In compression, transfer, and injection molding, hardened steel pins that maintain proper alignment of the mold halves as they open and close.

GUSSETS The inward fold in the sides of bags which reduce the width of the bag and allow the bags to assume a rectangular form when opened.

H

HAZE Cloudiness in plastic film. Measured as percent haze, anything below 5 percent is generally considered high clarity.

HEAT DISTORTION POINT The temperature at which a standard test bar deflects a specified amount under a stated load.

HEATER BANDS Electrical heating units shaped to fit extruder barrels, injection molding cylinders and the like, for heating the plastic material to the desired temperature.

HEAT SEALING The process of joining two or more thermoplastic films or sheets by heating areas in contact with each other to the temperature at which fusion occurs, usually aided by pressure.

HELIX ANGLE The angle of the flights on an extruder screw.

HEXENE A comonomer (hexene-1 or 4-methyl pentene-1) used in the production of linear low-density and high-density polyethylene.

HIGH-DENSITY POLYETHYLENE

This term is generally considered to include polyethylenes ranging in density from about 0.940 to 0.960 and over. Whereas the molecules in low-density polyethylene are branched in random fashion, those in the higher density polyethylenes have fewer side branches, resulting in more rigid material with greater strength, hardness, chemical resistance, and higher softening temperature.

HMW HIGH-DENSITY

POLYETHYLENE High molecular weight high-density polyethylene is usually defined as a polyethylene with a density of 0.940 or greater and a flow rate of 1 to 20 (190°C/21.6 Kg). The weight average molecular weight ranges from 200,000 to 500,000.

HIGH LOAD MELT INDEX The ASTM condition of 190°C and a load of 21.6 Kg used for determining the flow rate of molten HDPE through a standard orifice. More often referred to as flow rate.

HOMOPOLYMER The result of the polymerization of a single monomer, a homopolymer consists of a single type of repeating unit.

HOPPER In polymer processing, the container holding a supply of molding material to be fed to the screw or ram. The hopper may be intermittently filled or continuously fed.

HOPPER BLENDER Mixes material such as virgin resin, regrind, blowing agents, fillers, and colorants in desired proportions. Materials to be blended are metered in ratio to a mixing chamber and then discharged into the hopper of the processing machine.

HOPPER LOADER A device for automatically feeding resins to hoppers of extruders, injection molding machines and the like.

HOT RUNNER MOLD A mold in which the runners and secondary sprues are kept hot and fluid during the entire cycle and are not ejected with the molded part. This avoids the need for handling and reprocessing scrap normally generated from runners and sprues.

HYDRAULIC CLAMP Used in variety of molding and forming machines, a hydraulic clamp consists basically of a high speed, variable hydraulic pump, valving, a fast acting cylinder, and a high pressure cylinder. Cylinders can be single or combination units. The clamp closes the mold halves to form the part.

HYDROLYSIS Decomposition of a substance by reaction with water.

HYDROPHILIC Having a strong affinity for water.

HYDROPHOBIC Lacking affinity for water.

HYGROSCOPIC Readily absorbing and retaining environmental moisture.

I

IMMISCIBLE Incapable of intermittently mixing, i.e., oil and water are immiscible.

IMPACT STRENGTH Ability to withstand shock loading.

INITIATOR Peroxide used as initiator of free radicals by abstracting hydrogen from polymer backbone. They are used in free-radical polymerizations, curing thermo-setting resins, as crosslinking agents for elastomers and polyethylenes, and for polymer modification.

INJECTION MOLD A mold used in the process of injection molding. The mold usually comprises two sections held together by a clamping device with sufficient strength to withstand the pressure of the molten plastic when injected, and is provided with channels for heating, cooling, and venting.

INJECTION MOLDING Injection molding is a repetitive process in which plastic is melted or plasticated, and injected into a mold. With thermoplastics the mold is kept at a temperature below the solidifying point of the plastic, causing the injected polymer to freeze, thus forming the article. After cooling, the mold opens and the article is ejected.

Reciprocating Screw An extruder type screw rotates within a cylinder, which is typically driven by a hydraulic drive mechanism. Plastic material is moved through the heated cylinder via the screw flights and the material is plasticated and

accumulated for the next shot. When the mold clamp has locked, the injection phase takes place. At this time, the screw advances, acting as a ram. Simultaneously, the nonreturn valve closes off the escape passages in the screw and the screw serves as a solid plunger moving the plastic ahead into the mold. When the injection stroke and holding cycle is completed, the screw is energized to return, and the nonreturn valve opens, allowing plastic to flow forward from the cylinder again, thus repeating the cycle.

Two-stage Injection The two-stage plasticator injector unit utilizes two separate stages to perform its function. The first, or plasticating stage, is devoted to the melting and mixing of the plastic melt by utilizing long, rotating screws. This screw conveys the processed plastic forward where, by means of a diverter valve, it is transferred into the injection or holding cylinder. When a sufficient quantity of melt has been plasticated and transferred into the injection cylinder, the diverter valve shifts to create a flow path from the injection cylinder to the mold runner system, and the second stage, or injection stage, now begins. The melted plastic is forced out of the injection cylinder by a hydraulically driven piston or plunger. After injecting the melt into the mold, the diverter valve again shifts to connect the flow path from the rotating screw to the injection cylinder to transfer more plasticated material into the cylinder for the next cycle. During injection the plasticating screw continues to rotate and reciprocate to build up a change in front of it for the next cycle.

INJECTION PRESSURE Pressure applied to the injection ram to force the plastic from the barrel and into the mold (measured in psi or MPa).

INSERT An article of metal or other material which is incorporated into a plastic molding either by pressing the insert into the finished molding or by placing the insert in the cavity so that it becomes an integral part of the molding.

IONOMER Thermoplastic that combines transparency with toughness, particularly at low temperatures. The polymer's main component is ethylene but it contains both inorganic and organic materials linked by both covalent and ionic bonds. Film is used in skin packaging.

ISOTACTIC Pertaining to a type of polymeric molecular structure containing a sequence of regularly spaced asymmetric atoms arranged in like configurations in a polymer chain, usually used in reference to polypropylenes.

IZOD IMPACT A test for shock loading wherein a notched sample bar is held at one end and broken by striking.

J

JETTING Turbulence in the resin melt flow caused by undersized gate, an abrupt change in cavity volume, or low melt temperature.

K

KNIFE COATING An adjustable knife or blade controls.

KNOCKOUT BAR A bar which holds and actuates ejector pin(s) in mold. Used in ejection of molded piece from mold.

KNOCKOUT PIN A pin that ejects a molded piece the amount of coating material laid down on a moving from the mold. web.

L

LD RATIO The ratio of the length (L) to diameter (D) of an extruder or injection molding machine. This ratio can be expressed based on barrel length or screw flighted length.

LAMINAR FLOW The movement of one layer of fluid past or over another layer without the transfer of matter from one to the other. Laminar flow in injection molding is achieved by solidifying the layer in contact with the mold surface. This acts as an insulating tube through which material can flow to fill remainder of cavity. This process is essential to mold surface duplication.

LAND 1. The horizontal bearing surface of a semipositive or flash mold by which excess material escapes. 2. The bearing surface along the top of the flights of a screw in a screw extruder. 3. The surface of an extrusion die parallel to the direction of melt flow. 4. The mating surfaces of any mold, adjacent to the cavity depressions, which prevent the escape of material.

LEAD CHROME PIGMENTS A series of inorganic pigments including yellows, oranges, and greens, used in polyolefins and other plastics.

LENSING Is a term which refers to a film defect which causes undesirable elongated thin voids in an extruded film. Are sometimes referred to as windows or air pockets.

LINEAR POLYMER A polymer in which the monomeric units are linked together in linear fashion with little or no long chain branching. Examples are linear low-density polyethylene and high-density polyethylene.

LINEAR LOW-DENSITY POLYETHYLENE See Linear Polymer. Includes polyethylenes ranging in density from 0.95 to 0.935.

LOCATING RING Device which aligns nozzle of injection molding machine with the sprue bushing and the mold with the stationary platen.

LOW-DENSITY POLYETHYLENE This term is generally considered to include polyethylenes ranging in density from about 0.915 to 0.925. In low density polyethylenes, the ethylene monomeric units are linked in random fashion, with the main chains having long and short side branches. This branching prevents the formation of a closely knit pattern, resulting in material that is relatively soft, flexible and tough, and which will withstand moderate heat.

LUBRICANT A substance which when interposed between parts or particles tends to make surfaces slippery, reduce friction, and prevent sticking between the lubricated surfaces. Lubricants are added to plastics to assist flow in extrusion, assist in knitting and wetting of the resin in mixing and milling operations, and impart lubricity to finished products.

M

MANDREL 1. Core around which fiberglass impregnated with plastic resin is wound as in filament winding. 2. The portion of an extrusion die that forms the hollow center in an extruded tube.

MANIFOLD Configuration of piping in a block of metal that takes a single channel flow of resin from an extruder or injection molding machine and divides it into various flow channels to feed more than one outlet.

MASTERBATCH A concentrated blend of pigment, additives, filler, etc. in a base polymer. Masterbatch is added in small amounts to large volume of material (the same as or compatible with the base polymer) to produce the desired formulation.

MELT A thermoplastic stock which is in a molten state due to temperature.

MELT FRACTURE Is a phenomenon of melt extrudate in which the surface appears rough or wavy upon exit from the die. Melt fracture may appear uniformly or in certain sections only.

MELT INDEX The number of grams, of a thermoplastic resin which can be forced through a 0.0825 inch orifice when subjected to 2160 grams force in 10 minutes at 190°C.

MELT INSTABILITY An instability in the melt flow through a die that causes irregularities in the finished part.

MELT STRENGTH The elastic strength of a polymer in the molten state.

MELTING POINT The temperature at which a resin changes from a solid to a liquid.

METERING ZONE The final zone of an extruder barrel, in which the melt is conveyed at a uniform rate to the breaker, plate or die.

MICRON A unit of length equal to .001 millimeter (0.00003937 inch).

MIGRATION The exudation of an ingredient from one material by another material, such as the migration of a plasticizer from one material into an adjacent material with a lower plasticizer content.

MODULUS OF ELASTICITY The ratio of stress to strain below the yield point of the material.

MOISTURE ABSORPTION The pick-up of water vapor from the atmosphere by a material. It relates only to vapor withdrawn from the atmosphere by a material and must be distinguished from water absorption, which is the take-up of water by immersion.

MOISTURE VAPOR TRANSMISSION
The rate of permeation of water through a material at a specific temperature and relative humidity rate.

MOLD A hollow form or cavity into which molten plastic material is forced to give the shape of the required component. The term generally refers to the whole assembly of parts which go to make up the section of the molding equipment in which the parts are formed. Also called a tool or die. Also used to describe the action of forming the part and the operation required for forming parts.

MOLDING CYCLE 1. The period of time occupied by the complete sequence of operations on a molding press requisite for the production of one set of moldings. 2. The operations necessary to produce a set of moldings without reference to the time taken.

MOLECULAR WEIGHT (MW) The sum of the atomic weights of all atoms in a molecule.

MOLECULAR WEIGHT DISTRIBUTION (MWD) The relative amounts of polymers of different molecular weights (MW) that make up a specific polymer.

MONOMER A single molecule which can join with another monomer or molecule to form a polymer or molecular chain.

MOVABLE PLATEN The large back platen of an injection molding machine to which the back half of the mold is secured during operation. This platen is moved either by a hydraulic ram or a toggle mechanism.

N

NECK-IN In extrusion coating, the difference between the width of the extrusion die opening and the width of the coating on the substrate.

NECKING The localized reduction in cross-section which may occur in a material when deformed. (ASTM D-883-65T). This phenomenon can occur in extrusion under certain conditions as the extrudate leaves the die, but the term most often refers to the cold drawing of fibers at temperatures below

their melting points. Fibers of crystalline and some crystalline thermoplastics, e.g. polyethylene, exhibit necking at a critical stress near the yield point.

NEEDLE BLOW A specific blow molding technique where the blowing air is injected into the hollow article through a sharpened hollow needle which pierces the parison.

NEWTONIAN FLOW A flow characteristic evidenced by viscosity that is independent of shear rate, that is the rate of shear is directly proportional to the shearing stress. Water and thin mineral oils are examples of Newtonian fluids.

NIP The V-shaped gap between a pair of calender rolls where incoming material is nipped and drawn between the rolls.

NIP ROLLS In film blowing, a pair of rolls situated at the top of the tower which close the blown film envelope, seal air inside of it, and regulate the rate at which the film is pulled away from the extrusion die. One roll is usually covered with a resilient material, the other being bare metal.

NOTCH SENSITIVITY Extent to which the sensitivity of a material to fracture is increased by the presence of a surface inhomogeneity, such as a notch.

NOZZLE In injection or transfer molding, the orifice containing plug at the end of the injection cylinder or transfer chamber which contacts the mold sprue bushing and directs the molten resin into the mold. The nozzle is shaped to form a seal under pressure against the sprue bushing. Its orifice is shaped by tapering to maintain the desired flow of resin, and sometimes contains a check valve

to prevent back flow, or an on-off valve to interrupt the flow at any desired point in the molding cycle.

NUCLEAR MAGNETIC RESONANCE (NMR) Determinations of the number of hydrogen atoms in a complex molecule and the characteristic grouping in which they occur, conducted by placing the specimen in a strong constant magnetic field, then applying a perpendicular r.f. alternating magnetic field. At certain frequencies of the latter field, a hydrogen atom nucleus will absorb and emit energy, the frequency and amount of which are indicative of the characteristic grouping in which the atom is located - e.g., a CH₃, CH₂ or an -OH group.

NUCLEATING AGENT Finely divided solid material added to semicrystalline polymers to modify the crystalline structure by providing sites for initiation of crystalline growth. A properly nucleated polymer will possess improved clarity, hardness, and tensile strength.

NUMBER-AVERAGE MOLECULAR WEIGHT (MN) The average molecular weight of a high polymer expressed as the first moment of a plot of the number of molecules in each molecular weight range against the molecular weight. In effect, this is the total molecular weight of all molecules divided by the number of molecules.

NYLON Generic name for all long-chain polymers which have recurring amide groups (-CONH-) as an integral part of the main polymer chain. Various types of nylons are described in subsequent listings, the numbers of which relate to the number of carbon atoms in the various reactants.

O

OCTENE A comonomer used in the production of linear low-density polyethylenes.

OFFSET PRINTING A printing process in which the image to be printed is first applied to an intermediate carrier such as a roll or plate, then is transferred to a plastic film or molded article.

OFFSET YIELD STRENGTH The stress at which the strain exceeds by a specified amount (the offset) an extension of the initial proportional portion of the stress-strain curve. It is expressed in force per unit area, usually pounds per square inch. (ASTM D-638-60T).

OLEAMIDE An ivory-colored powder used as a slip additive in polyolefins.

OLEFINS The group of unsaturated hydrocarbons named after the corresponding paraffins by the addition of "ene" and "ylene" to the stem. Examples are ethylene, propylene, and butenes. Polymers of olefins are sometimes called olefin plastics or polyolefins.

OLIGOMER A polymer consisting of only a few monomer units such as a dimer, trimer, tetramer, etc. or their mixtures. Other definitions in the literature place the upper limit of repeating units in an oligomer at about ten.

ORANGE PEEL An uneven surface texture of a plastic article or its finished coating somewhat resembling the surface of an orange, see Melt Fracture.

ORIENTATION The process of stretching a hot plastic article to align the molecules, thus altering mechanical properties. When the stretching force is applied in one direction, the process is called uniaxial orientation. When stretching is in two directions, the term biaxial orientation is used. Upon reheating, an oriented film will shrink in the direction(s) of orientation. This property is useful in applications such as shrink packaging and for improving the strength of molded or extruded articles such as pipe and fibers.

ORIFICE In extrusion, the opening in the die formed by the orifice bushing (ring) and mandrel.

OXIDATION In respect to polyethylenes, the reaction of air or oxygen in polyethylene causing the formation of hydroxy groups which affects the physical properties adversely.

P

PACKING Filling of the mold cavity or cavities as full as possible without causing undue stress on the molds or causing flash to appear on the molding.

PARISON A hollow tube of plastic melt extruded from the die head of a blow molding machine and which is expanded within the mold cavity by air pressure to produce the molded part.

PARISON SWELL Expansion of the parison as it leaves the die head.

PARTING LINE The line formed by the mating surfaces of the mold halves.

PELLETS Tablets of uniform size, consisting of resins or mixtures of resins with compounding additives which have been prepared for molding operations by shaping in a pelletizing machine or by extrusion and chopping into short segments.

PERFORATING Processes by which plastic film or sheeting is provided with holes ranging from relatively large diameters for decorative effects (by means of punching or clicking) to very small, even invisible, sizes. The latter are attained by passing the material between rollers or plates, one of which is equipped with closely spaced fine needles or by spark erosion.

PERMEATION The passage or diffusion of a gas, vapor, liquid, or solid through a barrier without physically or chemically affecting it.

PERMEABILITY Permeability is the property of a material, i.e. the degree to which it allows permeation to occur.

PHENOLICS, HINDERED A group of primary antioxidants used to protect polyolefins against oxidation and thermal degradation.

PHENOLICS These thermosetting resins are credited with being the first commercialized wholly synthetic polymer or plastic. The basic raw material is usually formaldehyde and phenol. In the uncured and semicured condition, phenolic resins are used as adhesives, casting resins, potting compounds, and laminating resins. As molding powders, phenolic resins can be found in electrical uses.

PHOSPHITE, ORGANIC A group of antioxidants used to protect polyolefins against oxidation and thermal degradation.

PHOTODEGRADATION Degradation of plastics due to the action of light. Most plastics tend to absorb high-energy radiation in the ultraviolet portion of the spectrum, which results in the formation of free radicals and causes oxidation, cleavage, and other degradative reactions.

PINCH OFF Section of blow mold that seals the ends of the parison by pinching off excess material.

PINHOLE Tiny hole in cast, extrusion coating, or extruded sheet or blow molded product.

PINPOINT GATE Gate in an injection mold which is approximately 0.030 inch in diameter. This small gate minimizes the size of the mark left on the molded part.

PITCH With respect to extruder screws, the distance from any point on the flight of a screw to the corresponding point on an adjacent flight, measured parallel to the axis of the screw or threading.

PLASTIC (adj.) An adjective indicating that the noun modified is made of, consists of, or pertains to plastics. (noun) A material that, in its finished state, contains a synthetic polymer of high molecular weight, is a flexible or rigid solid but not an elastomer in its finished state, and at some stage in its manufacture or processing can be shaped by flow or by in-situ polymerization or curing.

PLASTICATE To impart flexibility in a plastic through the input of heat and mechanical work as in the plasticating of the resin in an extruder or injection molding machine.

PLASTIC DEFORMATION Occurs when an object does not return to its original shape or size after pressure, stress or load is removed.

PLASTIC MEMORY The tendency of a thermoplastic material which has been stretched while hot to return to its unstretched shape upon being reheated.

PLATE-OUT The undesirable deposition of additives or pigments on machinery during processing of plastics.

PLATEN The steel plates on a molding machine to which the mold is attached. Two platens are generally used, one being stationary and the other movable, and actuated hydraulically or mechanically to open and close the mold.

POCK MARKS Imperfections on the surface of a blow molded article consisting of irregular indentations caused by insufficient contact of the blown parison with the mold surface. Contributory factors are insufficient blowing pressure, entrapment of air or gases, and condensation of moisture on the mold surface.

POLYBUTENES The family of polymers of isobutene, butene-1, and butene-2. Depending on molecular weight, they range from oils through tacky waxes, crystalline waxes, and rubbery solids.

POLYCARBONATE Polymers derived from the direct reaction between aromatic and aliphatic dihydroxy compounds with

phosgene, or by the ester exchange reaction with phosgene-derived precursors. When the aromatic dihydroxy is bisphenol A, the resulting polycarbonate is thermoplastic - the most commonly used form. Such polycarbonates have high impact strength, good heat resistance, low water absorption, and good electrical properties. They are transparent, and may be injection molded, extruded, thermoformed, and blow molded.

POLYESTER RESINS

Saturated A family of polyesters in which the polyester backbones are saturated and hence unreactive. The most common commercial types are polyethylene terephthalate (PET), a thermoplastic which may be extruded, injection or blow molded.

Unsaturated Unsaturated polyesters are thermoset and used in the reinforced plastics industry for applications such as boats, auto components, etc.

POLYETHYLENE A family of resins obtained by polymerizing the gas ethylene. By varying the catalysts and methods of polymerization, properties such as density, melt index, crystallinity, degree of branching and crosslinking, molecular weight, and molecular weight distribution can be regulated over wide ranges. Further modifications are obtained by copolymerization, chlorination, and compounding additives.

POLYETHYLENE TEREPHTHALATE A saturated, thermoplastic polyester resin made by condensing ethylene glycol and terephthalic acid, used for fibers and films such as DuPont's Mylar film, and, more recently, for injection molded parts. It is extremely hard, wear-resistant, dimensionally stable, resistant to chemicals, and has good dielectric properties.

POLYISOBUTYLENE See Polybutene.

POLYMER The product of polymerization reaction. See Polymerization. The product of polymerization of one monomer is called a homopolymer, monopolymer, or simply a polymer. When two monomers are copolymerized, the product is called a copolymer. The term terpolymer is used for polymerization products of three monomers.

POLYMER PROCESS AID (PPA)

Additives incorporated into plastics as a modifier to aid in the extrusion of film, pipe, sheet, etc.

POLYMERIZATION A chemical reaction in which the molecules of a simple substance (monomer) are linked together to form large molecules whose molecular weight is a multiple of that of the monomer.

POLYOLEFINS The class of polymers made by polymerizing relatively simple olefins, including ethylene, propylene, butenes, isoprenes, and pentenes.

POLYPROPYLENE A tough, lightweight, rigid plastic made by the polymerization of high-purity propylene gas in the presence of an organometallic catalyst at relatively low pressures and temperatures.

POLYVINYL ACETATE A thermoplastic material composed of polymers of vinyl acetate in the form of a colorless solid. Used extensively in adhesives for paper and fabric coatings.

POLYVINYL ALCOHOL A

thermoplastic material composed of polymers of the hypothetical vinyl alcohol.

POLYVINYL CHLORIDE Thermoplastic compounds formed by polymerization or copolymerization of vinyl or vinylidene chlorides and vinyl esters.

POROSITY The ratio of the volume of air or void contained within a material to the total volume (solid material plus air or void), expressed as a percentage.

PORT LINES See Spider Lines.

PREFORM The formation of an intermediate part to be formed into the final part.

PRESSURE ROLL In extrusion coating, a roll used to apply pressure to consolidate the substrate and the plastic film with which it has been coated.

PROPORTIONAL LIMIT The greatest stress which a material is capable of sustaining without deviation from proportionality of stress and strain (Hooke's Law). It is expressed in force per unit area, usually pounds per square inch.

PSEUDOPLASTIC FLUID A

pseudoplastic fluid is one whose apparent viscosity or consistency decreases instantaneously with increase in rate of shear i.e., an initial relatively high resistance to stirring decreases abruptly as the rate of stirring is increased.

PUNCHING Method of producing components, particularly electrical parts, from flat sheets of rigid or laminated plastics by punching out shapes by means of a die and punch.

PURGING In extrusion or injection molding, the cleaning of one color or type of material from the machine by forcing it out

with the new color or material to be used in subsequent production, or with another compatible purging material.

PYROLYSIS The decomposition of a complex organic substance to one of simpler structure by means of heat in the absence of others. Some polymers will depolymerize in the presence of excessive temperatures, either to polymers of lower molecular weight, or, in some cases, back to the monomers from which they were derived.

PYROMETER An instrument for measuring heat. The type most widely used in plastics processing equipment consists of a thermocouple and a millivoltmeter for measuring the voltage which is proportional to the temperature of the junction.

Q

QUENCH A process of shock cooling thermoplastic materials from the molten state.

R

RADICAL A group of atoms existing in a molecule which is capable of remaining unchanged through many chemical reactions.

RANDOM COPOLYMER A copolymer consisting of alternating segments of two monomeric units of random distribution, including single molecules. A random copolymer usually results from the copolymerization of two monomers in the presence of a free-radical initiator.

REGRIND Waste material such as sprues, runners, excess parison material and reject parts from injection molding, blow molding and extrusion operations, which has been reclaimed by shredding or granulating. Regrind is usually mixed with virgin compound at a predetermined percentage for reprocessing.

REINFORCED PLASTICS Molded, formed, filament wound, or shaped plastic parts consisting of resins to which reinforcing fibers, mats, fabrics, etc., have been added before the forming operation. Strength properties are improved.

RECIPROCATING SCREW Extruder system in which the rotating screw is pushed backwards by the molten polymer collecting in front of the screw. When sufficient material has been collected, the screw moves forward and forces the material through the head and die at a high speed.

RESIDUAL MONOMER The unpolymerized monomer that remains incorporated in a polymer after the polymerization reaction is completed.

RESIN An organic substance of natural or synthetic origin characterized by being polymeric in nature. Most resins, though not all, are of high molecular weight and consist of long chain or network molecular structure. Usually resins are more soluble in their lower molecular weight forms.

RESTRICTED GATE A very small orifice between runner and cavity in an injection or transfer mold. When the piece is ejected this gate breaks cleanly, simplifying separation of runner from piece.

RESTRICTOR RING A ring-shaped part protruding from the torpedo surface which provides increase of pressure in the mold to improve, e.g., welding of two streams.

RETAINER PLATE In injection molding, a plate which reinforces the cavity block against the injection pressure, and also serves as an anchor for the cavities, ejector pins, guide pins, and bushings. The retainer plate is usually cored for circulating water or steam for cooling and heating.

RETAINING PIN A pin on which an insert is placed and located prior to molding.

RHEOLOGY The study of the behavior of materials as they are deformed.

RHEOMETER An instrument for determining the flow behavior of a thermoplastic material, usually of high viscosity or in the molten condition.

RIB Configuration designed into a plastic part to provide lateral, horizontal, or other structural support.

RIBBON BLENDERS Mixing devices comprising helical ribbon-shaped blades rotating close to the edge of a U-shaped vessel. They are used for relatively high-viscosity fluids and dry blends such as PVC calendering and extrusion compounds.

RING GATE An annular opening for entrance of material into the cavity of an injection or transfer mold.

ROLL MILL An apparatus for mixing a plastic material with compounding ingredients, comprising two rolls placed in close proximity to one another. The rolls

turn at different speeds to produce a shearing action to the materials being compounded.

ROTATIONAL MOLDING In rotational molding, or rotomolding, a product is formed from fine powder within a closed mold which is rotated in a heating chamber and then a cooling chamber. While the mold is slowly turning and tumbling, it is heated by forced hot air in an oven. As the mold wall heats, the resin begins to stick to the inside of the mold forming a hollow part.

RUNNER In an injection or transfer mold, the feed channel, usually of circular cross section, that connects the sprue with the cavity gate. The term is also used for the plastic piece formed in this channel.

S

SARAN Trade name (Dow Chemical Co.) for thermoplastics consisting of polymers of vinylidene chloride or copolymers of same with lesser amounts of other unsaturated compounds.

SCOTCH TAPE TEST A method for evaluating the adhesion of a coating to a substrate. The scotch tape is adhered to the coating and then pulled away. The degree to which the coating peels away from the substrate with the tape indicates its adhesion.

SCRAP All products of a processing operation which are not present in the primary finished articles. This includes flash, runners, sprues, excess parison, trimmings from film conveying operations, and reject articles. Scrap from operations

can usually be reclaimed for reuse in the processor's plant or for sale to a commercial reclaimer.

SCREEN Woven metal screens are installed across the flow of plastic in an extruder. They are located between the tip of the screw and the die. Supported by a breaker plate, the screens strain out contaminants and increase back pressure.

SCREW In extrusion, the shaft provided with helical grooves which conveys the material from the hopper outlet through the barrel and forces it out through the die.

SCREW FLIGHT The helical metal thread of a screw in an extruder or injection molding machine.

SCREW SPEED The rate of revolution (in rpm) of an extruder or injection molding machine screw.

SCREW TIP In molding, the tip of the reciprocating screw is the ram face that pushes the melt into the mold, and it contains the shutoff valve (nonreturn valve) which prevents the melt from sliding backward along the flights of the screw.

SHARKSKIN A surface irregularity of a blow molded container or film during extrusion. See Melt Fracture.

SHEAR Shear is the product of shear rate and resistance time. It is often used to describe the degree of mixing experienced by a material.

SHEAR HEATING Heat generated within the plastic melt as the polymer is sheared. It is caused by viscous dissipation of work.

SHEAR RATE Rate of change of velocity across the flow channel.

SHEAR STRESS Stress developed in a polymer melt where a material is sheared.

SHEETING Sheets are distinguished from films in the plastics and packaging industry only according to the thickness. A web under 10 mils (.010 inch) thick is usually called a film, whereas a web 10 mils and over in thickness is usually called a sheet. Sheeting is most commonly made by extrusion, casting, and calendering.

SHELF LIFE The length of time over which a product will remain fit for use during storage under specific conditions.

SHORT SHOT In injection molding, failure to fill the mold completely. It results in voids in the article, unfused particles showing through a surface covering, or possibly thin-skinned blisters.

SHOT The yield from one complete injection molding cycle.

SHRINKAGE The decrease in dimension of a molded part through cooling.

SHRINKING ALLOWANCE The dimensional allowance which must be made in molds to compensate for shrinkage of the plastics compound on cooling.

SHRINK FILM A term sometimes used for prestretched or oriented film used in shrink packaging.

SHRINK PACKAGING An item or group of items packaged by wrapping in a film or bag which, when heated, fits tightly around the contained article.

SILICA Naturally occurring silica occurs in deposits which are 99 percent silicon dioxide. The hardness provides both mechanical strength and abrasion resistance. Silicas are an economical extender-filler which is thermally stable, pure, low in ionic impurities, and hard. They are often used as antiblocking agents in polyolefins.

SILK SCREEN PRINTING A printing process widely used on plastic bottles and other articles which employs a taut woven fabric secured in a frame as a stencil. The fabric is coated in selected areas with a masking material which is not affected by the ink being used. The stencil fabric is commonly called a silk screen.

SINK MARK A shallow depression or dimple on the surface of an injection molded article caused by local internal shrinkage after the gate seals or by a short shot.

SKIN PACKAGING A variation of the thermoforming process in which the article to be packaged serves as the mold. The article is usually placed on a printed card prepared with an adhesive coating or mechanical surface treatment to seal the plastic film to the card.

SLIP AGENT Provides surface lubrication following the processing of plastics. Compounded into the plastic, the additive gradually migrates to the surface where it reduces the coefficient of friction.

SLITTING The conversion of a given width of plastic film, tube, or sheeting to several various widths by means of knives.

SOLID PHASE FORMING Technique in which a sheet or block of plastic is reshaped under heat and pressure. Forming temperature is below the melt temperature of the plastic.

SPECIFIC GRAVITY The ratio of the weight of a given volume of a substance to that of an equal volume of water at the same temperature. The temperature selected varies among industries, 15°C (60°F) being the usual standard.

SPECIFIC HEAT The amount of heat required to raise a specified mass by one unit of a specified temperature, usually expressed as Btu/lb/°F. or cal/g/°C.

SPHERULITES A rounded aggregate of radiating crystal lamella. Spherulites are present in most semicrystalline plastics. They originate from a nucleus such as a particle of contaminant, catalyst residue, or a chance fluctuation in density. They may grow through stages: first needles, then bundles and sheaflike aggregates, and finally the spherulites. Spherulites may range in diameter from a few tenths of a micron to several millimeters.

SPIDER 1. In a molding press, that part of an ejector mechanism which operates the ejector pins. 2. In extrusion, a term used to denote the arms supporting a mandrel within the head and die assembly. 3. In rotational molding, the gridwork of metallic members supporting cavities in a multi-cavity mold.

SPIDER LINES In blow molding or film extrusion, vertical marks on the parison molded part or film caused by improper welding of several melt flow fronts formed by the legs with which the torpedo is fixed in the extruder head.

SPIRAL FLOW TEST A method for determining the flow properties of a thermoplastic or thermosetting resin based on the distance it will flow under controlled conditions of pressure and temperature along a spiral runner of constant cross section. The test is usually performed with a test mold which the material is fed at the center of the spiral cavity.

SPIRAL MOLD COOLING A method of cooling injection molds or similar molds wherein the cooling medium flows through a spiral cavity in the body of a mold. In injection molds, the cooling medium is introduced at the center of the spiral, near the sprue section, as more heat is localized in this section.

SPLIT CAVITY MOLD A mold cavity designed with sections.

SPLIT RING MOLD A mold in which a split cavity block is assembled in a chase to permit the forming of undercuts in a molded piece. These parts are ejected from the mold and then separated from the piece.

SPRUE In an injection or transfer mold, the main feed channel that connects the mold filling orifice with the runners leading to each cavity gate. The term is also used for the piece of plastic material formed in this channel.

SPRUE BUSHING A hardened steel insert in an injection mold which contains the tapered sprue hole and has a suitable seat for the nozzle of the injection cylinder. Sometimes called an adapter.

SPRUE GATE A passageway through which molten resin flows from the nozzle to the mold cavity.

SPRUE PULLER A pin having a Z-shaped slot undercut in its end, by means of which it serves to pull the sprue out of the sprue bushing.

STABILIZER Ingredient used in the formulation of some polymers to assist in maintaining the physical and chemical properties of the compounded materials, for example, heat and UV stabilizers.

STATIC ELIMINATORS Mechanical devices for removing electrical static charges from plastics articles. Types of static eliminators include static bars, ionizing blowers, and air guns.

STACK MOLD Two-level mold (two sets of cores and cavities stacked one above the other) for increased part production rates. Effectively doubles the parts per hour a machine can make.

STATIONARY PLATEN In an injection molding machine, the large front plate to which the front plate of the mold is secured. This platen does not normally move.

STEARAMIDE A slip additive used in polyolefins.

STIFFNESS The capacity of a material to resist strain where stressed.

STRAIN In tensile testing, the ratio of the elongation to the gauge length of the test specimen, that is, the change in length per unit of original length. The term is also used in a broader sense to denote a dimensionless number that characterizes the change in dimensions of an object during a deformation or flow process.

STRESS The force producing or tending to produce deformation divided by the area over which the force is applied. As generally defined in tensile testing (engineering stress), stress is the ratio of applied load to the original cross-sectional area. True stress (instantaneous stress) is applied load per instantaneous cross-sectional area.

STRESS CONCENTRATION The amplification of the level of an applied stress in the region of a notch, void, or inclusion.

STRIPPER-PLATE A plate that strips a molded piece from core pins or force plugs. The plate is actuated by the opening of the mold.

STYRENE-ACRYLONITRILE COPOLYMER (SAN) Copolymers of about 70 percent styrene and 30 percent acrylonitrile, with higher strength, rigidity, and chemical resistance than straight polystyrene. They may be blended with butadiene, either as terpolymer or by grafting onto the butadiene, to make ABS resins.

SUBMARINE GATE Gate where the opening from the runner into the mold is located below the parting line or mold surface; as opposed to conventional edge gating where the opening is machined into the surface of the mold. With submarine gates, the item is broken from the runner system on ejection.

SURFACE TENSION A fluid in contact with a surface exhibits phenomena, due to molecular attractions, which appears to arise from a tension in the surface of the fluid. It may be expressed as dynes per centimeter or as ergs per square centimeter.

SUCK BACK Technique used to partially clear the resin from the injection nozzle after the injection cycle by pulling the screw rearward, thus drawing the resin back into the injector.

SURFACTANT A compound that alters surface tension of a liquid in which it is dissolved to improve contact area between two materials.

SURGING In extrusion, an unstable pressure buildup leading to variable output and waviness of the surface of the extrudate. In extreme cases, the flow of extrudate may even cease momentarily at intervals.

SYNERGISM A phenomenon wherein the effect of a combination of two additives is greater than the effect that could be expected from the known performance of each additive used singly.

T

TAB GATE A small removable tab of approximately the same thickness as the molded item, usually located perpendicularly to the item. The tab is used as a site for edge gate location, usually on items with large flat areas.

TACK The stickiness of an adhesive, measurable as the force required to separate an adherent from it by viscous or plastic flow of the adhesive.

TACKIFIER A substance such as a resin ester which is added to synthetic resins or elastomeric adhesives to improve the initial and extended tackiness of the film.

TAKE-OFF The mechanism for drawing extruded or calendered material away from the extruder or calender.

TALC A natural hydrous magnesium silicate, used frequently as a filler such as steatite, talcum, mineral graphite.

TEFLON DuPont's trademark covering all of its fluorocarbon resins, including PTFE, FEP, and various copolymers.

TEAR RESISTANCE Resistance of a material to a force acting to initiate and then propagate a failure at the edge of a test specimen.

TEAR PROPAGATION RESISTANCE Resistance of a material to a force acting to propagate an initiated tear in the material.

TENSILE STRENGTH The maximum tensile stress sustained by the specimen before failure in a tension test. Usually expressed in pounds per square inch or megapascals. The cross-sectional area used is that of the original specimen, not at the point of rupture.

TERPOLYMER The product of copolymerization of three different monomers, or of the grafting of one monomer to the copolymer of two different monomers. An example of a terpolymer is ABS resin, derived from acrylonitrile, butadiene, and styrene.

THERMAL CONDUCTIVITY The rate at which heat is transferred by conduction through a unit cross-sectional area of a material when a temperature gradient exists perpendicular to the area.

THERMAL DECOMPOSITION

Decomposition resulting from action by heat. It occurs at a temperature at which some components of the material are separating or reacting together, with a modification of the macro or micro-structure.

THERMAL STABILITY Ability of a polymer to maintain its initial physical and chemical properties at elevated temperature.

THERMOCOUPLE A device which uses a circuit of two wires of dissimilar metals or alloys, the two junctions of which are at different temperatures. A net electromotive force (emf) occurs as a result of differences in conductivity. The minute electromotive force, or current, is sufficient to drive a galvanometer or potentiometer.

THERMOFORMING The process of forming a thermoplastic sheet into a three-dimensional shape by clamping the sheet in a frame, heating it to render it soft, then applying differential pressure to make the sheet conform to the shape of a mold or die positioned below the frame.

THERMOGRAVIMETRIC ANALYSIS

The measurement of changes in weight of a specimen as it is heated. Some tests are conducted in air and some in other atmospheres. The resulting data reveals information about the materials thermal stability and polymerization processes.

THERMOPLASTICS Resins or plastic compounds which, in their final state as finished articles, are capable of being repeatedly softened by an increase of temperature and hardened by a decrease of temperature.

THERMOSETS Resins or plastic compounds which in their final state as finished articles are substantially infusible and insoluble. Thermosetting resins are often liquids at some stage in their manufacture or processing, and are cured by heat, catalysis, or other chemical means. After being fully cured, thermosets cannot be resoftened by heating.

THINNING This refers to the finished wall of a blow molded container or the corners of a thermoformed part. The wall thickness has thinned out in some areas due to improper blowing or excessive stretching.

TIE BARS Bars which provide structural rigidity to the clamping mechanism often used to guide platen movement.

TITANIUM DIOXIDE A white powder available in two crystalline forms, the anatase and rutile types. Both are widely used as opacifying pigments in thermosets and thermoplastics.

TOGGLE A mechanism that exerts pressure developed by applying force on a knee joint. It is used to close and exert pressure on a mold in a press.

TORPEDO A streamlined metal block placed in the path of flow of the plastic material in the heating cylinder of extruders and injection molding machines, to spread it into thin layers, thus forcing it into intimate contact with the heating areas.

TOXICITY The degree to which a substance is poisonous. Although most pure resins and polymers are relatively nontoxic, compounding additives such as stabilizers, colorants, and plasticizers must be carefully

selected when products are to be used for food packaging or other applications involving body contact.

TRANSITION SECTION In an extruder, the section of the screw that contains material in both the solid and molten state.

TRANSITION TEMPERATURE The temperature at which a polymer changes from (or to) a viscous or rubbery condition to (or from) a hard and relatively brittle one.

TREATER Equipment used for preparing resin-impregnated reinforcements including means for the delivery of a continuous web or strand to a resin tank, controlling the amount of resin pickup, drying, or partially curing the resin, and rewinding the impregnated reinforcement. Term also used to refer to equipment and process used to render a surface of inert plastics, such as polyethylene more receptive to inks, adhesives, or coatings.

U

ULTIMATE STRENGTH The maximum stress developed in a tensile-compression specimen.

ULTRAVIOLET (UV) STABILIZER Chemical agents which absorb or screen out radiation beyond the violet end of the spectrum of electromagnetic radiation. Such radiation has sufficient energy to initiate reactions leading to the degradation of many plastics. These agents are often combined with other additives, e.g. heat stabilizers and antioxidants, with which they act in synergistic fashion. UV stabilizers can be UV absorbers or radical scavengers.

UNDERCUT An indentation or protuberance in a mold that tends to impede withdrawal of a molded part from the mold. Articles of soft materials such as flexible vinyls can be removed from molds with severe undercuts, but undercuts must be avoided in molds for rigid materials. Slight undercuts are sometimes deliberately formed in one half of a mold to cause the article to remain in a desired half until ejected.

V

VAN DER WAALS FORCES Forces that exist between molecules of a substance after all of the primary valences within covalent molecules are saturated. Also called secondary valence forces or intermolecular forces.

VAPOR As most frequently used, the term vapor describes a substance which, although present in the gaseous phase, generally exists as a liquid or solid at room temperature.

VAPOR BARRIER A layer of material through which water vapor will not pass readily or at all.

VENT A small hole or shallow channel in a mold which allows air or gas to exit as the stock enters.

VENTED BARREL Port in extruder barrel through which volatiles can be removed.

VENTED SCREW Two-stage screw with vent in second stage to remove volatiles from the screw core.

VIBRATORY FEEDERS Devices for conveying dry materials from storage hoppers to processing machines, comprising a tray or tube vibrated by mechanical or electrical pulses. The frequency or amplitude of the vibrations control the rate of flow.

VICAT SOFTENING POINT The temperature at which a flat-ended needle of 1 square millimeter circular or square cross section will penetrate a thermoplastic specimen to a depth of 1 mm under a specified load using a uniform rate of temperature rise. (ASTM D-1525-58T).

VINYL ACETATE A colorless liquid obtained by the reaction of ethylene and acetic anhydride in the presence of a catalyst. It is the monomer for polyvinyl acetate, and a comonomer and intermediate for many members of the vinyl plastics family.

VIRGIN MATERIAL Any plastic compound or resin that has not been subjected to use or processing other than that required for its original manufacture.

VISCOELASTICITY The tendency of plastics to respond to stress as if they were a combination of elastic solids and viscous fluids. This property, possessed by all plastics to some degree, dictates that while plastics have solid-like characteristics such as elasticity, strength, and form-stability, they also have liquid-like characteristics such as flow depending upon time, temperature, rate, and amount of loading.

VISCOSITY The measure of the resistance of a fluid to flow (either through a specific orifice or in a rotational viscometer). The

absolute unit of viscosity measurement is the poise (or centipoise). Often expressed as kilopascal (kPa).

VISCOUS FLOW A type of fluid movement in which all particles of the fluid flow in a straight line parallel to the axis of a containing pipe or channel, with little or no mixing or turbidity.

VOID 1. An unfilled space in a cellular plastic substantially larger than the characteristic individual cells. 2. An empty space in any material or medium.

VOLATILE Capable of being driven off as a vapor at room or slightly elevated temperatures.

VOLATILE CONTENT The percent of volatiles which are driven off as vapor from a plastic or impregnated reinforcement.

VOLATILE LOSS The loss in weight of a substance caused by vaporization of a constituent.

W

WARP Dimensional distortion in a plastic object after molding or other fabrication due to the release of molded in stresses.

WATER VAPOR TRANSMISSION The amount of water vapor passing through a given area and thickness of a plastic sheet or film in a given time, when the sheet or film is maintained at a constant temperature and when its faces are exposed to certain different relative humidities. The result is usually expressed as grams per 24 hours per square meter.

WEATHEROMETER (WOM) An instrument which is used to subject articles to accelerated weathering conditions, e.g., rich UV source and water spray.

WEB 1. A thin sheet in process in a machine. In extrusion coating, the molten web is that which issues from the die, and the substrate web is the material being coated. 2. A continuous length of sheet material handled in roll form as contrasted with the same material cut into sheets.

WEIGHT-AVERAGE MOLECULAR WEIGHT (MW) The first moment of a plot of the weight of the polymer in each molecular weight range against molecular weight. The value of MW can be estimated by light scattering or sedimentation equilibrium measurements.

WELD LINE A flaw on a molded plastic article or blown film caused by the incomplete fusion of two flow fronts which meet during the molding or extrusion operation.

WRINKLE A surface imperfection in plastic films that has the appearance of a crease or wrinkle.

Y

YELLOWNESS INDEX A measure of the tendency of plastics to turn yellow upon long-term exposure to light or heat.

YIELD POINT In tensile testing, yield point is the first point on the stress-strain curve at which an increase in strain occurs without an increase in stress. This is the point at which permanent deformation of the stressed specimen begins to take place.

YIELD STRENGTH The stress at the yield point of a specimen, usually expressed in pounds per square inch or megapascals.

Z

ZIEGLER CATALYSTS A large group of catalysts made by reacting a compound of a transition metal chosen from groups IV through VIII of the periodic table with an alkyl, hydride, or other compound of a metal from groups I through III. A typical example is the reaction product of an aluminum alkyl with titanium tetrachloride or titanium trichloride. These catalysts were first developed by the German scientist Karl Ziegler for the polymerization of ethylene. Subsequent work by G. Natta showed that these and similar catalysts are useful for preparing stereoregular polyolefins. Thus, the family of catalysts is sometimes called Ziegler-Natta catalysts.

ZINC OXIDE An amorphous white or yellowish powder, used as a pigment in plastics. It is said to have the greatest ultra-violet light absorbing power of all commercially available pigments.

ZINC STEARATE A white powder used as a lubricant and antioxidant synergist.

Abbreviations

A

A Angstrom Unit.
AO Antioxidant.
ABS Acrylonitrile-butadiene-styrene.
ASTM American Society for Testing and Materials.

ATIR Attenuated Total Reflectance Infrared (Spectrometry).

B

BSI British Standards Institute.
Btu British Thermal Unit.

C

°C Degrees Celsius.
CA Cellulose Acetate.
CN Cellulose Nitrate.
CP Centipoise.
cm Centimeter.
COF Coefficient of Friction.

D

dm Decimeter.
DE Diatomaceous Earth.
DTA Differential Thermal Analysis.
DSC Differential Scanning Calorimeter.

E

EC Ethyl Cellulose.
EP Epoxy Resins.
EPOM Ethylene-propylene-diene Terpolymer.
EPR Ethylene-propylene Rubber.
ESCR Environmental Stress Cracking Resistance.
EVA Ethylene Vinyl Acetate.

F

°F Degrees Fahrenheit.
fl oz Fluid Ounce.
ft Foot

FDA Food and Drug Administration.
FEP Fluorinated Ethylene Propylene.
FI Flow Index.
FPA Flexible Packaging Association.
FTIR Fourier Transform Infrared
 (Spectrometry).
FR Flow Rate.
FRP Fiber Reinforced Plastics.

G

g Gram.
g/cc Grams per Cubic Centimeter.
gal Gallon.
GC Gas Chromatograph.
GPC Gel Permeation Chromatograph.
GRP Glass Reinforced Plastics.

H

HALS Hindered Amine Light Stabilizer.
hp Horsepower.
HDPE High-Density Polyethylene.
HLMI High Load Melt Index.
HPB Health Protection Branch.
HT-1 Nylon Resin.
HMW-HDPE High Molecular Weight
 High-Density Polyethylene.

I

in Inch.
in H₂O Inches of Water.
IR Infrared (Spectrometry).
IUPAC International Union of Pure and
 Applied Chemistry.

J

J/mm Joules per Millimeter.

K

kg Kilogram.
kgf Kilogram of Force.
kg/cm² Kilograms per Square Centimeter.
km Kilometer.
kPa Kilopascal.
kPH Kilometers per Hour.
kJ Kilojoule.
kW Kilowatt.
kT Kilotonne.

L

l Liter.
lb Pound.
lbf Pound Force.
lb/in² Pounds per Square Inch.
lb/ft² Pounds per Square Foot.
lb/ft³ Pounds per Cubic Foot.
LC Liquid Chromatography.
LDPE Low-Density Polyethylene.
LLDPE Linear Low-Density Polyethylene.

M

m Meter.
mil 0.001 Inches.
ml Milliliter.
mm Millimeter.
MPH Miles per Hour.
MPG Miles per Gallon.
MAN Methacrylonitrile.
MB Masterbatch.
MEK Methyl Ethyl Ketone.
MEKP Methyl Ethyl Ketone Peroxide.
MI Melt Index.
MFR Melt Flow Ratio.
MH_z Mega Hertz.
MPa Megapascal.
Mn Number Average Molecular Weight.

Mw Weight Average Molecular Weight.
MW Molecular Weight.
MWD Molecular Weight Distribution.
MVT Moisture Vapor Transmission.

N

NBR Acrylonitrile-butadiene Copolymer.
NBS National Bureau of Standards.
NMR Nuclear Magnetic Resonance.
NTC Novacor Technical Center.
NVCR Novacor Chemicals Ltd./Inc.

O

oz Ounce.
OIT Oxidative Induction Time.

P

pH # Expresses Acidity or Alkalinity.
pt Pint.
Pa Pascal.
PAN Polyacrylonitrile.
PB Polybutene.
PC Polycarbonate.
PCTFE Polychlorotrifluoroethylene.
PE Polyethylene.
PET Polyethylene Terephthalate.
PHR Parts per Hundred.
PIA Plastics Institute of America.
PIB Polybutylene.
PMAC Polymethyl Acetal.
PMAN Polymethacrylonitrile.
PVC Polyvinyl Chloride.
PP Polypropylene.
PTFE Polytetrafluoroethylene.
PS Polystyrene.
PVA Polyvinyl Alcohol.
PVAC Polyvinyl Acetate.
PVOH Polyvinyl Alcohol.

Q

qt Quart.

S

sec Second.
SAN Styrene-Acrylonitrile Copolymer.
SBR Styrene-Butadiene Rubber.
SPE Society of Plastics Engineers.
SPI Society of Plastics Institute.

T

t Tonne.
Tg Glass Transition Temperature.
TFE Tetrafluoroethylene.
TGA Thermogravimetric Analysis.
THF Tetrahydrofuran.
TPP Triphenyl Phosphate.
TEP Triethyl Phosphate.
TNPP Tris-Nonylphenyl-Phosphite.

U

UV Ultraviolet.
UHMW-HDPE Ultra High Molecular Weight High-Density Polyethylene.

W

WVT Water Vapor Transmission.