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PLASTIC

PLASTICS REFERENCE HANDBOOK

REGAL PLASTIC SUPPLY COMPANY

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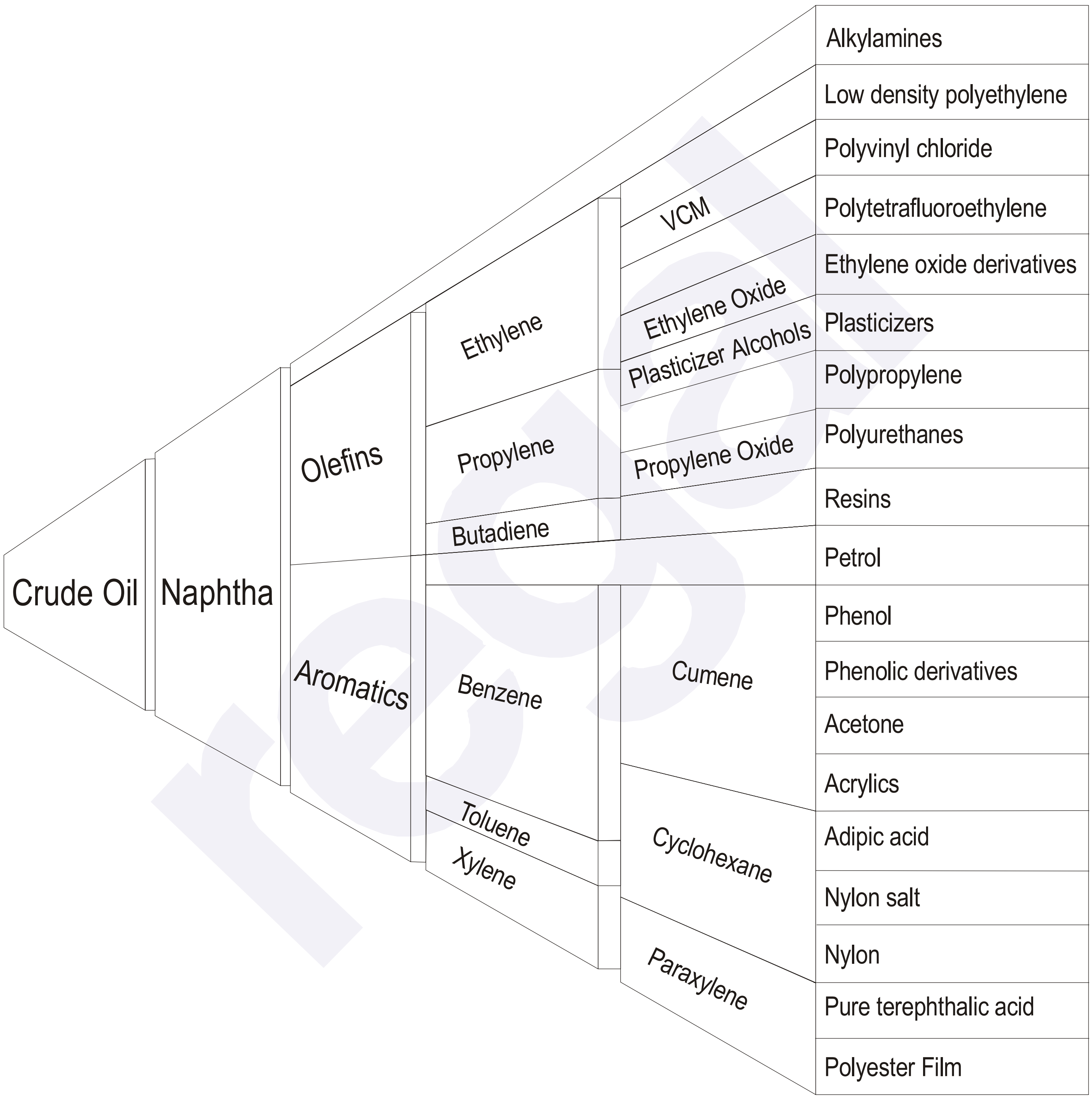
The Origins of Plastic Materials



Preface

Introduction

PLASTIC-(per Webster)- “Any numerous organic, synthetic, or processed materials that are high molecular weight polymers.”

Polymers are a tribute to man’s creativity and inventiveness. They are truly man-made materials. Like any other material, they have their origins in nature, in such basic chemical elements as carbon, oxygen, hydrogen, nitrogen, chlorine, and sulfur. These elements in turn are extracted from the air, water, gas, oil, coal, or even plant life.

It was man’s inspiration to take these elements and combine them, via various chemical reactions, in an almost unending series of combinations, to produce the rich variety of materials we know today as plastics.

The possibilities of combining chemical elements to create plastics with different properties are almost endless. It is this diversity that has made plastics so applicable to such a broad range of end uses and products today.

In the Beginning

Given this kind of versatility and the role that plastics play in modern living, it’s surprising to realize that a little over a century ago there was no such thing as commercial plastic in the United States. During the 1850's and 60's, developmental work was going on with hard rubbers and cellulose materials, but the U.S. plastics industry officially dates its beginnings back to 1868, when a product called Celluloid was created as the first commercial plastic in the U.S. The development was in response to a competition sponsored by a manufacturer of billiard balls. It came about when a shortage developed in ivory from which the billiard balls were made, and the manufacturer sought another production method. Celluloid was one of the materials considered, and the U.S. plastics industry was born.

As has been typical of new plastic materials ever since, Celluloid quickly moved into other markets. The first photographic film used by Eastman was made of celluloid: producing the first motion picture film in 1882. The material is still in use today under its chemical name Cellulose nitrate, for making products like eyeglass frames.

Forty years were to pass before the plastics industry took its second major step forward. In 1909, Dr. Leo Hendrik Baekeland introduced Phenol formaldehyde plastics (or Phenolics as they are more popularly known), the first plastic to achieve world wide acceptance.

The third big thrust in plastics development took place in the 1920's with the introduction of Cellulose acetate, ureaformaldehyde, polyvinyl chloride, or Vinyl, and Nylon.

Evolution

In the World War II years of the 1940’s, the demand for plastics accelerated, as did research into new plastics that could aid in the defense effort.

Preface

By the start of the 1950's plastics were on their way to being accepted by designers and engineers as basic materials, along with the more conventional ones.

Nylon, Teflon, Acetal, and Polycarbonate became the nucleus of a group in the plastics family known as the engineering thermoplastics. Their outstanding impact strength and thermal and dimensional stability enabled them to compete directly with metals. This group has grown since then to include a number of new plastics, as well as improved variations of older plastics that could similarly qualify for inclusion.

The Monomers & Polymers

Many plastics are derived from fractions of petroleum or gases that are recovered during the refining process. For example: ethylene monomer, one of the more important feedstocks, or starting materials for plastics, is derived in a gaseous form from petroleum refinery gas, liquefied petroleum gases, or liquid hydrocarbons. Although petroleum gas derivatives are not the only basic source used in making feedstocks for plastics, they are among the most popular and economical in use today. Coal is another excellent source in the manufacturing of feedstocks for plastics.

From these basic sources come the feedstocks we call monomers. The monomer is subjected to a chemical reaction known as polymerization; it causes the small molecules to link together into ever increasingly long molecules. Chemically, the polymerization reaction gas turns the monomer into a polymer, and thus a given type of plastic resin.

The Product as We See It

The polymer or plastic resin must next be prepared for use by the processor, who will turn it into a finished product. In some instances, it is possible to use the plastic resin as it comes out of the polymerization reaction. More often, however, it goes through other steps which turn it into a form that can be more easily handled by the processor and processing equipment. The more popular forms of resin for processing are pellet, granule, flake, and powder.

In the hands of the processor, these solids are generally subjected to heat and pressure. They are melted, forced into the desired shape (sheets, rods, and tubes) and then allowed to cure into a finished product. Resins are most readily available in their natural color, but by adding coloring agents, most any color can be achieved during the processing.

Plastics are a family of materials, not a single material. Each has its own distinct and special advantages.

Each day brings new plastic compounds, and new uses for the old compounds.

Chronology of Plastic

DATE	MATERIAL	ORIGINAL TYPICAL USE
1868	Cellulose Nitrate	Eye Glass Frames
1909	Phenol-Formaldehyde	Telephone Handsets
1926	Alkyd	Electrical Bases
1926	Analine-Formaldehyde	Terminal Boards
1927	Cellulose Acetate	Tooth Brushes, Packaging
1927	Polyvinyl Chloride	Raincoats
1929	Urea-Formaldehyde	Lighting Fixtures
1935	Ethyl Cellulose	Flashlight Cases
1936	Acrylic	Brush Backs, Displays
1936	Polyvinyl Acetate	Flash Bulb Lining
1938	Cellulose Acetate Butyrate	Irrigation Pipe
1938	Polystyrene or Styrene	Kitchen Housewares
1938	Nylon (Polyamide)	Gears
1938	Polyvinyl Acetal	Safety Glass Interlayer
1939	Polyvinylidene Chloride	Auto Seat Covers
1939	Melamine-Formaldehyde	Tableware
1942	Polyester	Boat Hulls
1942	Polyethylene	Squeezable Bottles
1943	Fluorocarbon	Industrial Gaskets
1943	Silicone	Motor Insulation
1945	Cellulose Propionate	Automatic Pens and Pencils
1947	Epoxy	Tools and Jigs
1948	Acrylonitrile-Butadiene-Styrene	Luggage
1949	Allylic	Electrical Connectors
1954	Polyurethane or Urethane	Foam Cushions
1956	Acetal	Automotive Parts
1957	Polypropylene	Safety Helmets
1957	Polycarbonate	Appliance Parts
1959	Chlorinated Polyether	Valves and Fittings
1962	Phenoxy	Bottles
1962	Polyallomer	Typewriter Cases
1964	Ionomer	Skin Packages
1964	Polyphenylene Oxide	Battery Cases
1964	Polymide	Bearings
1964	Ethylene-Vinyl Acetate	Heavy Gauge Flexible Sheeting
1965	Parylene	Insulating Coatings
1965	Polysulfone	Electrical/Electronic Parts
1970	Thermoplastic Polyester	Electrical/Electronic Parts
1973	Polybutylene	Piping
1975	Nitrile Barrier Resins	Containers

The information contained herein provides product data, suggestions, and guidelines we believe to be reliable. They are offered in good faith but without any guarantee, as conditions, type of product, and methods of product use are beyond our control.

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Sufficient verification and testing to determine the suitability for their own particular purpose of any information or products referred to herein, is strongly recommended.

Glossary

Absolute Viscosity
Of a fluid, the tangential force on unit area of either of two parallel planes at unit distance apart when the space between the planes is filled with the fluid in question, and one of the planes moves with unit deferential velocity in its own plane.

Abrasion Resistance
Ability to withstand the effects of repeated wearing, rubbing, scraping, etc.

Acceptance Test
An investigation performed on an individual lot of a previously qualified product, by or under the observation of the purchaser to establish conformity with a purchase agreement.

Acids
One of a class of substances compounded of hydrogen and one or more other elements, capable of uniting with a base to form a salt.

Acrylic Resins
A class of thermoplastic resins produced by polymerization of acrylic acid derivatives.

Acrylonitrile
A monomer with the structure (CH_2:CHCN). It is most useful in copolymers. Its copolymer with butadiene is nitrile rubber, and several copolymers with styrene exist that are tougher than polystyrene. It is also used as a synthetic fiber and as a chemical intermediate.

Acrylonitrile - Butadiene - Styrene (ABS)
This is a thermoplastic family consisting of more than 15 different groups of engineering materials formed basically from three different monomers: acrylonitrile, butadiene and styrene.

Adhesive
A substance capable of holding materials together by surface attachment.

Adiabatic
An adjective used to describe a process or transformation in which no heat is added to or allowed to escape from the system under consideration. It is used, somewhat incorrectly, to describe a mode of extrusion in which no external heat is added to the extruder, although heat may be removed by cooling to keep the output temperature of the melt passing through the extruder constant. The heat input in such a process is developed by the screw as its mechanical energy is converted to thermal energy.

Aging
The effect of time on materials.

Air-Assist Forming
A method of thermoforming q.v., in which air flow or air pressure is employed to partially preform the sheet immediately prior to the final pulldown onto the mold using vacuum.

Air Gap
In extrusion coating, the distance from the die opening to the nip formed by the pressure roll and the chill roll.

Air Ring
A circular manifold used to distribute an even flow of the cooling medium, air, onto a hollow tubular form passing through the center of the ring. In blown tubing, the air cools the tubing uniformly to provide uniform film thickness.

Air-Slip Forming
A variation of snap back forming in which the male mold is enclosed in a box in such a way that when the mold moves forward toward the hot plastic, air is trapped between the mold and the plastic sheet. As the mold advances, the plastic is kept away from it by the air cushion formed as described above, until the full travel of the mold is reached, at which point a vacuum is applied, destroying the cushion and forming the part against the plug.

Aliphatic
Derived from or related to fats and other derivatives of the paraffin hydrocarbons, including unsaturated compounds of the ethylene and acetylene series.

Alkalis
Compounds capable of neutralizing acids and usually characterized by an acrid taste. Can be mild like baking soda or highly caustic like lye.

Alkyd Resins
A class of thermosetting resins produced by condensation of a poly-based acid or anhydride and a polyhydric alcohol.

Alloy
Composite material made up by blending polymers or copolymers with other polymers or elastomers under selected conditions, e.g., styrene-acrylonitrile copolymer resins blended with butadiene acrylonitrile rubbers.

Allyl Resins
A class of resins produced from an ester or other derivative of allyl alcohol by polymerization.

Amorphous Phase
Devoid of crystallinity - no definite order. At processing temperatures, the plastic is normally in the amorphous state.

Anneal
To prevent the formation of or remove stresses in plastics parts by controlled cooling from a suitable elevated temperature.

Anti-Friction Compounds
Materials specifically formulated to reduce or eliminate friction.

Antioxidant
Substance which prevents or slows down oxidation of material exposed to air.

Antistatic Agents
Methods of minimizing static electricity in plastic materials. Such agents are of two basic types: (1) metallic devices which come into contact with the plastics and conduct the static to earth. Such devices have complete neutralization at the time, but because they do not modify the surface of the material it can become prone to further static during subsequent handling. (2) chemical additives which, mixed with the compound during processing, give a reasonable degree of protection to the finished products.

Average Molecular Weight
The molecular weight of polymeric materials determined by the viscosity of the polymer in solution at a specific temperature. This gives an average molecular weight of the molecular chains in the polymer independent of specific chain length. Falls between weight average and number average molecular weight.

Back Pressure
The viscosity resistance of a material to continual flow when a mold is closing. In extrusion, the resistance to the forward flow of molten material.

Baffle
A device used to restrict or divert the passage of fluid through a pipe line or channel. In hydraulic systems the device, which often consists of a disc with a small central perforation, restricts the flow of hydraulic fluid in a high pressure line. A common location for the disc is in a joint in the line.

When applied to molds, the term is indicative of a plug or similar device located in a steam or water channel in the mold and designed to divert and restrict the flow to a desired path.

Bakelite
The proprietary name for phenolic and other plastics materials produced by Bakelite Limited, but often used indiscriminately to describe any phenolic molding material or molding. The name is derived from that of Dr. Leo Hendrik Baekeland, a Belgian who, through his work on the synthesis of phenolic resins and their commercial development in the early 1900s, is generally considered to be the father of the plastics industry.

Banbury
An apparatus for compounding materials composed of a pair of contra rotating rotors which masticate the materials to form a homogeneous blend. This is an internal type mixer which produces excellent mixing.

Beta Gage (or Beta-Ray Gage)
A gage consisting of two facing elements, a B-ray emitting source and a B-ray detector. When a sheet material is passed between the elements, some of the B-rays are absorbed, the percent absorbed being a measure of the arial density or thickness of the sheet.

Bleed
To give up color when in contact with water or a solvent; undesired movement of certain materials in a plastic to the surface of the finished article or into an adjacent material. Also called migration.

Blister
A raised area on the surface of a molding caused by the pressure of gases inside it on its incompletely hardened surface; somewhat resembling in shape a blister on the human skin. A blister may burst and become flattened.

Block Copolymer
An essentially linear copolymer in which there are repeated sequences of polymeric segments of different chemical structure.

Blocking
An undesired adhesion between touching layers of a material, such as occurs under moderate pressure during storage or use.

Bloom
A visible exudation or efflorescence on the surface of a material.

Blow Pressure
The air pressure used to form a hollow part by blow molding.

Glossary

Blow Rate

The speed at which the air enters the parison during the blow molding cycle.

Blueing

A mold blemish in the form of a blue oxide film occurring on the polished surface of a mold as a result of the use of abnormally high mold temperatures.

Bond

To attach by means of an adhesive.

Boss

Protuberance on a plastic part designed to add strength, to facilitate alignment during assembly, to provide for fastenings, etc.

Bottom Blow

A specific type of blow molding machine which forms hollow articles by injecting the blowing air into the parison from the bottom of the mold.

Bottom Plate

Part of the mold which contains the heel radius and the push-up.

Breaker Plate

A perforated plate located at the rear end of an extruder head. It often supports the screens that prevent foreign particles from entering the die.

Bulk Density

The mass per unit volume of a molding powder as determined in a reasonably large volume. The generally accepted test method is ASTM D1182-54.

Burned

Showing evidence of thermal decomposition through some discoloration, distortion, or destruction of the surface of the plastic.

Butadiene

A gas, insoluble in water but soluble in alcohol and ether, obtained from the cracking of petroleum, from coal tar benzene or from acetylene produced from coke and lime. It is widely used in the formation of copolymers with styrene, acrylonitrile, vinyl chloride and other monmeric substances, where it imparts flexibility to the subsequent moldings.

Butadiene Styrene Plastics

A synthetic resin derived from the copolymerization of butadiene gas and styrene liquids.

Butylene Plastics

Plastics based on resins made by the polymerization of butene or copolymerization of butene with one or more unsaturated compounds, the butene being in greatest amount by weight.

Calender

(v) To prepare sheets of material by pressure between two or more counter rotating rolls. (n) The machine performing this operation.

Carbon Black

A black pigment produced by the incomplete burning of natural gas or oil. It is widely used as a filler, particularly in the rubber industry. Because it possesses useful ultraviolet protective properties, it is also much used in polyethylene compounds intended for such applications as cold water piping and black agricultural sheet.

Cast

(1) To form a "plastic" object by pouring a fluid monomer-polymer solution into an open mold where it finishes polymerizing. (2) Forming plastic film and sheet by pouring the liquid resin onto a moving belt or by precipitation in a chemical bath.

Cast Film

A film made by depositing a layer of plastic, either molten, in solution, or in a dispersion, onto a surface, solidifying it, and removing the film from the surface.

Casting (n)

The finished product of a casting operation; should not be used for molding, q.v.

Catalysis

The acceleration (or retardation) of the speed of a chemical reaction by the presence of a comparatively small amount of a foreign substance called a catalyst.

Cavity

Depression in a mold made by casting, machining, hobbing, or a combination of these methods; depending on the number of such depressions, molds are designated as single cavity or multi-cavity.

Celluloid

A thermoplastic material made by the intimate blending of cellulose nitrate, q.v., with camphor. Alcohol is normally employed as a volatile solvent to assist plasticization, and is subsequently removed.

Cellulose

A natural high polymeric carbonhydrate found in most plants; the chief component of the solid structure of plants, wood, cotton, linen, etc. The source of the cellulosic family of plastics.

Cellulose Acetate
An acetic acid ester of cellulose. It is obtained by the action, under rigidly controlled conditions, of acetic acid and acetic anhydride on purified cellulose usually obtained from cotton fibers. All three available hydroxyl groups in each glucose unit of the cellulose can be acetylated, but in the material normally used for plastics, it is usual to acetylate fully and then to lower the acetyl value (expressed as acetic acid) to 52-56% by partial hydrolysis. When compounded with suitable plasticizers it gives a tough thermoplastic material.

Cellulose Acetate Butyrate
A class of resins made from a cellulose base. Either cotton linters or purified wood pulp, by the action of acetic anhydride, acetic acid, and butyric acid.

Cellulose Ester
A derivative of cellulose in which the free hydroxyl groups attached to the cellulose chain have been replaced wholly or in part by acetic groups, e.g., nitrate acetate, or stearate groups. Esterification is affected by the use of a mixture of an acid with its anhydride in the presence of a catalyst, such as sulfuric acid. Mixed esters of cellulose, e.g., cellulose acetate butyrate, are prepared by the use of mixed acids and mixed anhydrides. Esters and mixed esters, a wide range of which is known, differ in their compatibility with plasticizers, in molding properties and in physical characteristics. These esters and mixed esters are used in the manufacture of thermoplastic molding compositions.

Cellulose Propionate
An ester of cellulose made by the action of propionic acid and its anhydride on purified cellulose. It is used as the basis of a thermoplastic molding material.

Cement
A dispersion of “solution" of a plastic in a volatile solvent. This meaning is peculiar to the plastics and rubber industries and may or may not be an adhesive composition.

Chalking
A powdery residue on the surface of a material often resulting from degradation.

Chemically Foamed Polymeric Material
A cellular material in which the cells are formed by gases generated from thermal decomposition or other chemical reaction.

Chill Roll
A cored roll, usually temperature controlled with circulating water, which cools the web before winding. For chill roll (cast) film, the surface of the roll is highly polished. In extrusion coating, either a polished or a matte surface may be used depending on the desired finished surface coating.

Chill Roll Extrusion (or Cast Film Extrusion)
The extruded film is cooled while being drawn around two or more highly polished chill rolls cored for water cooling for exact temperature control.

Chlorinated Polyether
The polymer is obtained from pentaerythritol by preparing a chlorinated oxetane and polymerizing it to a polyether by means of opening the ring structure.

Chromium Plating
An electrolytic process that deposits a hard film of chromium metal onto working surfaces of other metals where resistance to corrosion, abrasion, and/or erosion is needed.

Chlorinated Polyvinyl Chloride Plastics
Plastics based on chlorinated polyvinyl chloride, in which the chlorinated polyvinyl chloride is in the greatest amount by weight.

Clamping Plate
A plate fitted to a mold and used to fasten the mold to a molding machine.

Clearance
A controlled distance by which one part of an object is kept separated from another part.

Coalescence
The union or fusing together of fluid globules or particles to form larger drops or a continuous mass.

Cold Flow
Change in dimension or shape of some materials when subjected to external weight or pressure at room temperature.

Cold Slug
The first material to enter an injection mold; so called because in passing through the sprue orifice it is cooled below the effective molding temperature.

Cold Slug Well
Space provided directly opposite the sprue opening in an injection mold to trap the cold slug.

Glossary

Compound

A combination of ingredients before being processed or made into a finished product. Sometimes used as a synonym for material formulation.

Compression Ratio

In an extruder screw, the ratio of volume available in the first flight at the hopper to the last flight at the end of the screw.

Compressive Strength

The crushing load at failure applied to the resistance surface of a specimen per unit area.

Condensation

A chemical reaction in which two or more molecules combine with the separation of water. Also, the collection of water droplets from vapor onto a cold surface.

Conveyor

A mechanical device to transport material from one point to another, often continuously.

Cooling Fixture

Block of metal or wood holding the shape of a molded piece, used to maintain the proper shape or dimensional accuracy of a molding after it is removed from the mold, until it is cool enough to retain its shape. Also known as Shrink Fixture.

Copolymer

The product of simultaneous polymerization of two or more polymerizeable chemicals known as monomers.

Core

(1) The central member of a sandwich construction (can be honeycomb material, foamed plastic, or solid sheet) to which the faces of the sandwich are attached; the central member of a plywood assembly. (2) A channel in a mold for circulation of heat-transfer media. (3) Part of a complex mold that molds undercut parts. Cores are usually withdrawn to one side before the main sections of the mod open. Also called core pin.

Corona Resistance

A current passing through a conductor induces a surrounding electrostatic field. When voids exist in the insulation near the conductor, the high voltage electrostatic field may ionize and rapidly accelerate some of the air molecules in the void. These ions can then collide with the other molecules, ionizing them, and thereby “eating” a hole in the insulation. Resistance to this process is called Corona resistance.

Crazing

Fine cracks which may extend in a network on or under the surface or through a layer of a plastic material.

Creep

The dimensional change with time of a material under load, following the initial instantaneous elastic deformation. Creep at room temperature is sometimes called Cold Flow.

Crosshead (Extrusion)

A device generally employed in wire coating which is attached to the discharge end of the extruder cylinder, designed to facilitate extruding material at an angle. Normally, this is a 90 degree angle to the longitudinal axis of the screw.

Cross Laminate

A laminate in which some of the layers of material are oriented approximately at right angles to the remaining layers with respect to the strain or strongest direction in tension.

Cross-Linking

Applied to polymer molecules, the setting up of chemical links between the molecular chains. When extensive, as in most thermosetting resins, cross-linking makes one super molecule of all the chains.

Crystallinity

A state of molecular structure in some resins which denotes uniformity and compactness of the molecular chains forming the polymer. Normally can be attributed to the formation of solid crystals having a definite geometric form.

Cure

To change the properties of a polymeric system into a final, more stable, usable condition by the use of heat, radiation, or reaction with chemical additives.

Cycle

The complete repeating sequence of operations in a process or part of a process. In molding, the cycle time is the period, or elapsed time, between a certain point in one cycle and the same point in the next.

Daylight Opening

Clearance between two platens of a press in the open position.

Deckle Rod

A small rod inserted at each end of the extrusion coating die, used to adjust the length of the die opening.

Decomposition Product
The constituent elements or simpler compounds formed when a substance decays or decomposes.

Decorative Sheet
A laminated plastics sheet used for decorative purposes in which the color and/or surface pattern is an integral part of the sheet.

Deflection Temperature
The temperature at which a specimen will deflect a given distance at a given load under prescribed conditions of test. Formerly called Heat Distortion.

Degredation
A deleterious change in the chemical structure of a plastic.

Delamination
The separation of the layers in a laminate caused by the failure of the adhesive.

Density
Weight per unit volume of a substance, expressed in grams per cubic centimeter, pounds per cubic foot, etc.

Desiccant
Substance which can be used for drying purposes because of its affinity for water.

Destaticization
Treating plastic materials to minimize their accumulation of static electricity and consequently the amount of dust picked up by the plastic because of such charges.

Deterioration
A permanent change in the physical properties of a plastic evidenced by impairment of these properties.

Die Blades
Deformable member(s) attached to a die body which determines the slot opening and which are adjusted to produce uniform thickness across the film or sheet produced.

Die Cutting
(1) Blanking q.v., (2) Cutting shapes from sheet stock by striking it sharply with a shaped knife edge known as a XXsteel-rule die. Clicking and Dinking are other names for die cutting of this kind.

Die Gap
Distance between the metal faces of the die opening.

Dielectric Constant
Normally the relative dielectric constant; for practical purposes, the ratio of the capacitance of an assembly of two electrodes separated solely by a plastic insulating material to its capacitance when the electrodes are separated by air.

Dielectric Strength
The electric voltage gradient at which an insulating material is broken down or "arced through," in volts per mil of thickness.

Die Lines
Vertical marks on the parison caused by damage of die parts or contamination.

Die Swell Ratio
The ratio of the outer parison diameter (or parison thickness) to the outer diameter of the die (or die gap). Die swell ratio is influenced by polymer type, head construction, land length, extrusion speed, and temperature.

Diffusion
The migration or wandering of the particles or molecules of a body of fluid matter away from the main body through a medium or into another medium.

Dimensional Stability
Ability of a plastic part to maintain its original proportions under conditions of use.

Discoloration
Any change from the original color, often caused by overheating, light exposure, irradiation, or chemical attack.

Dispersion
Finely divided particles of a material in suspension in another substance.

Draft
The degree of taper of a side wall, or the angle of clearance designed to facilitate removal of parts from a mold.

Drape Forming
Method of forming thermoplastic sheet in which the sheet is clamped into a movable frame, heated, and draped over high points of a mal mold. Vacuum is then pulled to complete the forming operation.

Draw Down Ratio
The ratio of the thickness of the die opening to the final thickness of the product.

Glossary

Dry-Blend
A free-flowing dry compound prepared without fluxing or addition of solvents. Also called Powder Blend.

Dry Coloring
Method commonly used by fabricators for coloring plastics by tumble blending uncolored particles of the plastic material with selected dyes and pigments.

Durometer
Trade name of the Shore Instrument Company for an instrument that measures hardness. The Durometer determines the “hardness” of rubber or plastic by measuring the depth of penetration (without puncturing) of a blunt needle compressed on the surface for a short period of time.

Dyes
Synthetic or natural organic chemicals that are soluble in most common solvents. Characterized by good transparency, high tinctorial strength, and low specific gravity.

Elasticity
That property of plastic materials by virtue of which tend to recover their original size and shape after deformation.

Elastomer
A material which at room temperature stretches under low stress to at least twice its length and snaps back to the original length upon release of stress.

Electrical Properties
Primarily the resistance of a plastic to the passage of electricity, e.g. dielectric strength.

Electroformed Molds
A mold made by electroplating metal on the reverse pattern on the cavity. Molten steel may be then sprayed on the back of the mold to increase its strength.

Elongation
The fractional increase in length of a material stressed in tension.

Embossing
Techniques used to create depressions of a specific pattern in plastic film and sheeting.

Emulsion
A dispersion of one liquid in another - possible only when they are mutually insoluble.

Encapsulating
Enclosing an article (usually an electronic component or the like) in a closed envelope of plastic, by immersing the object in a casting resin and allowing the resin to polymerize or, if hot, to cool.

Engraved Roll Coating
The amount of coating applied to the web is metered by the depth of the over all engraved pattern in a print roll. This process is frequently modified by interposing a resilient offset roll between the engraved roll and the web.

Entrance Angle
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 (ESC)
The susceptibility of a thermoplastic article to crack or craze formation under the influence of certain chemicals and stress.

Ester
A compound formed by the reaction between an alcohol and an acid. Many esters are liquids. They are frequently used as plasticizers in rubber and plastic compounds.

Ethyl Cellulose
A thermoplastic material prepared by the ethylation of cellulose by diethyl sulfate or ethyl halides and alkali.

Ethylene Plastics
Plastics based on polymers of ethylene or copolymers of ethylene with other monomers, the ethylene being in greatest amount by mass.

Ethylene-Vinyl Acetate
Copolymers from these two monomers form a new class of plastic materials. They retain many of the properties of polyethylene, but have considerably increased flexibility for their density - elongation and impact resistance are also increased.

Extender
A substance generally having some adhesive action, added to a plastic composition to reduce the amount of the primary resin required per unit area.

Extrusion
The compacting of a plastic material and the forcing of it through an orifice in more or less continuous fashion.

Extrusion Coating
The resin is coated on a substrate by extruding a thin film of molten resin and pressing it onto or into the substrates, or both, without the use of an adhesive.

Fabricate
To work a material into a finished form by machining, forming, or other operation, or to make flexible film or sheeting into end products by sewing, cutting, sealing, or other operation.

Female
In molding practice, the indented half of a mold designed to receive the male half.

Fiber Stress
The unit stress, usually in pounds per square inch (psi) in a piece of material that is subjected to an external load.

Filler
A relatively inert material added to a plastic to modify its strength, permanence, working properties, or other qualities to lower costs.

Film
An optional term for sheeting having a nominal thickness not greater than 0.010 inch.

Fines
Very small particles (usually under 200 mesh) accompanying larger grains, usually of molding powder.

Finish
The plastic forming the opening of a container shaped to accommodate a specific closure. Also, the ultimate surface structure of an article.

Fish Eye
A fault in transparent or translucent plastic materials, such as film or sheet, appearing as a small globular mass and caused by incomplete blending of the mass with surrounding material.

Flake
Used to denote dry, unplasticized base of cellulosic plastics.

Flame Retardant Resin
A resin which is compounded with certain chemicals to reduce or eliminate its tendency to burn. For polyethylene and similar resins, chemicals such as antimony trioxide and chlorinated parrafins are useful.

Flame Treating
A method of rendering inert thermoplastic objects receptive to inks, lacquers, paints, adhesives, etc. in which the object is bathed in an open flame to promote oxidation of the surface of the article.

Flammability
Measure of the extent to which a material will support combustion.

Flexural Modulus
A measure of the strain imposed on the outermost fibers of a bent specimen.

Flexural Strength
The strength of a material in bending, expressed as the tensile stress of the outermost fibers of a bent test sample at the instant of failure. With plastics, this value is usually higher than the straight tensile strength.

Flock
Short fibers of cotton, etc., used as filler, q.v., for molding materials.

Flocking
A method of coating by spraying finely dispersed powders or fibers.

Flow Marks
Wavy surface appearance of an object molded from thermoplastic resins caused by improper flow of the resin into the mold.

Fluorescent Pigments
By absorbing unwanted wavelengths of light and converting them into light of desired wavelengths, these colors seem to possess an actual glow of their own.

Foaming Agents
Chemicals added to plastics and rubbers that generate inert gases on heating, causing the resin to assume a cellular structure.

Foil Decorating
Molding paper, textile, or plastic foils printed with compatible inks directly into a plastic part so that the foil is visible below the surface of the part as integral decoration.

Formulation
A combination of ingredients before being processed or made into a finished product. Sometimes used as a synonym for Material or Compound.

Glossary

Forming
The process of changing plastic pieces such as sheets, rods, or tubes into a desired configuration.

Friction Coefficient
A number expressing the amount of frictional effect.

Frost Line
In the extrusion of polyethylene lay-flat film, a ring shaped zone located at the point where the film reaches its final diameter. This line is characterized by a “frosty” appearance to the film, caused by the film temperature falling below the softening range of the resin.

Fuse
To join two plastic parts by softening the material through heat or solvents.

Gate
In injection and transfer molding, the orifice through which the melt enters the cavity. Sometimes the gate has the same cross section as the runner leading to it; often it is severely restricted.

Gel
(n) In polyethylene, a small amorphous resin particle which differs from its surroundings by being of higher molecular weight and/or cross linked, so that its processing characteristics differ from the surrounding resin to such a degree that it is not easily dispersed in the surrounding resin. A gel is readily discernible in thin films.

Generic
Common names for types of plastic material. They may be either chemical terms or coined names. They contrast with trademarks which are the property of one company.

Gloss
The shine or luster of the surface of a material.

Graves Tear Strength
The force required to rupture a specimen by pulling a prepared notched sample.

Hardness
A comparative gauge of resistance to indentation.

Haze
The degree of cloudiness in a plastic material.

Head
The end section of a low molding machine (in a general extruder) in which the melt is transformed into a hollow parison.

Heat Distortion
The temperature at which a specimen will deflect a given distance at a given load.

Heat Joining
Making a pipe joint by heating the edges of the parts to be joined so they become essentially one piece.

Heat Resistance
The ability to withstand the effects of exposure to high temperature. Care must be exercised in defining precisely what is meant when this term is used. Descriptions pertaining to heat resistance properties include boilable, washable, cigarette proof, sterilizable, etc.

Heat Sealing
A method of joining plastic films by simultaneous application of heat and pressure to areas in contact. Heat may be supplied conductively or dielectrically.

High Load Melt Index
The flow rate of molten resin through a 0.0825 inch orifice when subjected to a force of 21,600 grams at 190 degrees C.

High Polymer
A macromolecular substance which, as indicated by the term “polymer” and by the name (e.g. polyvinyl chloride) and formula by which it is identified, consists of molecules which are (at least approximately) multiples of the low molecular unit.

Homopolymer
A polymer, consisting of (neglecting the ends, branch junction, and other minor irregularities) a single type of repeating unit.

Hoop Stress
The circumferential stress imposed on a cylindrical wall by internal pressure loading.

Hopper
Conical feed reservoir into which molding powder is loaded and from which it falls into a molding machine or extruder, sometimes through a metering device.

Hopper Dryer
A combination feeding/drying device for extrusion and injection molding of thermoplastics. Hot air flows upward through the hopper containing the feed pellets.

Hopper Loader
A curved pipe through which molding powders are pneumatically conveyed from shipping drums to machine hoppers.

Hot Gas Welding
A technique of joining thermoplastic materials (usually sheet) whereby the materials are softened by a jet of hot air from a welding torch, and joined together at the softened points. Generally a thin rod of the same material is used to fill and consolidate the gap.

Hot Stamping
Engraving operation for marking plastics in which roll leaf is stamped with heated metal dies onto the face of the plastics. Ink compounds can also be used. By means of felt rolls, ink is applied to type and by means of heat and pressure, type is impressed into the material, leaving the marking compound in the indentation.

Hydraulic
A system in which energy is transferred from one place to another by means of compression and flow of a fluid (e.g., water, oil).

Impact Bar (Specimen)
A test specimen of specified dimensions which is utilized to determine the relative resistance of a plastic to fracture by shock.

Impact Resistance
Relative susceptibility of plastics to fracture by shock, e.g., as indicated by the energy expended by a standard pendulum type impact machine in breaking a standard specimen in one blow.

Impact Strength
(1) The ability of a material to withstand shock loading. (2) The work done in fracturing, under shock loading, with a specific test specimen in a specified manner.

Inhibitor
A substance that slows down chemical reaction. Inhibitors are sometimes used in certain types of monomers and resins to prolong storage life.

Injection Molding
Method of forming a plastic to the desired shape by forcing heat softened plastic into a relatively cool cavity where it rapidly solidifies (freezes).

Insert
An integral part of a plastics molding consisting of metal or other material which may be molded into position or may be pressed into the molding after the molding is completed.

Instron
An instrument utilized to determine the tensile and compressive properties of a material.

Interlock
A safety device used to insure an apparatus will not work until proper safety precautions have been taken.

Izod Impact Test
A test designed to determine the resistance of a plastic material to shock loading. It involves the notching of a specimen, which is then placed in the jaws of the machine and struck with a weighted pendulum.

Jig
Tool for holding component parts of an assembly during the manufacturing process, or for holding other tools. Also called a fixture.

Ketones
Compounds containing the carbonyl group (CO) to which is attached two alkyl groups. Ketones, such as methyl ethyl ketone, are commonly used as solvents for resins and plastics.

Kirksite
An alloy of aluminum and zinc used for the construction of blow molds; it imparts a high degree of heat conductivity to the mold.

Kiss Roll Coating
This roll arrangement carries a metered film of coating to the web. At the line of web contact, it is split with part remaining on the roll and part adhering to the web.

Kraft Paper
Paper made from sulfate wood pulp.

Laminar Flow
Laminar flow of thermoplastic resins in a mold is accompanied by solidification of the layer in contact with the mold surface. This acts as an insulating tube through which material flows to fill the remainder of the cavity. This type of flow is essential to duplication of the mold surface.

Laminate
A product made by bonding together two or more layers of material.

Laminated Plastics (Synthetic Resin Bonded Laminate)
Thin sheets of resin-impregnated material (paper , cloth, or glass), laid upon each other and pressed into a solid mass under high heat and great pressure.

Glossary

Laminated Wood
A high pressure bonded wood product composed of layers of wood with resin as the laminating agent. The term plywood covers a form of laminated wood in which successive layers of veneer are ordinarily cross laminated, the core of which may be veneer or sawed lumber in one or more pieces.

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.

Lay-Up
(n) As used in reinforced plastics, the reinforcing material placed in position in the mold; also the resin impregnated reinforcement. (v) The process of placing the reinforcing material in position in the mold.

L/D Ratio
A term used to define an extrusion screw which denotes the ratio of the screw length to the screw diameter.

Light Stability
Ability of a plastic to retain its original color and physical properties upon exposure to sun or artificial light.

Light Transmission
The amount of light that will pass through a plastic.

Linear Molecule
A long chain molecule, as contrasted to one having many side chains or branches.

Lip
The extreme outer edge of the top of a container intended to facilitate pouring.

Longitudinal Stress
The stress imposed on the long axis of any shape. It can be either a compressive or tensile stress.

Low Pressure Laminates
In general, laminates molded and cured in the range of pressures from 400 psi, down to and including pressures obtained by the mere contact of the plies.

Lubricant
A substance used to decrease the friction between solid faces, and improve processing characteristics of plastic compositions.

Manifold
A term used mainly with reference to blow and injection molding equipment. It refers to the distribution or piping system which takes the single channel flow output of the extruder or injection cylinder, and divides it to feed several blow molding heads or injection nozzles

Masterbatch
A plastic compound with a high concentration of additives, with which different colors of plastics can be created.

Melt Flow
The flow rate obtained from the extrusion of a molten resin through a die of specified length and diameter under prescribed conditions of time, temperature and load as set forth in ASTM D1238.

Melt Fracture
An instability in the melt flow through a die, starting at the entry to the die. It leads to surface irregularities on the finished article like a regular helix or irregularly spaced ripples.

Melt Index
The amount, in grams, of a thermoplastic resin which can be forced through a 0.0825 inch orifice when subjected to 2160 grams of force in 10 minutes at 190 degrees C.

Melting Point
The temperature at which solid and liquid forms of a substance are in equilibrium. In common usage the melting point is taken as the temperature at which the liquid first forms, in a small sample, as its temperature is increased gradually.

Melt Instability
An instability in the melt flow through a die starting at the land of the die. It leads to the same surface irregularities on the finished part as melt fracture.

Melt Strength
The strength of the plastic while in the molten state.

Melt Temperature
The temperature of the molten plastic just prior to entering the mold or being extruded through the die.

Metering Screw
An extrusion screw which has a shallow constant depth, and constant pitch section over, usually the last 3 to 4 flights.

Migration of Plasticizer
Loss of plasticizer from an elastomeric plastic compound, with subsequent absorption by an adjacent medium of lower plasticizer concentration.

Modulus
The load in pounds per square inch (or kilos per square centimeter) of the initial cross sectional area necessary to produce a stated percentage of elongation, which is used in the physical description of plastics (stiffness).

Modulus of Elasticity
The ratio of the stress per square inch to the elongation per inch due to this stress.

Moisture Resistance
Ability to resist absorption of water.

Mold Seam
A vertical line formed at the point of contact between the mold halves. The prominence of the line depends on the accuracy with which the mating mold halves are matched.

Molecular Weight Distribution
The ratio of the weight average molecular weight to the number average molecular weight.

Monomer
A relatively simple compound which can react to form a polymer.

Multi-Cavity Mold
A mold with two or more mold impressions, i.e., a mold which produces more than one molding per molding cycle.

Neck-In
In extrusion coating, the difference between the width of the extruded web as it leaves the die and the width of the coating on the substrate.

Nip
The “V” formed where the pressure roll contacts the chill roll.

Nonrigid Plastic
A plastic which has a stiffness or apparent modulus of elasticity not over 10,000 psi at 23 degrees C, determined in accordance with the Standard Method of Test for Stiffness in Flexure of Plastics.

Non-Toxic
Not Poisonous.

Notch Sensitivity
The extent to which the sensitivity of a material to fracture is increased by the presence of a notch, a sudden change in section, a crack, or a scratch. Low notch sensitivity is usually associated with ductile materials, and high notch sensitivity with brittle materials.

Nylon
The generic name for all synthetic fiber forming polyamides. They can be formed into monofilaments and yarns characterized by great toughness, strength and elasticity, high melting point, and good resistance to water and chemicals. The material is widely used for bristles in industrial and domestic brushes, and for many textile applications. It is also used in injection molding gears, bearings, combs, etc.

Olefin Plastics
Plastics based on resins made by the polymerization or copolymerization of olefins with other unsaturated compounds, the olefins being the greatest amount by weight. Polyethylene, polypropylene, and polybutylene are the most common olefin plastics encountered in pipe.

Opaque
Descriptive of a material or substance which will not transmit light. Opposite of transparent, q.v. Materials which are neither opaque nor transparent are sometimes described as semi-opaque, but are more properly classified as translucent, q.v.

Orange Peel
Said of injection moldings that have unintentional rough surfaces.

Organic Chemical
Originally applied to chemicals derived from living organisms, as distinguished from ‘inorganic” chemicals found in minerals and inanimate substances. Modern chemists define organic chemicals more exactly as those which contain the element carbon.

Organic Pigments
Characterized by brightness and brilliance. They are divided into toners and lakes. Toners are divided into insoluble organic toners and lake toners. The insoluble organic toners are usually free from salt forming groups. Lake toners are practically pure, water insoluble, heavy metal salts of dyes without the fillers or substrates of ordinary lakes. Lakes, which are not as strong as lake toners, are water insoluble, heavy metal salts or other dye complexes precipitated upon or mixed with a base or filler.

Glossary

Orientation
The alignment of the crystalline structure in polymeric materials to produce a highly uniform structure. Can be accomplished by cold drawing or stretching during fabrication.

Out-Of-Round
A plastic container manufacturing variance in which a round container, when formed, does not remain round.

Overlay Sheet (Surfacing Mat)
A nonwoven fibrous mat (glass, synthetic fiber, etc.) used as the top layer in a cloth or mat lay-up to provide a smoother finish or minimize the appearance of the fibrous pattern.

Parting Line
Mark on a molding or casting where halves of mold met in closing.

Pearlescent Pigments
A class of pigments consisting of particles that are essentially transparent crystals of a high refractive index. The optical effect is one of partial reflection from the two sides of each flake. When reflections from parallel plates reinforce each other, the result is a silvery luster. Effects possible range from brilliant highlighting to moderate enhancement of the normal surface gloss.

Pellet
A small ball or spherical shape.

Pelletizing
A process of producing pellets.

Permeability
(1) The passage or diffusion of a gas, vapor, liquid, or solid through a barrier without physically or chemically affecting it. (2) The rate of such passage.

Phenolic Resins
Resins made by reaction of a phenolic compound or tar acid with an aldehyde; more commonly applied to thermo-setting resins made from pure phenol and formaldehyde.

Pinch-Off
A raised edge around the cavity in the mold which seals off the part and separates the excess material as the mold closes around the parison in the blow molding operation.

Pinhole
A very small hole in the extruded resin coating.

Pit
An imperfection, a small crater in the surface of the plastic, its width approximately the same magnitude as its depth.

Plastic
(n) One of many high-polymeric substances, including both natural and synthetic products, excluding the rubbers. At some stage in its manufacture, every plastic is capable of flowing under heat and pressure, if necessary, into the desired final shape. (v) Made of plastic; capable of flow under pressure or tensile stress.

Plasticity
A property of plastics and resins which allow the material to be deformed continuously and permanently without rupture upon the application of a force that exceeds that yield value of the material.

Plastic Conduit
Plastic pipe or tubing used as an enclosure for electrical wiring.

Plastic Memory
A phenomenon of plastic to return to its original molded form. Different plastics possess varying degrees of this characteristic.

Plastic Pipe
A hollow cylinder of a plastic material in which the wall thicknesses are usually small when compared to the diameter, and in which the inside and outside walls are essentially concentric.

Plastics Tooling
Tools, e.g., dies, jigs, fixtures, etc., constructed of plastics, generally laminates or casting materials for the metal forming trades.

Plastic Tubing
A particular size of plastic pipe in which the outside diameter is essentially the same as that of copper tubing.

Plasticize
To soften a material and make it plastic or moldable, either by means of a plasticizer or the application of heat.

Plasticizer
Chemical agent added to plastic compositions to make them softer and more flexible.

Platens
The mounting plates of a press to which the entire mold assembly is bolted.

Platform Blowing
A special technique for blowing large parts. To prevent excessive sag of the heavy parison, the machine employs a table which, after rising to meet the parison at the die, descends with the parison at a slightly lower rate than the parison extrusion speed.

Plug-And-Ring
Method of sheet forming in which a plug, functioning as a male mold, is forced into a heated plastic sheet held in place by a clamping ring.

Plug Forming
A thermoforming process in which a plug or male mold is used to partially preform the part before forming is completed using vacuum or pressure.

Pock Marks
Irregular indentations on the surface of a blown container caused by insufficient contact of the blown parison with the mold surface. They are due to low blow pressure or air gas entrapment of moisture condensation on the mold surface.

Polishing Roll(s)
A roll or series of rolls, which have a highly polished chrome plated surface, that are utilized to produce a smooth surface on sheet as it is extruded.

Polybutylene
A polymer prepared by the polymerization of butene-1 as the sole monomer.

Polycarbonate Resins
Polymers derived from the direct reaction between aromatic and aliphatic dihydroxy compounds with phosgene, or by the ester exchange reaction with appropriate phosgene derived precursors.

Polyester
A resin formed by the reaction between a dibasic acid and a dihydroxy alcohol, both organic. Modification with multi-functional acids and/or bases and some unsaturated reactants permit cross linking to thermosetting resins. Polyesters modified with fatty acids are call Alkyds.

Polyethylene
A thermoplastic material composed by polymers of ethylene. It is normally a translucent, tough, waxy solid which is unaffected by water and by a large range of chemicals.

Polymer
A high molecular weight organic compound, natural or synthetic, whose structure can be represented by a repeated small unit, the mer; e.g., polyethylene, rubber, or cellulose. Synthetic polymers are formed by addition or condensation polymerization of monomers. If two or more monomers are involved, a copolymer is obtained. Some polymers are elastomers, some plastics.

Polymerization
A chemical reaction in which the molecules of a monomer are linked together to form large molecules whose weight is a multiple of that of the original substance. When two or more monomers are involved, the process is called copolymerization or heteropolymerization.

Polyolefin
A polymer prepared by the polymerization of an olefin as the sole monomer.

Polyolefin Plastics
Plastics based on polymer with an olefin as essentially the sole monomer.

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.

Polystyrene
A white thermoplastic produced by the polymerization of styrene (ethyl benzene). The electrical insulating properties of polystyrene are excellent and the material is relatively unaffected by moisture.

Polyvinyl Acetal
A member of the family of vinyl plastics, polyvinyl acetal is the general name for resins produced from a condensation of polyvinyl alcohol with an aldehyde. There are three main groups: polyvinyl acetal; polyvinyl butyral, and polyvinyl formal. Polyvinyl acetal resins are thermoplastics which can be processed by casting, extruding, molding, and coating, but their main uses are in adhesives, lacquers, coatings, and films.

Polyvinyl Acetate
A thermoplastic material composed of polymers of vinyl acetate in the form of a colorless solid. It is obtainable in the form of granules, solutions, latices, and pastes, and is used extensively in adhesives, paper and fabric coating, and in bases for inks and lacquers.

Glossary

Polyvinyl Chloride (PVC)

A thermoplastic material composed of polymers of vinyl chloride; a colorless solid with outstanding resistance to water, alcohols, and concentrated acids and alkalies. It is obtainable in the form of granules, solutions, latices, and pastes. Compounded with plasticizers it yields a flexible material superior to rubber in aging properties. It is widely used for cable and wire coverings, in chemical plants, and in the manufacture of protective garments.

Polyvinyl Chloride Acetate

A thermoplastic material composed of copolymers of vinyl chloride and vinyl acetate; a colorless solid with good resistance to water, and concentrated acids and alkalies. It is obtainable in the form of granules, solutions, and emulsions. Compounded with plasticizers it yields a flexible material superior to rubber in aging properties. It is widely used for cable and wire coverings, in chemical plants, and in protective garments.

Porosity

The presence of numerous visible voids.

Postforming

The forming, bending, or shaping of fully cured, C-stage thermoset (Postforming continued) laminates that have been heated to make them flexible. On cooling, the formed laminate retains the contours and shape of the mold over which it has been formed.

Power Factor

The ratio of the power in watts delivered in an alternating current circuit (real power) to the voltampere input (apparent power). The power factor of an insulation indicates the amount of the power input which is consumed as a result of the impressed voltage forcing a small leakage current through the material.

Preheating

The heating of a compound prior to molding or casting in order to facilitate the operation or reduce the molding cycle.

Preheat Roll

In extrusion coating, a heated roll installed between the pressure and unwind roll to heat the substrate before it is coated.

Premix

In reinforced plastics molding, the material made by “do it yourselfer,” molders, or end users who purchase polyester or phenolic resin, reinforcement, filler, etc. separately, and mix the reinforced molding compounds on their own premises.

Preprinting

In sheet thermoforming, the distorted printing of sheets before they are formed. During the forming process the print assumes its proper proportions.

Press Polish

A finish for sheet stock produced by contact, under heat and pressure, with a very smooth metal which gives the plastic a high sheen.

Pressure Forming

A thermoforming process wherein pressure is used to push the sheet to be formed against the mold surface, as opposed to using a vacuum to suck the sheet flat against the mold.

Pressure Roll

In extrusion coating, the roll with which the chill roll applies pressure to the substrate and the molten extruded web.

Printing of Plastics

More methods of printing plastic, particularly thermoplastic film and sheet, have developed with the popularity of the materials. The printing processes used are the same as in other industries, but the adaptation of machinery and development of special inks have been a constant necessity, particularly as new plastics materials have arrived, each with its own problems of surface decoration. Among the printing processes commonly used are gravure, flexographic, inlay (or valley) and silk screen.

Propylene Plastics

Plastics based on resins made by the polymerization or copolymerization of propylene with one or more unsaturated compounds, the propylene being in greatest amount by weight.

Prototype Mold

A simplified mold construction often made from a light acetal casing alloy or an epoxy resin in order as a model for the final mold and/or part design.

Purging

Cleaning one color or type of material from the cylinder of an injection molding machine or extruder by forcing it out with the new color or material to be used in subsequent production. Purging materials are also available.

Quench Tank Extrusion

The extruded film is cooled in a quench water bath.

Reciprocating Screw
An extruder system in which the screw, when rotating, is pushed backwards by the molten polymer which collects 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.

Recycled Plastic
A plastic prepared from used articles which have been cleaned and reground. (See Reprocessed Plastic)

Reformulated Plastic
Recycled plastic that has been upgraded to alter or improve performance capability, or to change characteristics through the use of plasticizers, fillers, stabilizers, pigments, etc.

Reinforced Plastic
A plastic with strength properties greatly superior to those of the base resin because of a high strength filler embedded in the composition.

Relative Viscosity
The relative viscosity of a polymer in solution, is the ratio of the absolute viscosities of the solution (of stated concentration) and of the pure solvent at the same temperature.

Resilience
Usually regarded as another name for elasticity. While both terms are fundamentally related, there is a distinction. Elasticity is a general term to describe the recovering of an original shape after a deformation. Resilience refers more to the speed of recovery; that is, a body may be elastic but not highly resilient.

Resin
Any of a class of solid or semi-solid organic products of natural or synthetic origin, generally of high molecular weight with no definite melting point. Most resins are polymers.

Reprocessed Plastic
A thermoplastic from a processor's own production that has been reground or pelletized after having been previously processed by molding, extrusion, etc.

Rheology
Study of the deformation and flow of matter in terms of stress, strain and time.

Rib
A reinforcing member of a fabricated or molded part.

Rigid Plastic
A plastic which has a stiffness or apparent modulus of elasticity greater than 100,000 psi at 23 degrees C when determined in accordance with the Standard Method of Test for Stiffness in Flexure of Plastics.

Rigid PVC
Polyvinyl chloride or a polyvinyl chloride/acetate copolymer characterized by a relatively high degree of hardness; it may be formulated with or without a small percentage of plasticizer.

Rockwell Hardness
A common method of testing a plastic material for resistance to indentation in which a diamond or steel ball, under pressure, is used to pierce the test specimen. The load used is expressed in kilograms and a 10 kilogram weight is first applied and the degree of penetration noted. The so called major load (60-150 kilograms) is next applied and a second reading (Rockwell Hardness continued) obtained. The hardness is then calculated as the difference between the two loads, and expressed with nine different prefix letters to denote the type of penetrator used and the weight applied as the major load.

Rubber
An elastomer capable of rapid elastic recovery after being stretched to at least twice its length at temperatures from 0 to 150 degrees F, at any humidity. Specifically, Hevea or natural rubber, the standard of comparison for elastomers.

Sag
The local extension (often near the die face) of the parison during extrusion by gravitational forces. This causes necking down of the parison. It also refers to the flow of a molten sheet in a thermoforming operation.

Sample
A small part or portion of a material or product intended to be representative of the whole.

Sandwich Heating
A method of heating a thermoplastic sheet prior to forming which consists of heating both sides of the sheet simultaneously.

Scrap
Any product of a molding operation that is not part of the primary product. In compression molding, this includes flash, culls, runners, and is not reusable as a molding compound. Injection molded and extrusion scrap (runners, rejected parts, sprues, etc.) can usually be reground and remolded.

Glossary

Segregation
A close succession of parallel, relatively narrow and sharply defined wavy lines of color on the surface of a plastic which differ in shade from surrounding areas, and create the impression that the components have separated.

Self Extinguishing
The ability of a plastic to resist burning when the source of heat or flame that ignited it is removed.

Set
To convert an adhesive into a flexed or hardened state by chemical or physical action, such as condensation, polymerization, oxidation, vulcanization, gelation, hydration, or evaporation of volatile constituents.

Shark Skin
A surface irregularity of a container in the form of finely spaced sharp ridges caused by a relaxation effect of the melt at the die exit.

Shear Rate
The overall velocity over the cross section of a channel with which molten polymer layers are gliding along each other or along the wall in laminar flow.

Shear Strength
(1) The ability of a material to withstand shear stress. (2) The stress at which a material fails is shear.

Shear Stress
The stress developing in a polymer melt when the layers in a cross section are gliding along each other or along the wall of the channel (in laminar flow).

Sheet (Thermoplastic)
A flat section of a thermoplastic resin with the length considerably greater than the width, and 10 mils or greater in thickness.

Sheet Train
The entire assembly necessary to produce sheet, which includes: extruder, die, polish rolls, conveyor, draw rolls, cutter, and stacker.

Shore Hardness
A method of determining the hardness of a plastic material using a scelroscope. This device consists of a small conical hammer fitted with a diamond point and acting in a glass tube. The hammer is made to strike the material under test, and the degree of rebound is noted on a graduated scale. Generally, the harder the material the greater the rebound will be.

Shrinkage
Contraction of a container upon cooling.

Shrink Mark
An imperfection, a depression in the surface of a molded material where it has retracted from the mold.

Silicone
One of the family of polymeric materials in which the recurring chemical group contains silicon and oxygen atoms as links in the main chain. At present, these compounds are derived from silica (sand) and methyl chloride. The various forms obtainable are characterized by their resistance to heat. Silicones are used in the following applications: freases for lubrication, rubber-like sheeting for gaskets, heat stable fluids and compounds for waterproofing, insulating, and thermosetting insulating varnishes and resins for both coating and laminating.

Simulated Aging
The exposure of plastics to cyclic laboratory conditions of high and low temperature, high and low relative humidities, and ultraviolet radiant energy in an attempt to produce changes in their properties similar to those observed over a long, continuous exposure outdoors. The laboratory exposure conditions are usually intensified beyond those encountered in actual outdoor exposure in an attempt to achieve an accelerated effect.

Slip Additive
A modifier that acts as an internal lubricant which exudes to the surface of the processing. In other words, a non visible coating blooms to the surface to provide the necessary lubricity to reduce friction and thereby improve slip characteristics.

Slip Forming
Sheet forming technique in which some of the plastic sheet material is allowed to slip through the mechanically operated clamping rings during a stretch forming operation.

Slot Extrusion
A method of extruding film sheet in which the molten thermoplastic compound is forced through a straight slot.

Snap-Back Forming
Sheet forming technique in which an extended heated plastic sheet is allowed to contract over a male form shaped to the desired contours.

Softening Range
The range of temperature when a plastic changes from a rigid to a soft state.

Solvent
The medium with which a substance is dissolved; it is most commonly applied to liquids used to bring particular solids into solution.

Solvent Cement
In the plastic field, a solvent adhesive that contains a solvent that dissolves or softens the surfaces being bonded so that the bonded assembly becomes essentially one piece of the same type of plastic.

Specific Gravity
The density (mass per unit volume) of any material divided by that of water at a standard temperature, usually 4 degrees C. Since water's density is nearly 1.00 g/cc, density in g/cc and specific gravity are numerically nearly equal.

Specific Heat
Ratio of the thermal capacity of a substance to that of water at 15 degrees C. The heat required to raise 1 gram of material 1 degree C.

Specific Viscosity
The specific viscosity of a polymer is the relative viscosity of a solution of a known concentration of the polymer minus one. It is usually determined for a low concentration of the polymer (0.5 g. per 100 ml. of solution or less).

Sprayed Metal Molds
A mold made by spraying molten metal onto a master until a shell of predetermined thickness is achieved. The shell is then removed and backed up with plaster, cement, casting resin, or other suitable material. It is used primarily as a mold in sheet forming processes.

Stabilizer
A chemical substance which is frequently added to plastic compounds to inhibit undesirable changes in the material, such as discoloration due to heat or light.

Strain
The ratio of deformation of the length, caused by the application of a load on a piece of material.

Stress Crack
An external or internal crack in a plastic caused by tensile stresses less than its short time mechanical strength.

Strength
The mechanical properties of a plastic such as a load or weight carrying ability, and ability to withstand sharp blows. Strength properties include tensile, flexural and tear strength, toughness, flexibility, etc.

Stress Relaxation
The decrease of stress with respect to time in a piece of plastic that is subject to an external load.

Stretch Forming
A plastic forming technique in which the heated thermoplastic sheet is stretched over a mold and subsequently cooled.

Styrene Plastics
Plastics based on resins made by the polymerization or copolymerization of styrene with other unsaturated compounds, the styrene being in greatest amount by weight.

Styrene-Rubber-Plastics
Compositions based on rubbers and styrene plastics, the styrene plastics being in greatest amount by weight.

Surface Treating
Any method of treating a polyolefin so as to alter the surface and render it receptive to inks, paints, lacquers, and adhesives such as chemical, flame, and electronic treating.

Surging
Unstable pressure build up in an extruder, leading to variable throughput and waviness of the parison.

Sweating
Exudation of small drops of liquid, usually a plasticizer or softener, on the surface of a plastic part.

Tear Strength
Resistance of a material to tearing.

Tensile Bar (Specimen)
A compression or injection molded specimen of specified dimensions which is used to determine the tensile properties of a material.

Tensile Strength
The pulling stress, in psi, required to break a given specimen. Area used in computing strength is usually the original, rather than the necked down area.

Glossary

Thermal Conductivity
The capacity of a plastic material to conduct heat.

Thermal Expansion (Coefficient of)
The fractional change in length (sometimes volume, specified) of a material for a unit change in temperature. Values for plastics range from 0.01 to 0.2 mils/in, degree C.

Thermal Stress Cracking (TSC)
The crazing and cracking of some thermoplastic resins from over- exposure to elevated temperatures.

Thermoforming
Any process of forming thermoplastic sheet which consists of heating the sheet and pulling it down over a mold surface.

Thermoplastic
(n) A plastic which is thermoplastic in behavior. (adj) Capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature.

Thermosetting
Plastic materials which undergo a chemical change and harden permanently when heated in processing. Further heating will not soften these materials.

Tolerance
A specified allowance for deviations in weighing, measuring, etc., or for deviations from the standard dimensions or weight.

Translucent
Permitting the passage of light, but diffusing it so that objects beyond cannot be clearly distinguished.

Tumbling
Finishing operation for small plastic articles by which gates, flash, and fins are removed and/or surfaces are polished by rotating them in a barrel together with wooden pegs, sawdust, and polishing compounds.

Ultraviolet
Zone of invisible radiation beyond the violet end of the spectrum of visible radiation. Since UV wavelengths are shorter than the visible, their photons have more energy, enough to initiate some chemical reactions and to degrade most plastics.

Undercut
(1) Having a protuberance or indentation that impedes withdrawal from a two piece, rigid mold. Flexible materials can be ejected intact even with slight undercuts. (n) Any such protuberance or indentation; depends also on design of mold.

UV Stabilizer (Ultraviolet)
Any chemical compound which, when mixed with a thermoplastic resin, selectively absorbs UV rays.

Vacuum Forming
Method of sheet forming in which the plastic sheet is clamped in a stationary frame, heated, and drawn down by a vacuum into a mold. In a loose sense, it is sometimes used to refer to all sheet forming techniques, including Drape Forming which involves the use of vacuum and stationary molds.

Vent
In a mold, a shallow channel or minute hole cut in the cavity to allow air to escape as the material enters.

Vinyl Chloride Plastics
Plastics based on polymers or copolymers of vinyl chloride with other monomers, the vinyl chloride being in greatest amount by mass.

Vinylidene Chloride Plastics
Plastics based on polymer resins made by the polymerization or copolymerization of vinylidene with other monomers, the vinylidene chloride being in the greatest amount by weight.

Virgin Material
A plastic material in the form of pellets, granules, powder, flock, or liquid that has not been subjected to use or processing other than that required for its initial manufacture.

Viscosity
Internal friction or flow resistance of a liquid. The constant ratio of shearing stress to rate of shear. In liquids, for which this ratio is a function of stress, the term “apparent viscosity” is defined as this ratio.

Viscosity, Inherent
The logarithmic viscosity number determined by dividing the natural logarithm of the relative viscosity (sometimes called viscosity ratio) by the concentration in grams per 100 mls. of solution.

Voids
(1) In a solid plastic, an unfilled space of such size that it scatters radiant energy such as light. (2) A cavity unintentionally formed in a cellular material and substantially larger than the characteristic individual cells.

Volatiles
That portion of a substance that is readily vaporized.

Volume Resistivity
The electrical resistance of a 1 centimeter cube of the material expressed in ohm/centimeters.

Warpage
Dimensional distortion in a plastic object after molding.

Water Absorption
The percentages by weight, or water absorbed by a sample immersed in water. Dependent upon area exposed and time of exposure.

Water Vapor Transmission
The penetration of a plastic by moisture in the air.

Weather Resistance
The ability of a plastic to retain its original physical properties and appearance upon prolonged exposure to outdoor weather.

Web
A thin sheet processed in a machine. The molten web is that which issues from the die. The substrate web is the substrate being coated.

Welding
The joining of two or more pieces of plastic by fusion at adjoining or nearby areas, either with or without the addition of plastic from another source.

Wood Model
A model of a container made from wood to assist in the design of a container.

Wrinkle
An imperfection in reinforced plastics that has the appearance of a wave molded into one or more plies of fabric or other reinforcing material.

Yield Point
The point at which a plastic material will continue to elongate at no substantial increase in load during a short test period.

Yield Strength
The stress at which a plastic material will continue to elongate at no substantial increase in load during a short test period.

Yield Stress
The stress at which a plastic material elongates without further increase of stress. Up to this point, the stress strain relationship is linear (Young’s Modulus).

Comparative Materials Chart

Property	Units	Test Method ASTM	ABS	Acetal Homopolymer	Acrylic	CAB
Specific Gravity	——	D-792	1.04	1.42	1.19	1.15 -1.22
Tensile Strength, 73°F	PSI	D-638	5,000 - 7,500	10,000	10,500	2,600 - 6,400
Tensile Modulus of Elasticity, 73°F	PSI	D-638	3.1×10^5	4.5×10^5	4.5×10^5	$0.5 - 2.0 \times 10^5$
Elongation, 73°F	%	D-638	5 - 70	40	2.0	60 - 100
Flexural Strength, 73°F	PSI	D-790	6,000 - 11,500	14,300	14,000	6,500
Flexural Modulus of Elasticity, 73°F	PSI	D-790	3.4×10^5	4.10×10^5	4.5×10^5	$0.9 - 3.0 \times 10^5$
Shear Strength, 73°F	PSI	D-732	——	9,500	——	——
Compressive Strength	PSI	D-695	2.5 -11	18.0	14.0 - 18.0	4,500
Compressive Modulus of Elasticity, 73°	PSI	D-695	——	670	——	——
Coefficient of Friction (Dry vs. Steel) Dynamic	——	——	0.35	.15	——	——
Hardness, Rockwell, 73°F	——	D-785	R105	R 120	M 90	R101 -111
Durometer, 73°F	——	D-676	——	——	——	——
Tensile Impact (notched), 73°F	ft. lb. / in.	D-256	——	170	——	——
Coefficient of Linear Thermal Expansion	in./ in. / F°	D-696	5.3	6.8×10^{-5}	4.5×10^{-5}	$11- 17 \times 10^{-5}$
Deformation Under Load (122°F, 2,000 psi)	%	D-621	——	0.5	——	——
Deflection Temperature 264 psi 66 psi	°F °F	D-648 D-648	215 220	264 334	200 - 215 225	156 130 - 227
Melting Point	°F	D-789	220	347	——	——
Continuous Service Temperature in Air (Maximum)	°F	——	140-230	185	150	140 - 220
Dielectric Strength, Short Time	Volts/ Mil	D-149	450	500	500	250 - 400
Volume Resistivity	OHM-CM	D-257	10^{15}	10^{15}	$>10^{17}$	$10^{11} - 10^{15}$
Dielectric Constant, 60 Hz	——	D-150	2.87	3.7	3.5 - 4.5	3.5 - 6.4
10^3	——	D-150	——	3.7	3.0 - 3.5	
10^6			——	3.7	3.0	
Water Absorbtion, Immersion — 24 hours	%	D-570	.30	0.25	0.3	.9 - 2.2
Saturation	%	D-570	.70	.90	7-9	7 - 9

Comparative Materials Chart

Property	Units	Test Method ASTM	CPVC	HDPE	LDPE	Noryl	Nylon
Specific Gravity	——	D-792	1.53	.955	.910 - .925	1.06	1.14-1.15
Tensile Strength, 73°F	PSI	D-638	8,200	3,100 - 5,500	600– 2,300	9,600	12,400
Tensile Modulus of Elasticity, 73°F	PSI	D-638	4.3 x 10^5	1.3 x x 10^5	.14 - .38 x 10^5	3.5 x 10^5	4.7 x 10^5
Elongation, 73°F	%	D-638	27	20 - 800	90 - 800	25	20 - 200
Flexural Strength, 73°F	PSI	D-790	14,600	N.A.	N.A.	14,400	14,000
Flexural Modulus of Elasticity, 73°F	PSI	D-790	4.1 x 10^5	2.0 x 10^5	.08 - .60 x 10^5	3.7 x 10^5	4.1 x 10^5
Shear Strength, 73°F	PSI	D-732	9,220	——	2,400	——	9,600
Compressive Strength	PSI	D-695	11,400	——	——	——	375 - 550,000
Compressive Modulus of Elasticity, 73°	PSI	D-695	——	——	——	——	——
Coefficient of Friction (Dry vs. Steel)Dynamic	——	——	——	——	——	0.39	0.12 - 0.22
Hardness, Rockwell, 73°F	——	D-785	R118	R69	R10	R119	R120
Durometer, 73°F	——	D-676	D82	——	——	——	D80 - 85
Tensile Impact 73°F	ft. lb. / In.	D-256	——	——	——	——	90 - 180
Coefficient of Linear Thermal Expansion	in./ in. / F°	D-696	.000037	N.A.	5.6 - 12.2 x 10^{-5}	3.3 x 10^{-5}	4x10^{-5}
Deformation Under Load (122°F, 2,000 psi)	%	D-621	230	——	——	——	1.0 - 3.0
Deflection Temperature 264 psi 66 psi	°F °F	D-648 D-648	212 230	122 175 - 196	90 - 105 100 - 121	265 279	194 455
Melting Point	°F	D-789	360	275	——	310	491
Continuous Service Temperature in Air (Maximum)	°F	——	200	180	160	220	200 - 250
Dielectric Strength, Short Time	Volts/ Mil	D-149	1,250	450 - 500	700	500	400 - 600
Volume Resistivity	OHM-CM	D-257	——	10^{15}	10^{15}	10^{17}	10^{15}
Dielectric Constant, 60 Hz	——	D-150	——	2.30 - 2.35	2.25 -2.35	2.7	4.0
10^3	——	D-150	——		——	——	4.0
10^6			——		——	——	3.4
Water Absorbtion, Immersion — 24 hours	%	D-570	.05	0.00	<0.01	.07	1.20
Saturation	%	D-570	——	——	——	0.20	8.5

Comparative Materials Chart

Property	Units	Test Method ASTM	Oil Filled Nylon	PBT	PEEK	PPS	PTFE
Specific Gravity	——	D-792	1.14-1.15	1.31	1.32	1.35	2.1 - 2.3
Tensile Strength, 73°F	PSI	D-638	9,500 - 11,000	8,000	14,500	7,000 - 12,500	3,350
Tensile Modulus of Elasticity, 73°F	PSI	D-638	375 - 475,000	390,000	490,000	220 - 550,000	5,000 -
Elongation, 73°F	%	D-638	45 - 55	5 - 300	50	1.5 - 15	75 - 350
Flexural Strength, 73°F	PSI	D-790	14,000 - 16,000	12,000	24,600	14,000 - 21,000	no break
Flexural Modulus of Elasticity, 73°F	PSI	D-790	410,000	340,000	590,000	540,000 - 600,000	9,000 - 11,000
Shear Strength, 73°F	PSI	D-732	8,000 - 9,000	7700	7,690	9,000	90,000 - 110,000
Compressive Strength	PSI	D-695	12,000 - 14,000	11.0	17.0	18,000	——
Compressive Modulus of Elasticity, 73°	PSI	D-695	275 - 375,000	375,000	450,000	410,000	95,000 - 115,000
Coefficient of Friction (Dry vs. Steel)Dynamic	——	——	.14	.25	.40 - .45	.20 - .40	.04 - .10
Hardness, Rockwell, 73°F	——	D-785	R118	R120	R126	M93	R10 - 20
Durometer, 73°F	——	D-676	——	——	D85	D85	D55 - 70
Tensile Impact 73°F	ft. lb. / In.	D-256	——	——	40 - 60	75	30 - 200
Coefficient of Linear Thermal Expansion	in./ in. / F°	D-696	5 x 10^{-5}	4.3 - 8.7 x 10^{-5}	2.6 x10^{-5}	2.8 x 10^{-5}	5.5 - 7.5 x 10^{-5}
Deformation Under Load (122°F, 2,000 psi)	%	D-621	0.78	——	——	——	3 - 7
Deflection Temperature 264 psi 66 psi	°F °F	D-648 D-648	330 - 400 400 - 430	130 310	320 ——	250 390	100 - 140 250
Melting Point	°F	D-789	428	420	640	540	621
Continuous Service Temperature in Air (Maximum)	°F	——	230	240	480	425	500
Dielectric Strength, Short Time	Volts/ Mil	D-149	500 - 600	410	480	540	500 - 650
Volume Resistivity	OHM-CM	D-257	10^{15}	4 x 10^{16}	4.9 x10^{16}	4.5 x 10^{16}	›10^{17}
Dielectric Constant, 60 Hz	——	D-150	3.7	3.3	3.2	3.0	2.0 - 2.1
10^3	——	D-150	——	——	——	——	2.0 - 2.1
10^6			——	——	3.25	3.0	2.0 - 2.1
Water Absorbtion, Immersion — 24 hours	%	D-570	0.5 - 0.6	.08 - .09	.15	.01 .02	0 - .05
Saturation	%	D-570	2 - 2.5	.40	.50	.03	——

TECHNICAL DATA

Comparative Materials Chart

Property	Units	Test Method ASTM	PVC	PVDF	Polyamide-imide	Polycarbonate
Specific Gravity	——	D-792	1.47	1.78	1.41	1.20
Tensile Strength, 73°F	PSI	D-638	7,000	5,200 -7,400	18,000	9,500
Tensile Modulus of Elasticity, 73°F	PSI	D-638	350,000 - 1,000,000	348,000	700,000	320,000
Elongation, 73°F	%	D-638	50 -150	50 - 250	5 - 18	100
Flexural Strength, 73°F	PSI	D-790	12,500	10,750	26,000 - 30,700	14,200
Flexural Modulus of Elasticity, 73°F	PSI	D-790	300,000 - 800,000	300,000	730,000	350,000
Shear Strength, 73°F	PSI	D-732	9,240	——	16,000 - 18,500	9200
Compressive Strength	PSI	D-695	10,830	8.0 - 10.0	30,000 - 32,000	11,000
Compressive Modulus of Elasticity, 73°	PSI	D-695	——	——	450,000 - 680,000	——
Coefficient of Friction (Dry vs. Steel)Dynamic	——	——	——	0.24	.35	0.38
Hardness, Rockwell, 73°F	——	D-785	R115	R83	M119	R118
Durometer, 73°F	——	D-676	D82	76 - 80	M119 - 120	D80 - 85
Tensile Impact 73°F	ft. lb. / In.	D-256	——	——	——	——
Coefficient of Linear Thermal Expansion	in./ in. / F°	D-696	5.6×10^{-5}	7.1×10^{-5}	1.7×10^{-5}	3.7×10^{-5}
Deformation Under Load (122°F, 2,000 psi)	%	D-621	——	——	——	0.3
Deflection Temperature 264 psi 66 psi	°F °F	D-648 D-648	165 135 - 180	183 - 244 280	532	270 285
Melting Point	°F	D-789	360	345	N.A.	310
Continuous Service Temperature in Air (Maximum)	°F	——	160	285	500	250
Dielectric Strength, Short Time	Volts/ Mil	D-149	350 - 500	280	600	380
Volume Resistivity	OHM-CM	D-257	10^{12}	2×10^{14}	8×10^{16}	› 10^{15}
Dielectric Constant, 60 Hz	——	D-150	3 - 4	9	4.2	3.17
10^3	——	D-150	——	7.46	4.2	3.1
10^6			——	6.10	3.9	2.96
Water Absorbtion, Immersion — 24 hours	%	D-570	.05	.04	.33	.15
Saturation	%	D-570	——	.10	.33	.35

TECHNICAL DATA

Comparative Materials Chart

Property	Units	Test Method ASTM	Polyimide	Polypro-pylene	Polystyrene	Polysulfone
Specific Gravity	——	D-792	1.34	.90	1.03 - 1.10	1.24
Tensile Strength, 73°F	PSI	D-638	12,500	4,500	1500 - 7000	10,200
Tensile Modulus of Elasticity, 73°F	PSI	D-638	300 - 400,000	16,500 - 100,000	140,000 - 500,000	360,000
Elongation, 73°F	%	D-638	7.5	200 - 700	2 - 60	50 - 100
Flexural Strength, 73°F	PSI	D-790	13,000 - 23,000	6,000 - 8,000	3,000 - 12,000	15,400
Flexural Modulus of Elasticity, 73°F	PSI	D-790	450,000	17,000 - 100,000	150,000 - 460,000	390,000
Shear Strength, 73°F	PSI	D-732	13,000	5,710	——	——
Compressive Strength	PSI	D-695	19,000	6,720	2700 - 3600	——
Compressive Modulus of Elasticity, 73°	PSI	D-695	350,000	——	——	——
Coefficient of Friction (Dry vs. Steel)Dynamic	——	——	.29	——	——	.37
Hardness, Rockwell, 73°F	——	D-785	M120	80 - 102	10 - 90	R120
Durometer, 73°F	——	D-676	——	——	——	——
Tensile Impact 73°F	ft. lb. / In.	D-256	——	——	——	——
Coefficient of Linear Thermal Expansion	in./ in. / F°	D-696	2×10^{-5}	9.58×10^{-5}	1.9 - 4.4	3.1×10^{-5}
Deformation Under Load (122°F, 2,000 psi)	%	D-621	0.14	——	——	——
Deflection Temperature 264 psi 66 psi	°F °F	D-648 D-648	592 ——	130 210	160 - 200 180 - 220	345 358
Melting Point	°F	D-789	N.A.	335	212	371
Continuous Service Temperature in Air (Maximum)	°F	——	580	180	140 - 175	300
Dielectric Strength, Short Time	Volts/ Mil	D-149	500	500 - 660	300 - 600	420
Volume Resistivity	OHM-CM	D-257	——	10^{17}	10^{16}	5×10^{16}
Dielectric Constant, 60 Hz	——	D-150	——	2.3	——	3.1
10^3	——	D-150		——	2.5 - 4.5	3.1
10^6			3.55	——	——	3.03
Water Absorbtion, Immersion — 24 hours	%	D-570	.24 - .34	.03	.05 - .07	0.3
Saturation	%	D-570	1.2	——	——	.62

Comparative Materials Chart

Property	Units	Test Method ASTM	UHMW	Ultem®
Specific Gravity	——	D-792	.94	1.27
Tensile Strength, 73°F	PSI	D-638	4,000 - 6,000	15.2
Tensile Modulus of Elasticity, 73°F	PSI	D-638	80,000 - 100,000	430,000
Elongation, 73°F	%	D-638	200 - 500	60
Flexural Strength, 73°F	PSI	D-790	——-	21,000
Flexural Modulus of Elasticity, 73°F	PSI	D-790	100,000 - 200,000	480,000
Shear Strength, 73°F	PSI	D-732	3500	15,000
Compressive Strength	PSI	D-695	——-	20,300
Compressive Modulus of Elasticity, 73°	PSI	D-695	——-	420,000
Coefficient of Friction (Dry vs. Steel)Dynamic	——	——	.2 - .25	——-
Hardness, Rockwell, 73°F	——	D-785	R67	M109
Durometer, 73°F	——	D-676	——-	——
Tensile Impact 73°F	ft. lb. / In.	D-256	1000	——-
Coefficient of Linear Thermal Expansion	in./ in. / F°	D-696	7.2×10^{-5}	3.45×10^{-5}
Deformation Under Load (122°F, 2,000 psi)	%	D-621	6 - 8 (6 hrs)	——-
Deflection Temperature 264 psi 66 psi	°F °F	D-648 D-648	118 170	392 410
Melting Point	°F	D-789	266	——-
Continuous Service Temperature in Air (Maximum)	°F	——	160 - 180	340
Dielectric Strength, Short Time	Volts/ Mil	D-149	710	830
Volume Resistivity	OHM-CM	D-257	10^{13}	6.7×10^{17}
Dielectric Constant, 60 Hz	——-	D-150	2.3	3.15
10^3	——	D-150		3.15
10^6				——
Water Absorbtion, Immersion — 24 hours	%	D-570	‹0.01	.25
Saturation	%	D-570	——-	1.25

Explanation of Mechanical Properties

Tensile Strength

The word tensile means "to pull apart." Tensile strength is the resistance of material being pulled apart and is expressed in lbs. per square inch. One square inch of marshmallow would require very little force or total lbs. to pull it apart. Because plastics have much greater strength, the force required to pull apart 1 square inch of plastic may range from 1,000 to 50,000 psi. Steel and other structural alloys have tensile strengths that run as high as hundreds of thousands of pounds per inch.

Applying Tensile Strength

To illustrate the use of tensile strength, picture a circular cross section of tubing. Assume that the internal pressure exerted equally in all directions along the I.C. is 1,000 psi. Since the tubing wall must be strong enough to support the internal pressure, the strength of the 2 walls must at least be equal to the force exerted inside the tube. In other words, at burst, the I.D. of the tube times the pressure of the fluid contained must equal the wall thicknesses x the tensile strength of the material. Since the material must have at least 1,000 psi tensile strength, the choice would be nylon since a greater safety factor exists over materials with a lower tensile such as Teflon®.

Elongation

This property which is always associated with tensile strength, is the increase in original length at fracture, expressed as a percentage. For example, as a strip of wiring paper can be pulled apart with almost no visual stretching or "elongation," a piece of taffy may be stretched several times its original length before breaking. Assume that the taffy is 4" long and stretches to a total length of 12" before breaking, the elongation would be 200%.

Applying Elongation

Consider the application of Teflon tape applied by wrapping with considerable tension in the wire and cable field. Actually, these tensions represent portions of the tensile strength of the material. Consequently, elongation occurs. In order to obtain a tight, void free interface between overlapping layers of tape, both the tension and the elongation are important factors. Tensile strength and elongation are also important where toughness is required. A material which has a high tensile and a relatively high degree of elongation, is a tougher material than one having a high tensile with low elongation.

Toughness is required in such applications as insulators where a piece of nylon tubing is slipped over a wire lug, and crimped with force so that the tubing is mechanically fastened to the wire lug and in cases where snap fits are to be made between parts.

Modulus

The term modulus may be applied to either tensile, compressive, flexural or torsional actions. It defines the number of lbs. per square inch required to cause deformation, elongation, flexure, etc. in material. In other words, it represents stiffness. Imagine a rubber band and a piece of string four inches long. Placing a 1 lb. weight on the rubber band will cause stretching or elongation, whereas the same weight on the string would cause little or no visual elongation. Assume the rubber band stretched to double its original length. The relative modulus of the material is found by dividing the 1 lb. force by the elongation in terms of percentage. We therefore have 1 lb. over percentage in decimal form of 1/1=1. Assume the four inch length of string has stretched .040". This represents an elongation of 1%. Dividing this into the 1 lb. load, we have 1/.01=100. The relative modulus of the string is 100 times higher than that of the rubber band. In actual practice, the modulus would be expressed in psi; consequently, the modulus for a material like string might be about 100,000 psi.

In determining the compressive or flexural modulus, the same type of units are involved except that we are dealing with compressive deformation and flexural displacement.

Applying Modulus

Consider a nylon bearing having a 1/2" wall which is going to support a load of 2,000 psi. One of the considerations is how much additional clearance will be developed due to elasticity of the bearing. In this case, the modulus of the material is found by dividing the load by the resulting deformation which is expressed in percentage. The modulus of Nylon 66 in compression, is approximately 400,000 psi. To find the percentage of deformation, divide the 2,000 psi load by 400,000 with the resulting answer of .5%. Multiply this by the 1/2" wall thickness and find that a deformation of 2 1/2 mils will ocur. Tensile modulus is important in the design of a hydraulic system utilizing pressure tubing. During pressure build-up the tubing stretches slightly and causes a slight lag in pressure build-up over what might be epected if the tube was rigid.

Explanation of Mechanical Properties

Flexural Strength

This property is also expressed in lbs. per square inch and is the same type of force applied in folding a sheet of paper. The extended paper illustrated assumes a slight downward curvature while a piece of cloth will hang almost perpendicular. This means the flexural strength of the paper is considerably higher since it resists bending under its own weight.

Applying Flexural Strength

This property is applied in applications where the plastic is being bent or continually flexed as in plastic gearing. In determining the load which a single gear tooth must carry, consider the flexural strength of the material selected.

Hardness

There is really very little that can be said about this property since there is no exact term which defines values of hardness. In some cases the diameter of the indentation of a small ball on the material being tested is taken as a hardness measurement. In other cases it is the penetration of a sharp point. Generally a harder surface provides better wear and abrasion resistance in a material.

Tensile Impact

The test involves breaking the sample in tension at very high speeds. The sample is normally broken before any apparent elongation occurs. In certain applications, the tensile impact test can be more readily correlated to field experience and engineering requirements. The speed of impacting has a very definite effect on impact strength. Some materials increase in impact strength with increasing speed while others decrease.

Compressive Strength

This property is the maximum load in lbs. which a 1" square section of material will support without fracturing. It is a less meaningful term than tensile strength, primarily because some of the malleable materials, Teflon® for example, really do not exhibit fracturing. Consequently, compressive strength will continue to increase as deformation of the sample occurs. The meaningful compressive properties would be better expressed in terms of the force in lbs. per square inch required to deform a given material prior to reaching its yield point.

As an example of the differences in compressive strength, a 5 lb. weight placed on a 1" cube of marshmallow would seriously deform it, whereas the same weight on a 1" cube of taffy will cause only slight deformation.

Applying Compressive Strength

Compressive strength is important in plastic bearing applications. The load to be carried by the bearing must be well within the compressive strength characteristics of the material. However, at this point one must consider other properties such as the modulus and deformation under load of the bearing material. It is apparent what would happen if nylon (with a compressive strength of approximately 15,000 psi) was selected to support a load of 12,000 psi. Recalling that compressive strength is a value at failure, the 12,000 psi load would crush the bearing beyond use. Compressive strength can be used to distinguish the better of 2 materials, but once the material has been selected, other considerations must be made.

Yield Point

There are various types of yield points: compressive, tensile, flexural, and torsional. The term simply means the point at which material under compression, tension, etc. will no longer return to its original dimensions after removal of stress. You can visualize yield point by taking a wooden matchstick and gently bending it until a slight fracture occurs. Prior to this fracture, for all visual purposes, a matchstick will return to its original straightness. In actual practice, plastic materials under tension, compression, etc. show a small degree of fracture at the yield point. They consequently will not return to their original dimensions because the internal physical structure has now been slightly modified.

Explanation of Thermal Properties

Coefficient of Linear Thermal Expansion

This term deals with the amount of growth which occurs in a material when it is heated, and is normally expressed in terms of in/in/ºF. Visualize a mercury thermometer where a few degrees temperature rise causes a very substantial growth in the column of mercury but has no visual effect on the glass container.

Applying Coefficient of Linear Thermal Expansion

Thermal expansion for plastics is 4 to 8 times higher than other engineering materials, and requires close attention in certain design areas. Materials which exhibit high thermal expansion could cause instability in electronic tuning devices where a change in temperature could cause inaccurate tuning due to thermal expansion of components. Fluorosint® exhibits a coefficient of thermal expansion that matches and makes an ideal insulating companion to aluminum.

Thermal expansion must also be considered in bearings at elevated temperature. Bearings which are completely housed will show a closing-in of the I.D., and, for proper bearing performance, this close-in must be considered in order to prevent seizure of the rotating shaft.

Deformation Under Load

This property tells us what percentage of deformation will occur in a material under a given load in a given period of time.

The time element is critical. While 1% deformation might be indicated under the standard 24 or 48 hour exposure, leaving the sample under the load for a 2 week period may show substantially higher deformation. The lower the deformation under load, the more likelihood there is that the value will not change with increased time. After placing the piece of furniture on a run and immediately removing it, little or no indentation can be seen. However, after allowing the object to stand overnight, a substantial indentation is present.

This property indicates the major portion of the creep which will occur over long periods of time, but which would not be evident in a short test.

Plastics exhibit creep characteristics which are uncommon in other engineering materials. When measuring properties, consider that differences would be seen if the tests were carried out over long periods of time.

Applying Deformation Under Load

In a bearing application, deformation under load contributes to total bearing clearance. For example, a Fluorosint® bearing having a 1/2” wall, operating at 200º F under a 1,200 psi. load, will deform .2%. Multiplying this .2% by the wall thickness tells us the bearing clearance will be increased by a factor of 1 mil. If you had recommended Teflon® for this application, not taking into consideration the deformation under load, the effect on clearance would be approximately 28 times as great, and a clearance of 28 mils would result within the first day of operation.

Heat Distortion

This property has little or no practical engineering meaning. It is simply a comparison of various materials. It is the temperature at which a sample bends a given number of mils under a given load. This value can only be used to separate materials having widely different heat distortion points. For example, 2 materials having a heat distortion point of 150º F. and 175º F are not very different. You should consider other properties such as deformation under load and modulus.

Explanation of Electrical Properties

Dielectric Strength

Dielectric strength differs from tensile or compressive strength in that the force is applied electrically rather than mechanically. This electrical force, rather than acting on the entire mass, acts upon portions of the molecules. Dielectric strength is expressed in volts per mil and represents the number of volts required to cause an electrical breakthrough of the sample. As the voltage increases, the molecule approaches a failure point. Portions of the molecule fly off and carry a charge or conduct a current. You may have had the experience of placing a piece of paper between the electrodes on a spark generating machine in a high school laboratory, and finding that upon removal the paper was perforated with small blackened holes. You may also have experienced placing other materials between the electrodes, and found that such perforations did not appear. Assuming that the materials were of the same thickness, the one which was not perforated would have a higher dielectric strength.

Applying Dielectric Strength

Dielectric strength is of primary importance in the application of plastics in wire or cable covering. Normally, the heavy sections encountered in other applications are more than adequate to withstand the voltage. As thickness of insulation increases, the dielectric strength in volts per mil increases at a different rate for each material. Consequently, in thin sections, Teflon® exhibits a higher dielectric strength than nylon. Keep this in mind when recommending insulating materials.

Volume Resistivity

The volume resistivity of a material is its ability to impede the flow of electricity expressed in ohms per centimeter. This measurement is always made on a 1 centimeter cube.

Wire, for example, is a conductor having negligible volume resistivity and electrical current occurs instantaneously. This electrical current can be simply defined as motion of electrons. As one electron moves, the next one moves in turn to carry the electrical current. This could be pictured as a series of dominoes standing on end, spaced so that if one falls the next will fall in turn.

Electron movement in plastics is virtually impossible due to the complex nature of the molecule. The more readily the current flows, the lower the volume resistivity. Copper wire would have a very low volume resistivity, while insulating materials are considerably higher.

Applying Volume Resistivity

The volume resistivity of almost all plastics is extremely high and need not be considered in most applications. However, it must be considered when dealing with sensitive electronic measuring equipment. There are instruments which will measure voltages and currents as small as 10^{-13}. This value is close to the value for volume resistivity of plastics. If you were to apply nylon as an insulator in such an instrument, the resistivity of the plastic itself could cause serious errors in the equipment. Therefore, it is important to have a material with considerably higher volume resistivity than 10^{10}. You should consider materials such as Teflon® and Q200.5.

Dielectric Constant

This property describes the ability of a material to store an electric charge and is sometimes referred to as specific capacitance. This value is commonly associated with electronic capacitors which are nothing more than 2 metallic electrodes separated by an insulating material such as Teflon® or nylon. Picture dielectric constant as a larger build up of electrons on the surface of the nylon capacitor since the dielectric constant of nylon is several times that of Teflon®. If we use the same voltage source to charge the capacitors, upon shorting them out we would expect twice the work out of the capacitor having the higher dielectric constant due to that fact that current x volts = watts or, work equivalent.

Dielectric Loss Tangent

In order to discuss dielectric loss tangent, it is necessary to look inside of hte plastic molecule to understand why it has a higher dielectric constant. Picture the molecules as a random arrangement of small magnets. Under applied voltage these molecules will attempt to arrange themselves in a uniform fashion. Materials having a higher dielectric constant therefore organize themselves more uniformly than those having a lower dielectric constant.

The dielectric loss tangent is the ease of difficulty withwhich molecular ordering occurs. Materials having a higher dielectric loss tangent have molecules which must move in an atmosphere of higher viscosity. Consider a material which stores 1,000 electrons. This material will actually require 1,000 plus a certian percentage of electrons more due to dielecric loss.

Explanation of Electrical Properties

The product of dielectric constant and dielectric loss is directly proportional to the energy lost in charging a material. In other words if 2 different materials both have a dielectric loss of .001 but one has a dielectric constant of 2 and the other 4 the second materials will actually use twice the energy of the first.

Applying Dielectric Constant and Dielectric Loss Tangent

Dielectric constant and loss must be considered together. The dielectric loss of materials should be as low as possible to prevent excess power consumption. In some cases it is desirable to have a low dielectric constant. In other cases a high dielectric constant is desirable, assuming that the dielectric loss in both cases is relatively low. An example where a low dielectric constant is desirable is insulating material for coaxial cable. Imagine a coaxial cable many hundred of feet long. Even though power losses per foot may be extremely low, as the cable becomes longer, this power loss becomes a very important fator. Therefore, as low a dielectric constant as possible must be utilized in order to minimize energy losses.

To convert temperature, use the following calculation:

°F = (°C x 9/5) + 32

°C = (°F- 32) x 5/9

Temperature Conversion			
°C	°F	°C	°F
-70	-74	110	230
-60	-76	120	248
-50	-58	130	266
-40	-40	140	284
-30	-22	150	302
-20	-4	160	320
-10	14	170	338
0	32	180	356
10	50	190	374
20	68	200	392
30	86	210	410
40	104	220	428
50	122	230	446
60	140	240	464
70	158	250	482
80	176	260	500
100	212	300	572

Bonding Basic Information

Surface Tension

The surface tension of substrates affects the bondability and/or wetting out of an adhesive. If a given substrates' surface tension is lower than the adhesive being applied, the adhesive will not "wet" or spread correctly. The low surface tension of the substrate will cause the adhesive to bead up. Conversely, if an adhesive has a lower surface tensino than the substrate, the adhesive will wet/spread over the surface allowing for maximum bond area and strength. (Poor bonds resulting from this condition can be improved by using a surface treatment.)

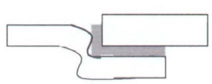
Basic Joints

Joint -The area in which adhesive can be applied to join two substrates together.

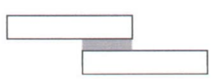
Butt Joint: The adhesive bond in a butt joint is formed by adhering two substrates end to end.

Cylindrical Joint: This joint bonds two cylindrical substrates end to end.

Joggle Lap Joint: A joggle joint features at least one bent or curved substrate. Also referred to as an offset joint.



Lap Joint: This joint is formed when one substrate partially overlaps another to create the bond area.



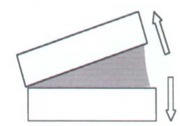
Scarf Joint: When the ends of two substrates are cut at an angle and bonded at those ends, a scarf joint is formed. By cutting the joint at this type of angle, the bond area is increased.

Strap Joint (Single & Double): This joint is actually a combination of a butt joint and a lap joint. A single strap joint is formed with only one lap joint on one side of the butt joint. The double obviously occurs on both sides.

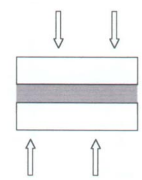
Adhesion vs. Stress

When considering the proper selection of an adhesive, one needs to carefully examine many things. One of the most important considerations is the type of stress the adhesive will have to withstand. Stress is the force pulling bonded materials apart. The basic type of stress are illustrated below:

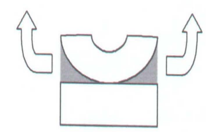
Cleavage Stress: This type of stress is concentrated at one end of a joint and occurs when a prying force is placed on the adhesive bond.



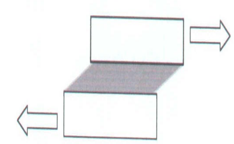
Compressive Stress: Compressive stress occurs when two substrates are squeezed or pressed together.



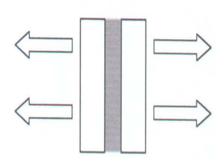
Peel Stress: In order for peel stress to occur, at least one of the substrates must be flexible. The stress occurs as the flexible substrate is being peeled or lifted away from the other substrate.



Shear Stress: As two bonded substrates are being forced to slide over each other, shear stress occurs. The stress direction is parallel to the adhesive. As shear stress occurs, the ends of the bond resist a greater amount of the stress than will the middle of the bond.



Tensile Stress: This type of stress exerts an equal force over the entire joint. The direction of tensile stress is straight and apart from the adhesive bond. (Elongation of the object can occur with this type of stress.)



Bonding Basic Information

Surface Treatments

In order to successfully bond or to increase the bond strength between some substrates, a surface treatment may be required. Some of the more common surface treatments are described below:

Adhesive Abrading: This process involves the abrading of a substrate's surface in the presence of an adhesive. Once completed, the two substrates are placed together to allow the adhesive to cure.

Corona Discharge: By exposing a substrate to a corona discharge, the surface is roughened which allows for better wetting and reactivity of the surface.

Flame Treatment: Increased wettability, which results in increased bondability, can be accomplished by oxidizing the surface through exposure to flame.

Plasma Treatment: When ions of a gas, such as O_2, N_2, or He_2 are exposed at low pressure to a substrate surface, the bondability of the substrate is increased.

Primers: Surface primers generally improve bondability by acting chemically bridging an adhesive to the substrate. Primers are usually a reactive chemical held within a solvent. They are typically brushed or sprayed upon the substrate and then allowed to flash off.

Surface Roughening: A simple method of increasing the bondability of substrates by roughening the surface, thereby increasing the number of mechanical interlocking cells.

Activators/Accelerators

These chemicals can be applied directly to a surface, substrate, or mixed with an adhesive to speed up the curing of an adhesive.

Bond Failure

When conducting bond tests, it is critical to understand the different types of failures which may occur, as well as, how to correct the failure. Four basic types of failure are as follows:

Adhesive Failure: This failure occurs when the adhesive fails to adhere to the substrate surface. One can detect adhesive failure by mating the failed parts to examine the adhesive in the bond area. During adhesive failure the adhesive will commonly be on one surface or the other in any given spot throughout the bond.

> ***Common Problems***—Many times the substrate may have been dirty, oily, or have contained a mold release on them. Chemically treating, solvent wiping, or abrading the surface can correct this.

Cohesive Failure: Cohesive failure results when the adhesive itself separates under a stress load. To identify this type of failure, examine the substrates and look for adhesive on both substrate surfaces at any given point throughout the bond area.

> ***Common Problems***—Unless the bond is under extreme impact or high stress loads, cohesive failure is unlikely to occur. If it does occur, try to identify alternative substrates which would transmit less shock or try bonding a thin rubber pad between the substrates.

Substrate Failure: When a substrate cracks, breaks, tears, etc. as one tries to separate bonded parts, substrate failure has occurred. During this failure, the bonded area remains intact.

> ***Common Problems***—The adhesive in this case has been demonstrated to be stronger than the material being bonded so in order to increase the overall strength of the assembly, one would have to change materials or redesign the part.

Surface Failure: This failure normally occurs on soft substrates. It can be identified by examining the adhesive in the bond area, which will be lightly covered with particles from the substrate.

> ***Common Problems***—the adhesive in this case has been demonstrated to be stronger than the material being bonded so in order to increase the overall strength of the assembly, one would have to change materials or redesign the part.

TROUBLESHOOTING		
Problem	**Probable Cause(s)**	**Possible Solution(s)**
Bond Failure at R.T.	• Unclean or unsuitable surface	• Solvent wash with compatible solvent
Poor adhesion to one surface	• Release agent or coating on surface	• Abrade surface
Bond failure after aging exposure to high temperatures	• Migration of internal components of substrates (Plasticizers, oils, etc.)	• Abrade to increase surface area • Investigate alternate substrates
Whitening or colored contamination near bond area (a.k.a. blooming/chlorosis)	• Over application of adhesive • Poor ventilation • Excessive heat and humidity • Slow cure of fillet	• Reduce amount • Ventilate assembly area and/or assembled parts • Same as above • Accelerate cure with pre or post-applied accelerator
Electrical discontinuity of changes in electrical properties of electrical device	• Over application • Heating of assembled part • Slow fillet cure	• Reduce amount • Accelerate cure of fillet
Crazing of materials/devices	• Crazing of plastic parts due to excess liquid adhesive or slow cure • Dimensional change in adhesive due to temperature cycling	• Investigate alternative materials • Increase cure speed with faster adhesive or accelerator
Slow fixture and cure	• Inhibiting (acidic) surface • Low part temperature • Over application of adhesive	• Neutralize surface • Raise working temp • Reduce amount
Application variability	• Part dimensional variation or part surface variation • Application technique change • Conditions of assembly change (temperature, etc.)	• Surface preparation • Adjust/modify/retrain • Call technical support

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MACHINING GUIDE FOR ENGINEERED PLASTICS

	TURNING				SAWING				MILLING				DRILLING			
	Clearance Angle	Rake Angle	Speed Ft./Min.	Feed In./Rev.	Clearance Angle	Rake Angle	Pitch Teeth/In.	Speed Ft./Min.	Clearance Angle	Rake Angle	Speed Ft./Min.	Feed In./Rev.	Clearance Angle	Rake Angle	Speed Ft./Min.	Feed In./Rev.
ABS	5-15°	25-30°	650 - 1,640	.005-.020	15-30°	0-5°	.07-.31	850 - 1000	5-10°	0-10°	980 - 1,640	-----	8-12°	10-30°	160 - 650	.008-.012
ACETALS	6-8°	0-5°	980 - 1,970	.004-.015	20-30°	0-5°	.07-.19	1,640 - 2,625	5-15°	5-15°	820 - 1,640	.004-.016	5-10°	15-30°	160 - 650	.004-.012
ACRYLIC	10-20°	0-5°	450 - 600	.005-.010	10-20°	0-10°	-----	2,500 - 4,000	15°	0-5°	300 - 600	.003-.010	12-15°	0-5°	150 - 200	.002-.050
NORYL®	5-10°	6-8°	1,500 - 2,500	.004-.020	15-30°	5-8°	.11-.31	980	10-20°	5-15°	1,500 - 2,000	-----	8-10°	10-20°	160 - 650	.008-.012
NYLON	5-10°	0-5°	500 - 700	.002-.016	20-30°	0-5°	.07-.19	1,500 - 3,000	7-15°	0-5°	1,000 - 3,000	.004-.016	10-15°	0-5°	180 - 450	.004-.015
PEEK	-----	-----	600 - 1,000	.004-.016	3-10°	0-5°	-----	2,500 - 4,000	-----	-----	500 - 750	.002-.004	9-15°	-----	400 - 500	.002-.012
POLYCARBONATE	5-10°	6-8°	500 - 700	.004-.020	15-30°	5-8°	.11-.31	1,000 - 2,500	10-20°	5-15°	1,300 - 2,000	.002-.004	8-10°	10-20°	160 - 330	.008-.012
POLYESTER	5-10°	0-5°	980 - 1,300	.008-.015	15-30°	5-8°	.11-.31	980	5-15°	0-5°	980	-----	5-10°	10-20°	160 - 330	.008-.015
POLYOLEFIN	15-25°	0-15°	600 - 800	.0015- .025	15°	0-8°	-----	1,650 - 5,000	10-20°	0-10°	1,000 - 3,000	.06-.02	10-20°	0-5°	200 - 600	.004-.020
POLYSULFONE	6°	0°	1,150 - 1,300	.004-.012	15-30°	0-4°	.07-.19	2,500 - 4,000	2-10°	1-5°	820 - 1,640	.002-.004	3-10°	10-20°	65 - 260	.004-.012
PVDF	10°	5-8°	490 - 1,640	.004-.012	20-30°	5-8°	.11-.19	980	5-15°	5-15°	820 - 1,640	-----	10-16°	5-20°	490 - 650	.004-.012
TEFLON®	15-30°	0-5°	400 - 700	.002-.010	20-30°	0-5°	-----	8,000 - 12,000	7-15°	3-15°	1,000 - 3,000	.004-.016	20°	0-10°	200 - 500	.002-.010
ULTEM®	6-10°	0-5°	500 - 2,000	.005-.020	-----	0-5°	.39	3,000 - 5,000	-----	-----	1,300 - 2,000	.002-.004	9-15°	10-20°	150 - 300	.005-.015

THESE ARE SUGGESTED GUIDELINES ONLY AND SHOULD NOT BE CONSIDERED AS ABSOLUTE. REGAL RECOMMENDS RUNNING A TEST WORKPIECE BEFORE STARTING A PRODUCTION RUN.

This chart is available printed on Lexan® Sheet. If you would like to receive a copy, please call 1-800-627-2102 or fax your request to 1-816-421-8206.

Machining Thermoplastics

Sawing

Most saws used for metals (including manual and roller hack saws, hand, circular, and jig saws) can also be used on plastics. It must be remembered, however, that reciprocating saws generate considerable heat which can lead to cracking and very rough surfaces. A cooling agent (liquid or compressed air) is usually needed (product dependent), unless the cut is very short.

Circular saws may be used for making straight cuts in sheet and plate, and traveling circular or panel saws are good for sawing stacks of several sheets. If hollow ground blades with a set are used to minimize friction, the buttress type tooth form, having a 45° to 60° clearance and a 0° front rake is recommended. Hollow ground circular saw blades without set produce a smoother cut, but will exhibit more rapid wear because of the lesser side clearance, resulting in unsatisfactory surface after a short period of use. Blade diameter and number of teeth per inch will vary with the thickness and the properties of the material being cut; however, 3 to 6 teeth per inch 1/32” to 1/8” thick, is a good general purpose blade.

Band saws can be used for straight cuts and irregular or curved contours, and their long blade lengths cause less overheating. For best results use a skip tooth or buttress type tooth having a zero front rake and (raker) sets of teeth. Thick stock can be cut using 4 to 6 teeth per inch.

Both band and jig saws should have enough set to give good clearance to the back of the blade. Plastics tend to close in behind the cutting edge unless enough set is used. Chrome plating reduces friction and gives a better finish.

Drilling

Remember that drilling generates more heat than any other operation. To avoid gumming, melted surfaces on the drilled hole, and cracks around the hole, be sure to stop and clear the chips from the drill regularly and use an air or water-spray mist to cool the area that is being machined.

In general, a slow spiral (low helix) drill or general purpose drill ground to a point angle of 118° with a lip clearance of 9° to 15° is recommended. In either case, the lip rake should be ground off and the web thinned.

Blunt angles (115° - 130°) are better for thin-walled pieces, as they prevent the outside diameters from expanding.

Reaming

Reaming can be done on thermoplastics to obtain very accurate holes. Using a standard reamer .001” to .002” over the size of the finished hole will allow for “fall in.” Tolerances as close as ±0005” can be held in thru holes 1/4” in diameter or less where the length of the hole does not exceed one drill diameter.

Fluted reamers are recommended for trouble-free side wall shearing. For interrupted cuts, such as those with keyways, splines, etc., a helical flute reamer with right hand spiral cuts are recommended. For finishing a hole in soft plastic to close tolerance, use a single point boring tool or a secondary drilling.

Although reaming may be done dry, using a water or light cutting oil coolant will enhance the finish. (before using any type of coolant containing oil, check with the manufacturer).

Turning, Milling and Boring

When employing these machining techniques, it is important that sharp tools with generous clearances be used so that only the cutting edge touches the material. In addition, 0° to 5° negative rakes on the tool are recommended.

For short runs, regular or chrome-plated high speed steel is acceptable. For long production runs, tungsten carbide and diamond bit tools are recommended. For best results, hone carbide tools with a very fine 400 grit diamond wheel after grinding.

When machining TFE (Teflon®), make sure that the tools are centered accurately. Because Teflon® is relatively soft and flexible, it will deflect from its center and follow the misaligned tool. This can cause a convcave, torn threads, tapered holes, and other inaccuracies in the finish.

Cut - Off

Cut off operations are performed with conventional tools modified for plastics. The cut-off blade is ground to suit a variety of conditions and materials. It must also have ample clearance to prevent rubbing and overheating, as well as be set square to the work to prevent a concave or convex surface.

Burrs can be caused by the cut-off blade unless the work piece is prepared with a chamfer. To do this, form a “V” in the surface of the work with a cutter mounted on the machine cross slide. This will chamfer both sides of the work piece and eliminate the problem.

Machining Thermoplastics

Blanking / Piercing

Parts such as washers, grommets, and cams 3/32" or less in thickness can be economically produced by punching, blanking, or stamping from extruded strip or profile shapes. Accurately aligned, minimum punch and die side clearances should be used in all blanking operations to prevent extrusion of the material at the edges of the cut. Because plastics extrude and recover more than metals, allowances for the produced part size must be made, and it is suggested that a test die first be made. Tolerances to ± 1 / 64" can easily be met.

Shearing

Guillotine squaring shears, preferably power operated, are used for shearing plastic. Blade angle should be parallel, but a variance up to 1 1 / 2° is allowed.

Tapping / Threading

Since plastics are notch sensitive, sharp V-threads should be avoided. A thread with a rounded root, such as a British Standard series (Whitworth Thread) or American Standard Unified Thread form with rounded root is recommended.

For tapping holes, high speed oversize taps, such as H-3 oversize for small diameters, up to H-5 for larger diameters are suggested. For deep holes (over 3: 1), four flute taps are recommended for greater chip clearance. Taps for all thermoplastics should have maximum back clearance with a pitch diameter of 0.005", unless a tight fit is required. Taps should be nitrated or chromeplated, and all new taps should be honed to remove burrs.

Bottom taps should be avoided when possible. If necessary, however, they should be modified by grinding a 50° chamfer angle on the face measured from the axis of the tap.

After tapping, a chamfering operation is sometimes necessary to remove burrs. Chips from tapping can be removed from the bottom of the tapped hole by redrilling with the tap drill. For maximum strength and dimensional stability, all tapped parts should be annealed to relieve the stresses of the tapping procedure.

Spindle speeds for both tapping and threading should be below those used for drilling and turning, or the first few threads may tear. Chamfering the hole prior to tapping and providing a positive feed for the first few threads can reduce this problem. Threads may be cut with a single point tool. Heavy cuts can be used for the initial pass and reduced to 0.007" to 0.010" in the final pass. Class I and II threads may both be cut in one pass.

TECHNICAL DATA

Welding Basic Information

Welding is the fusion of thermoplastics by heat and pressure. The bond achieved, depending on the type of weld, is general as strong (90%) as the original material.

Typical thermoplastic welding applications:

- Ductwork
- Fan Housings
- Scrubbers
- Tables
- Screns
- Chick Hatchery Boxes
- Dampers
- Waste Canisters
- Pan
- Etching Tanks
- Grills
- Vanes
- Fixtures
- Trays
- Etching Machines
- Frames
- Gaskets
- Conduit Fittings
- Pails
- Flues
- Displays
- Pipes
- Drains
- Sinks
- Stands
- Beams
- R.V.s
- Vents
- Fauces
- Stack Caps
- Manifolds
- Valves
- Hoods
- Drums
- Graduates
- Plenums
- Pipe Fittings
- Tanks
- Storage Tanks
- Dippers
- Filter Housings
- Slide Gates
- Hangers
- Lines
- Pitchers
- Blower Housings
- Louvers
- Bumpers

Common Weldable Thermoplastic Materials

HDPE (high density polyethylene). HDPE welds very well and is the most common form. LDPE (low density polyethylene) also welds well, but is a much softer and flexible product. It is important to note that you can weld a higher density with a lower density rod, but you cannot weld a lower density with a higher density rod. UHMW (ultra high molecular weight polyethylene) requires a special welder, rod, and tip for effective welding. Consult with your plastics distributor for specifics. Cross link formulations of polyethylene (thermoset materials) are not weldable.

CPVC (Chlorinated Polyvinyl Chloride). The plasticizer in CPVC requires sanding or scraping of both the rod and the surface to be welded in order to obtain a good weld. Removal chemically is not recommended due to possible material softening or residue.

Note: Guard against scorching to avoid significant weaking of the weld.

TPUR (Thermoplastic Polyurethane). A strong bond is possible with TPUR once a proper cure time is determined. Immediately after welding, with no curing time, the bond will pull loose. A test piece is recommended to test the strength of the bond at five minute intervals.

PP (Polypropylene). To avoid separation of rod and substrate during the melted state, the parts must be held in place until the product color returns to its original appearance. This rod does not soften all the way through making corner welds difficult. When multiple welds are required, it is recommended that the weld and the areas surrounding the weld be heated and then slowly cooled. This process is called annealing, and is a recognized process to lengthen the time of the weld.

PVC (Polyvinyl Chloride). To achieve an effective weld with PVC it is imperative to avoid scorching or discoloration.

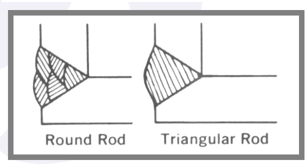
Note: Never attempt to weld over cement.

PVDF (Polyvinyl Fluoride). Welds with PVDF are very strong and can be achieved by hand or automatic feed. Annealing is recommended to extend the life of the weld.

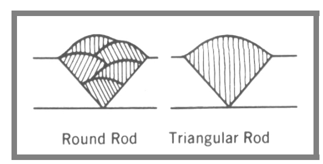
ABS (Acrylonitrile Butadiene Styrene). With a good esthetic value, this product can be finished by sanding and painting.

TYPES OF WELDS

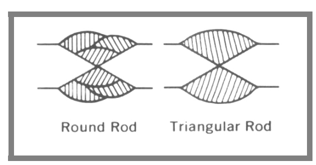
Outside Corner Welds



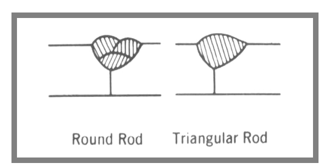
Single "V" Butt Welds



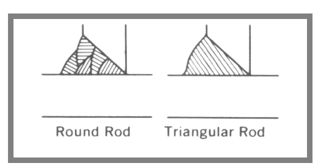
Double "V" Butt Welds



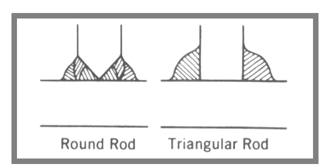
Edge Welds



Inside Corner Welds



Fillets and Corner Welds



Welding Basic Information

STANDARD WELDING CHART		
PLASTIC TYPE	**TEMP (E.)**	**AIR/PSI**
Polypropylene (PP)	790°	3 to 5
Polyethylene (PE)	725°	3 to 5
Acrylonitrile Butadiene Styrene (ABS)	790°	3 to 5
Polyvinyl Chloride (PVC)	790°	3 to 5
Chlorinated Polyvinyl Chloride (CPVC)	890°	3 to 5
Polyvinyl Fluoride (PVDF)	790°	3 to 5
Polyurethane (TPUR)	625°	3 to 5

Rod Sizing Chart	
Base Material Thickness	**Welding Rod Size (diameter)**
1/16”	1/8”
1/8”	1/8”
3/16”	3/16”
1/4”	3 rods of 5/32”
For thicknesses greater than 1/4”, use multibeads to fill.	5/32” or 3/16”

Welding Tips:

- **Only thermoplastics can be welded.**
- **Thermoset plastics cannot be welded.**
- **Hot-air welding should not be confused with the heat sealing of film or thin sheets.**
- **Materials must be at least 1/16” thick to be successfully hot-air welded.**
- **If there is a question as to the weldability of a material, the supplier or the manufacturer should be asked for their recommendations on weld method.**

Conversion Chart

FRACTIONS	DECIMALS	MILLIMETERS
1/64	.015625	00.396875
1/32	.03125	00.79375
3/64	.046875	01.190625
1/16	.0625	01.5875
5/64	.078125	01.984375
3/32	.09375	02.38125
7/64	.109375	02.778125
1/8	.125	03.175
9/64	.140625	03.571875
5/32	.15625	03.96875
11/64	.171875	04.365625
3/16	.1875	04.7625
13/64	.203125	05.159375
7/32	.21875	05.55625
15/64	.234375	05.953125
1/4	.250	06.35
17/64	.265625	06.746875
9/32	.28125	07.14375
19/64	.296875	07.540625
5/16	.3125	07.9375
21/64	.328125	08.334375
11/32	.34375	08.73125
23/64	.359375	09.128125
3/8	.375	09.525
25/64	.390625	09.921875
13/32	.40625	10.31875
27/64	.421875	10.715625
7/16	.4375	11.1125
29/64	.453125	11.509375
15/32	.46875	11.90625
31/64	.484375	12.303125
1/2	.500	12.7

FRACTIONS	DECIMALS	MILLIMETERS
33/64	.515625	13.096875
17/32	.53125	13.49375
35/64	.546875	13.890625
9/16	.5625	14.2875
37/64	.578125	14.684375
19/32	.59375	15.08125
39/64	.609375	15.478125
5/8	.625	15.875
41/64	.640625	16.271875
21/32	.65625	16.66875
43/64	.671875	17.065625
11/16	.6875	17.4625
45/64	.703125	17.859375
23/32	.71875	18.25625
47/64	.734375	18.653125
3/4	.750	19.05
49/64	.765625	19.446875
25/32	.78125	19.84375
51/64	.796875	20.240625
13/16	.8125	20.6375
53/64	.828125	21.034375
27/32	.84375	21.43125
55/64	.859375	21.828125
7/8	.875	22.225
57/64	.890625	22.621875
29/32	.90625	23.01875
59/64	.921875	23.415625
15/16	.9375	23.8125
61/64	.953125	24.209375
31/32	.96875	24.60625
63/64	.984375	25.003125
1	1.000	25.4

MILLIMETERS x .03937 = INCHES   INCHES X 25.4 = MILLIMETERS

This chart is available on adhesive-backed Lexan®. Request a copy at 1-800-627-2102 or fax your request to 1-816-421-8206.

TECHNICAL DATA

Conversion Tables

Product	Formula
Acrylic	L x W x GA. x .0432 = LBS./Sheet
Expanded PVC	L x W x GA x .035 = LBS./Sheet
Polyethylene Sheet Stock (HDPE)	L x W x GA. x .035 = LBS./Sheet
PET	L x W x GA. x .04795 = LBS./Sheet
PETG	L x W x GA. x .04608 = LBS./Sheet
Polycarbonate Film/Sheet	L x W x GA. x .04333 = LBS./Sheet
Polyester	L x W x GA. x .0507 = LBS./Sheet
Rigid Vinyl	L x W x GA. x .049 = LBS./Sheet
OPS	L x W x GA. x .03765 = LBS./Sheet
Styrene	L x W x GA. x .039 = LBS./Sheet
Polyethylene Banner Films	
.008 Poly Print I	L x W ÷ 3750 = LBS./Banner
.010 Poly Print I	L x W ÷ 3000 = LBS./Banner
.008 Strata Print II	L x W ÷ 3500 = LBS./Banner
.010 Strata Print II	L x W ÷ 2800 LBS./Banner
General Formulas	
To Figure MSI (1000 square inches)	L x W ÷ 1000 = MSI
To Figure Square Feet	L x W ÷ 144 = Square Feet
To Figure Lbs./Sheet	L x W ÷ Sq. Inches Per Pound
To Convert Millimeters and Inches	Millimeters x .03937 = Inches Inches x 25.4 = Millimeters
To Figure Square Meters	L x W ÷ 1550 = Square Meters
To Figure Square Yards	L x W ÷ 1296 = Square Yards
Typical Density is in Grams/CC - To Convert	.03605184 x Density (Grams/CC) = A L x W x GA. x A = LBS./Sheet

Temperature Conversion

°C	°F	°C	°F
-70	-74	110	230
-60	-76	120	248
-50	-58	130	266
-40	-40	140	284
-30	-22	150	302
-20	-4	160	320
-10	14	170	338
0	32	180	356
10	50	190	374
20	68	200	392
30	86	210	410
40	104	220	428
50	122	230	446
60	140	240	464
70	158	250	482
80	176	260	500
100	212	300	572

Conversion Tables for Units

To Convert	Into	Multiply By	To Convert	Into	Multiply By
Centimeters	Feet	3.281 x .01	Meters	Inches	39.37
Centimeters	Meters	0.01	Meters	Kilometers	0.001
Centimeters	Inches	0.3937	Meters	Yards	1.094
Centimeters	Millimeters	10.0	Millimeters	Inches	0.03937
Centigrade	Fahrenheit	(C° x 9/5) + 32°	Millimeters	Mils	39.37
Cubic Feet	Cubic Inches	1,728.0	Mils	Inches	0.001
Cubic Feet	Cubic Yards	0.03704	Ounces	Grams	28.349527
Cubic Inches	Cubic Feet	5.787 x .0001	Ounces	Pounds	0.0625
Feet	Centimeters	30.48	Pints	Gallons	0.125
Feet	Meters	0.3048	Pints	Quarts	0.5
Grams	Ounces	0.03527	Pounds	Grams	453.5924
Grams	Pounds	2.205 x .001	Pounds	Ounces	16.0
Inches	Centimeters	2.540	Sq. Centimeters	Sq. Inches	0.1550
Inches	Millimeters	25.40	Sq. Centimeters	Sq. Meters	0.0001
Inches	Mils	1,000.0	Sq. Feet	Sq. Inches	144.0
Kilograms	Grams	1,000.0	Sq. Inches	Sq. Feet	.006944
Kilograms	Pounds	2.205	Sq. Inches	Sq. Centimeters	6.452
Kilometers	Mils	0.6214	Sq. Mils	Sq. Inches	.000001
Meters	Centimeters	100.0	Yards	Meters	0.9144
Meters	Feet	3.281			

To convert temperature, use the following calculations:

°F = (°C x 9/5) + 32 °C = (°F- 32) x 5/9

Plastics Identification Chart

- PLASTICS MATERIALS
  - Press a soldering iron or a hot rod (500°F) against the sample
    - Softens: Thermoplastics
      - Drop a small sample in water
        - Floats: PP, PE
        - Sinks: All others
          - Burn a small corner of the sample
            - No flames: PTFE, CTFE, PVF, FEP
              - Drips
                - Yes: FEP, CTFE
                - No: PTFE, PVF
            - Continues to burn: ABS Acrylics, Acetals, Cellulose acetate, Cellulose acetate, Butyrate, Cellulose propionate, Cellulose nitrate, Polystyrene, Polyurethane, Polyester
              - Drips
                - Yes: ABS, Acetal, Cellulose acetate, Cellulose acetate butyrate, Cellulose propionate, Polystyrene, Polyester
                - No: Cellulose nitrate, Poly-urethane
            - Self-extinguishing: Nylon, Polycarbonate, PPO, Polysulfone, PVC
              - Drips
                - Yes: Nylon, Polysulfone, Polycarbonate
                - No: PPO, PVC
    - Thermosets
      - Burn a small corner of the sample
        - Self-extinguishing: Dap, Melamine formaldehyde, Phenol formaldehyde, Urea formaldehyde
        - Continues to burn: Polyester, Silicone, Epoxy

Thermosets – Self-extinguishing

Observations \ Material	Dap	Melamine formaldehyde	Phenol formaldehyde	Urea formaldehyde
Color of flame	Yellow	Yellow with blue tip	Yellow	Yellow with greenish blue edge
Odor	Faint odor of phenol	Fish like	Phenol	Formaldehyde
Other characteristics	Black smoke	Swells and cracks	May or may not be self-exiting	Swells and cracks

Thermosets – Continues to burn

Observations \ Material	Polyester	Silicone	Epoxy
Color of flame	Yellow with blue edges	Bright yellow	Yellow
Odor	Sour cinnamon	None	Pungent amine
Other characteristics	Black smoke with soot	Continues to burn	Black smoke

Thermoplastics

Observations \ Material	PE	PP
Color of flame	Blue with yellow tip	Blue with yellow tip
Odor	Paraffin	Acrid or diesel fumes
Speed of burning slow < 3 inches fast > 3 per min.	Fast	Slow
Other characteristics	Melts & drips	....

Observations \ Material	FEP	CTFE	PTFE	PVF
Color of flame	....	....	....	....
Odor	Burnt hair	Acetic acid	Burnt hair	Acidic
Speed of burning slow < 3 inches fast > 3 per min.	....	....	....	....
Other characteristics	....	....	....	....

Observations \ Material	ABS	Acetal	Cellulose acetate	Cellulose acetate butyrate	Cellulose propionate	Polystyrene	Polyester	Cellulose nitrate	Poly-urethane
Color of flame	Blue with yellow edges	Blue	Yellow with sparks	Yellow with blue tip	Yellow	Yellow	Yellow with blue edges	Pale yellow	Yellow
Odor	Acrid	Formal-dehyde	Vinegar	Rancid butter	Burnt sugar	Illuminating gas or marigold	Burning rubber	Camphor	Faint apple
Speed of burning slow < 3 inches fast > 3 per min.	Slow	Slow	Slow	Slow	Fast	Fast	Fast	Fast	Fast
Other characteristics	Black smoke with soot	No Smoke	Black smoke with soot	Some smoke with soot	Some black smoke	Dense smoke with soot	Black smoke with soot	Sample burns completely	Slight black smoke

Observations \ Material	Nylon	Polysul-fone	Polycar-bonate	PPO	PVC
Color of flame	Blue with yellow tip	Orange	Orange or Yellow	Yellowish orange	Yellow with green edges
Odor	Burnt wool or hair	Odor of sulphur	Phenol	Phenol	Hydro-chloric acid
Speed of burning slow < 3 inches fast > 3 per min.	Slow	Fast	Slow	Slow	Slow
Other characteristics	Froths	Black smoke with soot	Black smoke with soot	Difficult to ignite smoke	White smoke

TECHNICAL DATA

Specifications

Title	Specification #
Rubber, Sheet, Solid	A-A-1719
Plastic Sheet (Household Wrap)	A-A-1742
Plastic Sheet and Strip (for use in contact with food)	A-A-1742A
Plastic Sheet (Meat Wrapping)	A-A-1766
Plastic Sheet, Acrylic, Modified	A-A-1827
Plastic Sheet, Pressure Sensitive Adhesive Coated, Paper-backed	A-A-2681
Plastic Sheet, Polyethylene, Terephthalate (for cartographic operations)	A-A-56021
Rubber, Ethylene Propylene, Hydrazine Base Fluid Resistant	AMS329A-79
Rubber, Silicone, General Purpose	AMS 3303G-75
Rubber, Silicone Extreme Low Temperature Resistant	AMS 3332B-76
Rubber, Silicone, Lubricating Impression Set Resistant, Electrical grade	AMS 3356C-78
Rubber, Synthetic Ethylene Propylene Terpolymer, General Purpose	AMS 3260-73
Rubber Compound, Room Temperature Vulcanizing, 15,000 Centiposes Viscosity Durometer	AMS 3362A-65
Rubber Compound, Silicone Room Temperature Vulcanizing, 50,000 Cntiposes Viscosity Durometer	AMS 3363B-74
Rubber Compound, Room Temperature Vulcanizing, 50,000 Centiposes Viscosity, Short Pot Life Durometer	AMS 3364A-65
Rubber Compound, Silicone room Temperature Vulcanizing, 35,000 Centiposes Viscosity Durometer	AMS 3365B-65
Rubber Compound, Silicone Room Temperature Vulcanizing, 55,000 Centiposes Viscosity Durometer	AMS 3366B-65
Rubber compound, Silicone Rom Temperature Vulcanizing, 1,200,000 Centiposes Viscosity Durometer	AMS 3367A-65
Fibre Sheet - Vulcanized	AMS 3564B
Polyurethane Foam, Flexible - Open Cell Medium Flexibility, 2.5 lb. per cu. ft.	AMS 3570A
Plastic Castings - Methyl Methacrylate, General Purpose	AMS 3580
Plastic Castings - Methyl Methacrylate, Heat Resistant	AMS 3581
Plastic Sheet, Copper Faced - Paper Reinforced Phenol-Formaldehyde	AMS 3590A
Plastic Sheet, Copper Faced - Glass Fabric Reinforced Polytetrafluoroethylene	AMS 3598A
Plastic Sheet, Copper Faced - Glass Fabric Reinforced Epoxy Resin	AMS 3601B
Plastic Sheet - Post Forming, Cotton Fabric Reinforced Phenol-Formaldehyde	AMS 3605D
Plastic Sheet and Plate - Cotton Fabric Reinforced Phenol-Formaldehyde	AMS 3607C
Plastic Sheet - Methyl Methacrylate, General Purpose	AMS 3608
Plastic Sheet - Methyl Methacrylate, Heat Resistant	AMS 3609
Sheet - Water Vapor Resistant, Flexible, Transparent	AMS 3610C
Plastic Sheet - Polycarbonate	AMS 3611A
Polyester Film Electrical Grade, General Purpose	AMS 3612
Plastic Tubing - Cotton Fabric Reinforced Phenol-Formaldehyde	AMS 3615B
Plastic Moldings & Extrusions - Polyamide (Nylon)	AMS 3617
Plastic Moldings & Extrusions - Polystyrene	AMS 3620B
Plastic Moldings & Extrusions - Cellulose Acetate, General Purpose	AMS 3622A
Elastomeric Tubing - Electric Insulation, Irradiated Polychloroprene, Flexible, Heat Shrinkable, 1.750 to 1 Shrink Ratio	AMS 3623
Plastic Moldings & Extrusions - Cellulose Acetate Butyrate	AMS 3624A
Elastomeric Tubing - Electrical Insulation, Crosslinked Silicone, Pigmented, Flexible, Heat Shrinkable, 1.750 to 1	AMS 3625
Plastic Moldings & Extrusions - Methyl Methacrylate	AMS 3626C
Plastic Moldings & Extrusions - Methyl Methacrylate, Heat Resistant	AMS 3627
Plastic Extrusions and Moldings, Polycarbonate, General Purpose	AMS 3628B-79
Tubing - Extruded - Polyvinyl Chloride, High Temperature, Electrical Insulation	AMS 3629
Plastic Extrusions - Flexible - Polyvinyl Chloride	AMS 3630C
Plastic Extrusions - Flexible, High Temperature, Polyvinyl Chloride	AMS 3631
Plastic Tubing - Electrical Insulation, Irradiated Polyvinylidene Fluoride, Heat Shrinkable, Semi-Rigid, 2 to 1 Shrink Ratio	AMS 3632B
Plastic Tubing - Electrical Insulation, Irradiated Polyolefin Heat Shrinkable	AMS 3633
Plastic Tubing - Electrical Insulation, Polyolefin, Dual Wall, Semi-Rigid,Heat Shrinkable	AMS 3634
Polychlorotrifluoroethylene Sheet, Molded, Unplasticized	AMS 3635B-78
Plastic Tubing - Electrical Insulation, Irradiated Polyolefin, Heat Shrinkable, Pigmented, Flexible, 2 to 1 Shrink Ratio	AMS 3636B
Plastic Tubing - Electrical Insulation, Irradiated Polyolefin, Clear, Flexible, Heat Shrinkable, 2 to 1 Shrink Ratio	AMS 3637B
Plastic Tubing, Electrical Insulation, Irradiated Polyolefin, Semi-Rigid, Pigmented, Heat Shrinkable, 2 to 1 Shrink Ratio	AMS 3638F
Plastic Tubing, Electrical Insulation, Irradiated Polyolefin, Clear, Semi-Rigid, Heat Shrinkable, 2 to 1 Ratio	AMS 3639F

Title	Specification #
Plastic Moldings - Melamine - Formaldehyde, Mineral Filled	AMS 3640E
Plastic Moldings, Thermosetting - Phenol-Formaldehyde Macerated, Fabric Filled	AMS 3641D
Plastic Moldings, Laminated, Thermosetting Resin, Glass Fabric Reinforced, Heat Resistant, 500°F	AMS 3642D
Plastic Moldings, Thermosetting, Glass Roving Filled Silicone, Heat Resistant	AMS 3643B
Polytrifluorochloroethylene, Compression Molded - Heavy Sections, Unplasticized (Kel-F)	AMS 3645B
Polyfluoroethylenepropylene Film 7 Sheet	AMS 3646A-77
Polychlorotrifluoroethylene Tubing, Unplasticized	AMS 3647A-77
Polycholotrifluoroethylene Film, Unplasticized	AMS 3648A-77
Polytetrafluoroethylene	AMS 3649B-77
Polychlorotrifluoroethylene, Rods, Sheets, and Molded Shapes	AMS 3650C
Film, Polytetrafluoroethylene Non-critical Grade	AMS 3651C-66
Tubing, Electrical Insulation, Standard Walll, Extruded Polytetrafluoroethylene	AMS 3652A-66
Tubing, Electrical Insulation, Thin Wall, Extruded Polytetrafluoroethylene	AMS 3653C-63
Polytetrafluoroethylene Extrusions, Normal Strength, As Sintered, Radiographically Inspected	AMS 3654A-65
Extruded Polytetrafluoroethylene - Tubing, Electrical Insulation, Thin Wall (Teflon®)	AMS 3655 B
Film, Polytetrafluoroethylene, General Purpose Grade	AMS 3656C-78
Polytetrafluoroethylene Extrusions, Radiographically Inspected, Premium Strength, As Sintered	AMS 3657C
Polytetrafluoroethylene Extrusions, Radiographically Inspected, Premium Strength, Stress Relieved	AMS 3658C
Polytetrafluoroethylene Extrusions, Premium Strength, Stress Relieved	AMS 3659C
Polytetrafluoroethylene Moldings, As Sintered, General Purpose Grade	AMS 3660B
Polytetrafluoroethylene Film, General Purpose Grade	AMS 3661C
Sheet, Polytetrafluoroethylene, Glass Fabric Reinforced	AMS 3662A-76
Fabric, Glass - Vinyl Coated, Porous	AMS 3663
Fabric Glass - Vinyl Coated	AMS 3664B
Plastic Sheet & Strip, Modified Vinyl, Foamed, Closed Cell	AMS 3666B-78
Polytetrafluoroethylene Sheet - Molded, As Sintered, General Purpose Grade	AMS 3667C
Polytetrafluoroethylene - Moldings, Premium Grade, As Sintered	AMS 3668B
Polyamide-imide Bar, Rod, and Shapes, Molded or Extruded	AMS 3670
Insulation, Sound & Thermal - Resin Bonded Glass Fiber, Medium Filament	AMS 3676C
Fabric, Polybenzimidazole (PBI) Polyamide Fiberglass, Polytetrafluoro-ethylene (PTFE) Impregnated,	AMS 3677
Sintered	AMS 3680C
Insulation, Thermal - Silica Fiber	AMS 3681B
Adhesive, Electrically Conductive - Silver - Organic Resin	AMS 3682D
Coating, Electrically Conductive - Silver - Organic Resin	AMS 3685A
Adhesive - Synthetic Rubber - Buna “N” Type	AMS 3690B
Adhesive Compound - Epoxy, Room Temperature Curing	AMS 3691B
Adhesive Compound - Epoxy, Medium Temperature Application	AMS 3692B
Adhesive Compound - Epoxy, High Temperature Application	AMS 3693C
Adhesive Modified - Epoxy, Mod. Heat Resistant, 250°F Curing, Film Type	
Sandwich Structures - Glass Fabric Resin, Low Pressure Molded, Heat	AMS 3710C
Resistant	AMS 3720A
Paper Honeycomb - 60 lb. Paper	AMS 3722A
Paper Honeycomb - 125 lb. Paper	AMS 3730
Potting Compound - Foamed Epoxy Type, Amine Hardened	AMS 3731B
Potting Compound, Epoxy, Bisphenol A-Type	AMS 3731/1B
Potting Compound, Epoxy, Bisphenol A-Type, Unfilled, Room Temperature	
Potting Compound, Epoxy, Bisphenol A-Type, Filled, Heat Cure, Low CTE, Thermal Shock Resistant	AMS 3731/2C
Potting Compound, Epoxy, Bisphenol A-Type, Filled, Heat Cure, Machinable	AMS 3731/3B
Potting Compound, Epoxy, Bisphenol A-Type, Filled, Room Temperature Cure, Low Exo Therm	AMS 3731/5B
Potting Compound, Epoxy, Bisphenol A-Type, Filled, Room Temperature	AMS 3731/7B
Cure, Low Shrinkage	AMS 3731/9B
Potting Compound, Epoxy, Flexible, Thermal Shock Resistant, Heat Cure	
Potting Compound, Epoxy, Bisphenol A-Type, Unfilled, Room	AMS 3731/10B
Temperature Cure, Semi-Flexible	AMS 3734A
Superceded by AMS 3731 and 3731/10	AMS 3735B
Superceded by AMS 3731 and 3731/2	AMS 3736A
Superceded by AMS 3731 and 3731/7	AMS 3737A
Sueprseded by AMS 3731 and 3731/1	AMS 3738B
Superceded by AMS 3731 and 3731/5	AMS 3740B
Superceded by AMS 3731 and 3731/3	AMS 3750A

Title	Specification #
Copper Wire - Polytetrafluoroethylene Covered, Miniature	AMS 3780
Copper Wire - Magnet, Single Film Insulated, High Temperature	AMS 3781
Cloth - Airplane - Cotton, Mercerized, 50 Lb. Breaking Strength	AMS 3802E
Cloth - Airplane - Cotton, Mercerized, 65 Lb. Breaking Strength	AMS 3804D
Cloth - Airplane - Cotton, Mercerized, 80 Lb. Breaking Strength	AMS 3806E
Tape - Adhesive - Cloth Back	AMS 3810A
Braid Flat, Nylon - Electrical Tying, Synthetic Rubber Coated	AMS 3815D
Braid Flat, Nylon - Electrical Tying Wax Coated	AMS 3816C
Braid Flat, Nylon - Electrical Tying Resin Coated	AMS 3817C
Fabric, Glass (181) - Chrome Treated	AMS 3825
Glass Roving, Epoxy Resin, Preimpregnated, Type 'E" Glass	AMS 3828B
Cloth-Silica, "B" Stage Phenolic Resin Impregnated High Pressure Molding	AMS 3830
Fabric, Glass (181) - Decorative Grade	AMS 3835
Superceded by AMS 3677	AMS 3839E
Superceded by AMS 3677	AMS 3840D
Asbestos Fiber Reinforced-Polytetrafluoroethylene Sheet, TFE Fluorocarbon Resin	AMS 3842
Polytetrafluorooethylene Sheet, Asbestos Fiber Reinforced, High Compressibility, Low Density	AMS 3843C
Fire Resistant Properties for Aircraft Materials	AMS 3851A
Flame Resistant Properties for Aircraft Materials	AMS 3852A
Flame Resistant Treatment for Interior Fabrics	AMS 3855A
Asbestos Felting - "B" Stage Phenolic Resin Impregnated, Low Pressure Molding	AMS 3858D
Ceramic - Moldings & Extrusions, Dense Ultra-High Alumina (99% A1203)	AMS 3870D
Crystalized Glass Ceramic	AMS 3880C
Plastic And Electrical Insulating Materials, Impact Resistance Of	ANSI/ASTM D 256-78E
Plastics, Tensile Properteis Of, By Use Of Microtensil Specimens	ANSI/ASTM D 638-80
Plastic, Rigid, Compressive Properties Of	ANSI/ASTM D 695-80
Plastics, Coefficient Of Linear Thermal Expansion Of	ANSI/ASTM D 696-79
*Plastic Sheeting, Thin, Tensile Properties Of - 31 Aug 79	ANSI/ASTM B 882-79
Plastics, Sampling Of	ANSI/ASTM D1898-68R9E
*Plastic, Unidirectional Reinforced, Inplane Sheer Stress Strain Response Of	ANSI/ASTM D 3518-76
Plastics, Transparent Organic, Index Of Refraction Of	ASTM D 542-50R70
Plastic, Water Absorption Of	ASTM D 543-67RBE
Plastics, Resistance Of, to Chemical Reagents	ASTM D 543-87R78
Plastic To Chemical Reagents, Resistance Of	ASTM D 570-81
*Plastics, Flexible, Flammability	ASTM D 588-74
Plastics Under Load, Deformation Of	ASTM D 621-64
Plastics, Rate Of Burning and/or Extent & Time Of Burning Of Self-supporting Plastics In a Horizontal Position	ASTM D 635-81
Plastic Sheet, Flat Transparent, ce Irregularities of	ASTM D 637-50R70
*Plastics, Deflection Temperature Of, Under Flexural Load	ASTM D 646-72
Plastic, Deflection Temperature Of, Under Flexural Load	ASTM D 648-82
Plastics, Flexural Fatique Of, By Constant Amplitude Of Force	ASTM D 671-71R8E
Plastics, Mar Resistance Of	ASTM D 673-70
Plastic, Rigid, Compressive Properties Of	ASTM D 695-80
Plastics, Shear Strength Of	ASTM D 732-78
Plastics & Elastomers, Brittleness Temperature Of, by Impact	ASTM D 746-79
*Plastics, Rigid, In a Horizontalion, Incandescence Resistance Of	ASTM D 757-77
Plastics & Electrical, Insulatinrials, Rockwell Hardness Of	ASTM D 785-85R70
Plastics & Electrical Insulating Materials, Flexural Properties Of Unreinforced & Reinforced	ASTM D 790-81
Plastics, Specific Gravity & Density Of, By Displacement	ASTM D 792-66R75
*Plastics Containing Chlorine, Short Time Stability At Elevated Temperatures Of	ASTM D 793-49R76
Plastic, Standard Definitions Of Terms Relating To	ASTM D 883-80C
Plastic, Bearing Strength Of	ASTM D 953-80
Plastics, Transparent, Haze & Luminous Transmittance Of	ASTM D 1003-6-61R70
*Plastics, Sheet, Warpage Of	ASTM D 1181-56R71
Plastics, Loss Of Plasticizer From, (Activated Carbon Methods)	ASTM D 1203-87R74
Plastic Materials, Resistance To Abrasion Of	ASTM D1242-56R75
*Plastic Sheeting Flexible Thin, Rate of Burning and/or Extent & Time Of Burning, Supported on a 45º Incline- 1 Jul 77	ASTM D 1433-77
Plastics, Polychlorotrifluoroethylene (PCTFE)	ASTM D 1430-81
Plastic, Outdoor Weathering Of	ASTM D 1435-75R9E
Rubber, Property Elongation At Specific Stress	ASTM D1456-81
Plastics, Operating Light & Water Exposure Apparatus (Carbon Arc Type) For Exposure Of	ASTM D 1499-84R77
*Plastic, Corrugated Reinforced, Tranverse Load Of, Panels	ASTM D 1502-60
Plastics, Density Of, By the Density-gradient Technique	ASTM D 1505-88
Plastics, Viacat Softening Temperature Of	ASTM D 1525-76

Title	Specification #
Plastic, Rigid Cellular, Apparent Density Of	ASTM D 1622-63R75
Plastic, Ethylene, Environmental Stress Cracking Of	ASTM D 1693-70R75
Plastic Sheeting, Transparency Of	ASTM D 1746-70R78
*Plastics, Rigid Acrylonitrile Butadiene Styrene (ABS)	ASTM D 1788-81
Plastics, Rigid Cellular, Compressive Properties Of	ASTM D 1821-73
Plastics, Ignition Properties Of	ASTM D 1929-77
Plastics, Rigid Cellular, Response Of, To Thermal & Humid Aging	ASTM D 2126-75
Plastics, Ring Or Tubular, Apparent Tensile Strength Of, By Split Disc Method	ASTM D 2290-76
*Plastics, Reinforced, Apparent Horizontal Sheer Strength Of, By Short Beam Method	ASTM D 2344-76
Plastic Pipe Fittings, Schedule 80, Threaded Poly(Vinyl Chloride) (PVC)	ASTM D 2464-76
Plastics, Indentation Hardness Of, By Means Of A Barcol Impressor	ASTM D 2583-75
Plastics, Indentation Hardness Of, By Means Of a Barcol Impressor	ASTM D 2583-81
Rubber, Hard, Tension Testing Of	ASTM D2707-72
*Plastics, Structural Reinforced, Interlaminar Shear Strength Of, At Elevated Temperatures	ASTM D 2733-70R76
Plastics, Measuring The Density Of Smoke From The Burning Or Decomposition Of	. ASTM D 2843-77
Plastics, Measuring the Minimum Oxygen Concentration To Support Candle Like Combustion Of, (Oxygen Index)	ASTM D 2863-77
Plastics, Tensile Properties Of	ASTM D 2990-77
Plastics, Rigid Cellular, Flame Height, Time Of Burning, & Loss Of Weight Of, in a Vertical Position	ASTM D 3014-76
Rubber, Hydrolytic Stability Of	ASTM D3137-75
Plastic, Packaging/Packing	ASTM D 3692-80
* Plastic Panels, Polyester, Glass Fiber Reinforced - 12 Feb 80	ASTM D 3841-80
Plastic Materials, identification Of	ASTM D 4000-82
Plastic, Methods Of Testing	FED-STD-406A
Rubber, Sampling And Testing	FED-STD-601 NOTICE 7
Plastic Filling Instruments and Contouring Instruments, Dental	GG-P-001278A
Plastic Molding and Extrusion Material, Cellulose Acetate Butyrate	L-P-249C
Polyethylene Pipe	L-P-315
Pipe and fittings, plastic (PVC, drain, waste and vent)	L-P-320
Pipe and fittings, plastic (acrylonitrile-butadiene-styrene (ABS) drain, waste and vent)	L-P-322
Plastic Molding and Extrusion Material, Cellulose Acetate Butyrate	L-P-349C
Plastic Molding Material (Propylene Plastics, Injection & Extrusion)	L-P-349B
Plastic Film, Sheet and Strip (Polyvinyl Chloride, Copolymer Of Vinylidene Chloride and Vinyl Chloride, Or Polyethylene)	L-P-370C
Plastic Film, Flexible, Vinyl Chloride	L-P-375C
Polyethylene Terephthalate Plastic Film	L-P-377A
Plastic Sheet and Strip, Polyester	L-P-377B
Polyethylene Plastic Film Thin Gauge	L-P-378A
Plastic Sheet and Strip, Thin Gauge, Polyolefin	L-P-378D
Plastic Molding Material, Methacrylate	L-P-380C
Plastic Material, Polyester Resin, Glass Fiber Base, Low Pressure Laminated	L-P-383
Plastic Molding & Extrusion Material, Polychlorotrifluoroethylene	L-P-385C
Plastic Material, Cellular, Urethane (Flexible)	L-P-386C
Plastic Sheet Laminated Thermosetting (For Designation Plate)	L-P-387 INT AMD 2
Plastic Sheet Laminated Thermosetting (For Design Plates)	L-P-387A INT AMD 2 (SH)
Plastic Molding Material, FEP Fluroro-carbon, Molding & Extrusion	L-P-389A
Plastic, Molding and Extrusion Material, Polyethylene and Copolymers (Low, Medium, and High Density)	L-P-390C
Plastic Sheets, Rods and Tubing, Rigid Cast, Methacrylate (Multiapplication)	L-P-391D
Plastic Molding Material, Acetal, Injection and Extrusion	L-P-392A
Plastic Molding Material, Polycarbonate, Injection and Extrusion	L-P-393A
Polypropylene Material for Injection Moldings and Extrusion	L-P-394A
Plastic Molding (and Extrusion) Material, Nylon, Glass Fiber Reinforced	L-P-395C
Plastic Molding and Extrusion Material, Polystyrene	L-P-396B
Plastic Molding Material, Cellulose Acetate	L-P-397C
Plastic Molding Material, Styrene-butadiene	L-P-398B
Plastic Molding & Extrusion Material, Styrene Acrylonitrile Copolymers	L-P-399B
Urea-Formaldehyde Molding Material	L-P-401
Plastic Molding Material, Polytetrafluorethylene (Tfefluorocarbon)	L-P-403C
Plastic, Polyamide (Nylon), Rigid, Rods, Tubes, Flats, Molded and Cast Parts	L-P-410A
Cancelled (Superceded by L-P-1041)	L-P-501
Cancelled (Superceded by L-P-1036)	L-P-503

TECHNICAL DATA

Specifications

Title	Specification #
Plastic Sheet and Film, Cellulose Acetate	L-P-504D
Shatter-Resistant, Rigid, Reinforced, Translucent Corrugated Sheet, Polyester, Acrylic or Combination	L-P-505B
Cancelled (Superceded by ASTM D1463)	L-P-506A
Acrylic Sheet, Extruded	L-P-507
Plastic Sheet, Laminated, Decorative and Nondecorative	L-P-508H
Plastic Sheet, Rod and Tube, Laminated, Thermosetting	L-P-509A
Cancelled (Superceded by L-P-535)	L-P-510A
Plastic Sheet, Laminated, Thermosetting Cotton Fabric Base, Phenolic Resin	L-P-511 (1)
Plastic Sheet (Sheeting), Polyethylene	L-P-512C
Thermoset Phenolic Sheet, Paper Reinforced	L-P-513A
Cancelled (Superceded by L-P-528B)	L-P-514A
Plastic sheet, polystyrene, modified	L-P-515
Plastic Sheet & Plastic Rod, Thermosetting, Cast	L-P-516A
Plastic Sheet, Scribe-coated	L-P-517C (1)
Plastic Sheet, Tracing, Glazed and Matte Finish	L-P-519C
Cancelled (Superceded by ASTM D3368)	L-P-523D
Polyethylene, Laminated, Nylon Reinforced Sheet	L-P-524
Plastic Strip, Dental Matrix	L-P-525A
Plastic sheet, Styrene-Acrylonitrile	L-P-526
Plastic Sheet, Styrene-Butadiene	L-P-527B
Cancelled (Superceded by A-A-2681)	L-P-528B
Plastic Sheet (Sheeting), Plastic Strip, Vinyl Chloride Polymer and Vinyl Chloride Vinyl Acetate Copolymer, Rigid	L-P-535E
Cancelled (Superceded by L-P-1036)	L-P-540
Plastic Sheet & Insulation Sheet, Electrical (Laminated, Thermosetting, Paper Base, Phenolic Resin)	L-P-543C
Cancelled (Superceded by L-P-315)	L-P-545
Cancelled (Superceded by L-P-390)	L-P-590
Plastic Molding Material, Vinyl Chloride Polymer and Vinyl Chloride-vinyl Acetate Copolymer, Rigid	L-P-1035A
Plastic Rod Solid, Plastic Tubes and Tubing, Heavy Walled, Polyvinyl Chloride, Rigid	L-P-1036A
Plastic Sheets And Strips (Polyvinyl Fluoride)	L-P-1040B
Plastic Molding and Extrusion Material, Vinylidene Chloride Vinyl Chloride Copolymer	L-P-1041A
Cancelled (Superceded by MIL-M-14)	L-P-1125
Chlorotrifluoroethylene Copolymer Extruded	L-P-1174
Cancelled (Superceded by ASTM D1788)	L-P-1183B
Plastic Polyamide (Nylon) Rigid, Rod, Tube, Flat and Molded Parts	L-P-00410
Plastic Strip, Dental Matrix	L-P-00525B
Plastic For Aerospace Vehicles Part 1 Reinforced Plastics	MIL-HDBK 17A-1 NOTICE 1 # 11 #
Plastic For Flight Vehicles Part 2 Transparent Glazing Materials	MIL-HDBK 17A-2
Plastic, Processing Of	MIL-HDBK 139
Plastic Coating Compound, Strippable, Hot and Cold Dip	MIL-HDBK 696
Plastics	MIL-HDBK 700A
Adhesive, Acrylic Monomer Base, For Acrylic Plastic	MIL-A-8576A
Adhesive, Plastic Sheet	MIL-A-24084
Adhesive Acrylic Monomer & Polymer Base, for Acrylic Plastics	MIL-A-25055
Board, Composition, Water-Resistant, Solid	MIL-B-3106
Container, Ammunition, Fiber Spirally Wound	MIL-C-2439B
(ASG) - Cloth, Polyethylene, Leno	MIL-C-4222B
Cellulose Acetate Butyrate	MIL-C-5537A
Cord, Nylon, Cordless	MIL-C-7515B
Cloth, Coated Asbestos	MIL-C-7637B
Core Material, Plastic Honeycomb Laminated Glass Fabric Base (for aircraft structural applications)	MIL-C-8073A
Coating Compound, Metal Pre-treatment, Resin Acid	MIL-C-8514C
Cloth, Glass, Finished, for Polyester Resin Laminates	MIL-C-9084B
Cellulose Nitrate Plastic (celluloid or pyroxylin type) for use in ammunition	MIL-C-15567
Cover, Plastic, Shipboard Lighting Fixture Protective	MIL-C-17954
Cloth, Polyethylene, Aluminum Foil & Nylon Leno (radar reflective)	MIL-C-18097
Curtain, Shower, Vinyl Film	MIL-C-18336C
Cleaning & Polishing Compound Transparent Plastic Aircraft Materials	MIL-C-18767B
Capacitors Fixed Plastic (or paper plastic) Dielectric (hermetically sealed in metallic, ceramic or glass cases)	MIL-C-19978B
Clamp, Loop, Plastic, Wire Support	MIL-C-21565A
Epoxy-Polyamide Chemical & Solvent Resistant for Weapon Systems	MIL-C-22750A
Coating System, Epoxy-Polyamide Chemical & Solvent Resistant	MIL-C-22751B
Cushioning Material, Packaging, Synthetic Fibers	MIL-C-26296
Cloth, Laminated, Vinyl-Nylon, High Strength, Flexible	MIL-C-43006B
Cloth, Coated and Laminated, Chloroprene on Nylon	MIL-C-53028
Fiber Sheet, Vulcanized	MIL-F-10336C
Film, Flexible Vinyl	MIL-F-10400A

Title	Specification #
Fiber, Rod (Sheet) for Small Arms Buffer Disks	MIL-F-13526
Faucets, Polyethylene	MIL-F-14547
Fiberboard, Solid, Non-Corrosive, Fungi Resistant for Interior Blocking	MIL-F-26862B
Glass Laminated, Flat (Except Aircraft)	MIL-G-3787E
Glass Fiber Base Laminate Epoxy Resin	MIL-G-21792A
Havelock, Plastic	MIL-H-19793B
Hose Assembly, Tetrafluoroethylene, High Temperature, Power Plant Aircraft	MIL-H-25597B
Hose, Tetrafluoroethylene, High Temperature, Medium Pressure	MIL-H-27267
Hose Assembly, Tetrafluoroethylene, Pneumatic, High Pressure	MIL-H-38390A
Insulation, Electrical, Synthetic, Resin Composition, Non-Rigid	MIL-I-631D
Fiberglass Thermal Insulation Board	MIL-I-742F
Insulation, Electrical, Plastic-Sealer	MIL-I-3064
Insulation Tape, Electrical, Glass-Fiber (resin-filled) and Cord, Fibrous-Glass	MIL-I-3158D
Insulation Sleeving, Flexible, Treated	MIL-I-3190F
Insulation Tape, Electrical, Self-fusing	MIL-I-3825B
Insulation Sleeving, Flexible, Electrical	MIL-I-7444D
Cancelled (Superceded by MIL-I-24391)	MIL-I-7798A
Insulation Sheet, Cellular, Plastic, Thermal	MIL-I-14551
Insulation Tape, Electrical, Pressure Sensitive	MIL-I-15126F
Inhibitor, Cellulose Acetate, Extruded	MIL-I-17276A
Cancelled (Superceded by MIL-I-3190)	MIL-I-18057A
Cancelled (Superceded by MIL-I-22444)	MIL-I-18622A
Insulation Tape, Glass Fabric, TFE Coated	MIL-I-18746B
Plastic Sheet, Teflon TFE and Glass Cloth, Laminated	MIL-I-19161A
Insulation Tape, Electrical, Pressure Sensitive, High Temperature Glass	MIL-I-19166C
Insulation Sheets, Electrical, Pasted Mica, Silicone Bonded	MIL-I-19526
Insulation Sleeving, Electrical, Flexible Vinyl, Treated Glass Fiber	MIL-I-21557B
Insulation Sleeving, Electrical, Flexible, Low Temperature	MIL-I-22076B
Insulation Sleeving, Electrical, Non-Rigid Teflon TFE Resin	MIL-I-22129C
Insulation Tape, Electrical, Self-Bonding, Silicone Rubber Treated Bias Weave or Sinusoidal Weave Glass, Cable Splicing, Naval Shipboard	MIL-I-22444C
Insulation Sleeving, Electrical, Flexible, Heat Shrinkable	MIL-I-23053D
Insulation Tape, Electrical, High Temperature, Teflon, Pressure Sensitive	MIL-I-23594C
Insulation Electrical, High Temperature, Bonded, Synthetic Fiber Paper	MIL-I-24204A
Insulation Tape, Electrical, Plastic Pressure-Sensitive	MIL-I-24391C
Insulation, Plastics, Laminated, Thermosetting: General Specification For	MIL-I-24768
Insulation, Plastic, Laminated, Thermosetting, Glass Cloth, Melamine-Resin (GME)	MIL-I-24768/1
Insulation, Plastic, Laminated, Thermosetting, Glass Cloth, Epoxy-Resin (GEE)	MIL-I-24768/2
Insulation, Plastic, Laminated, Thermosetting, Glass Cloth, Epoxy-Resin (GEB)	MIL-I-24768/3
Insulation, Plastic, Laminated, Thermosetting, Glass Cloth, Melamine-Resin (GMG)	MIL-I-24768/8
Insulation, Plastic, Laminated, Thermosetting, Nylon Fabric Base, Phenolic Resin (NPG)	MIL-I-24768/9
Insulation, Plastic, Laminated, Thermosetting, Paper Base, Phenolic Resin (PBE)	MIL-I-24768/10
Insulation, Plastic, Laminated, Thermosetting, Paper Base, Phenolic Resin (PBG)	MIL-I-24768/11
Insulation, Plastic, Laminated, Thermosetting, Paper Base, Phenolic Resin (PBM)	MIL-I-24768/12
Insulation, Plastic, Laminated, Thermosetting, Cotton Fabric Base, Phenolic Resin (FBE)	MIL-I-24768/13
Insulation, Plastic, Laminated, Thermosetting, Cotton Fabric Base, Phenolic Resin (FBG)	MIL-I-24768/14
Insulation, Plastic, Laminated, Thermosetting, Cotton Fabric Base, Phenolic Resin (FBI)	MIL-I-24768/15
Insulation, Plastic, Laminated, Thermosetting, Cotton Fabric Base, Phenolic Resin (FBM)	MIL-I-24768/16
Insulation, Plastic, Laminated, Thermosetting, Glass Cloth, Silicone Resin (GSG)	MIL-I-24768/17
Luminescent Material & Equipment (Non-Radioactive)	MIL-L-3891A
Light Panel, Plastic Plate Lighting	MIL-L-7806A
Lacquer, Acrylic-Nitrocellulose Gloss (for aircraft use)	MIL-L-19537C
Molding Plastics and Molded Parts, Thermosetting	MIL-M-14G
Adhesive, Epoxy	MIL-M-14042B
Molding Plastic, Polytetrafluorethylene, TFE-Fluorocarbon Resin	MIL-M-14077A
Mats, Fibrous Glass, for Reinforcing Plastic	MIL-M-15617A
Cancelled (Superceded by L-P-410A)	MIL-M-19098
Cancelled (Superceded by ASTM D4066)	MIL-M-20693B
Polychlorotrefluorethylene Resin for Molding	MIL-M-21470
Molding Plastic & Molded Plastic Parts, Asbestos-Fiber Filled Arc & Flame-Resistant Phenolic Resin	MIL-M-21556

Specifications

Title	Specification #
Cancelled (Superceded by L-P-1183)	MIL-M-22544
Cancelled (Superceded by ASTM D4066)	MIL-N-18324D
Nylon Plastic, Flexible Molded or Extruded	MIL-N-18352
Cancelled (Superceded by L-P-516)	MIL-P-77
Cancelled (Superceded by L-P-387)	MIL-P-78A
Cancelled (Superceded by MIL-I-24768/8, 10, 11, 13, 14, and 16)	MIL-P-79C
Acrylic Sheet, Anti-Electrostatic Coated	MIL-P-80
Plastic Coating Compound, Strippable Hot Dripping	MIL-P-149C
Cancelled (Superceded by MIL-I-24768/17)	MIL-P-997D
Laminated Plastic Sheet, Copper-Clad	MIL-P-1394C
Cancelled (Superceded to L-P-590)	MIL-P-3054A
Non-Rigid Polyamide (Nylon) Resin	MIL-P-3086
Cancelled (Superceded to L-P-513A)	MIL-P-3115C
Plastic Material, Molding, Rigid Thermoplastic, Aniline, Formaldehyde for use in Electronic Communications	MIL-P-3408
Plastic Material, Molding, Rigid Thermoplastic, Polydichlorostyrene, For Use in Electronic, Communications, & Allied Electrical Equipment	MIL-P-3409
Plastic Material, Molding, Rigid Thermoplastic, Polyvinylchloried and Copolymers Thereof; for use in Electronic Communications and Allied Equipment	MIL-P-3410
Plastic Sheet, Polyvinylchloride, Plasticized Elastomeric	MIL-P-3584A
Resin, Phenol-Formaldehyde, Laminating	MIL-P-3745
Cancelled (Superceded by MIL-P-21922, L-P-390, L-P-512A, L-P-378A)	MIL-P-3803
Plastic Molding Material, Asphalt, Asbestos Filled	MIL-P-4309B
Plastic Sheet (Sheeting) Pressure Sensitive, Adhesive Coated, Cellulose Acetate, Transparent	MIL-P-4614B
Plastic Film, Polyethylene, For Balloon Use	MIL-P-4640A
Plastic, Sheet, Acrylic, Heat Resistant	MIL-P-5425D
Plastic, Phenolic, Graphited, Sheets, Rods, Tubes, and Shapes	MIL-P-5431A
Plastic Sheet, Vinyl Copolymer, Thin	MIL-P-6265A
Plastic Sheet and Film, Vinyl Copolymers	MIL-P-6264B
Plastic, Working and Installation Of Transparent sheet, General Specification For	MIL-P-6997B NOTICE 2
Plastic Parts, Aircraft Exterior, General Requirements and Tests for Rain-Erosion Protection Of	MIL-P-7094A NOTICE 1 # 11 #
Plastic Materials, Polyester Resin, Glass Fiber Base, Low Pressure Laminated	MIL-P-8013C
Plastic, Self-sealing and Non-self-sealing Tank Backing Material	MIL-P-8045B
Thermoset Phenolic Resin Sheets and Tubes, Asbestos Paper and Cloth Reinforced (see L-P-509A)	MIL-P-8059A
Plastic Sheet, Acrylic, Modified	MIL-P-8184B
Plastic Sheet, Acrylic, Modified	MIL-P-8184C
Polyester Base, Cast Transparent Sheet, Thermosetting	MIL-P-8257
Cancelled (Superceded by L-P-511)	MIL-P-8587A
Plastic, Sheet, Colored, Instrument Flying Training	MIL-P-8655A
Plastic Laminate and Sandwich Construction Parts, Aircraft Structural, Process Specification Requirements	MIL-P-9400B
Cancelled (Superceded by MIL-P-26514)	MIL-P-9969
Plastic, Cellulose Acetate Molding Material & Molded Parts	MIL-P-10408A
Plastic, Phenolic, Fabricated Parts	MIL-P-10420A
Protractor, Rectangular (Plastic, 1 3/4 inches by 6 inches)	MIL-P-11720B
Plastic Material, Cellular, Elastomeric	MIL-P-12420C
Plastic Sheet, Filled Phenolic, Uncured	MIL-P-13436A
Polystyrene Sheet, Rod, Tube	MIL-P-13491
Padding Materials, Resilient (for packaging of ammunition)	MIL-P-13607
Plastic Sheet, Base Material PX, Paper Base, Epoxy Resin, Flame Retardant, Copper Clad	MIL-P-13949/1
Plastic Sheet, Base Material GE, Glass Base, Epoxy Resin, General Purpose, Copper-CLAD	MIL-P-13949/3A
Plastic Sheet, Base Material GT, Glass Base Polytetrafluoroethylene Resin, Copper-CLAD	MIL-P-13949/8B
Plastic Sheet, Laminated, Materials (For Printed Wiring Boards), GF Base Material, Glass Cloth, Resin Preimpregnated (B-Stage)	MIL-P-13949/12
Plastic Sheet, Laminated, Materials (For Printed Wiring Boards), GI Base Material, Glass Coth, Resin Preimpregnated (B-Stage)	MIL-P-13949/13
Plastic Sheet, Laminated, Materials (For Printed Wiring Boards), GE Base Material, Glass Cloth, Resin Preimpregnated (B stage)	MIL-P-13949/11
Plastic Sheet, Laminated, Metal Clad (For Printed Wiring Boards), Base Material GP, Glass Base, Polytetrafloroethylene Resin, Flame Retardant, Copper Clad	MIL-P-13949/6C
Plastic Sheet, Laminated, Metal Clad (For Printed Wiring Boards), Base Material GT, Glass Base, Polyimide Resin, Heat Resistant, Copper Clad	MIL-P-13949/10A
Plastic Sheet, Laminated, Metal Clad (For Printed Wiring Boards), Base Material GH, Glass Base, Epoxy Resin, Heat Resistant & Flame Retardant, Copper Clad (0.031 in. & Over)	MIL-P-13949/5A
Plastic Sheet, Laminated, Metal Clad (For Printed Wiring Boards), Base Material GY, Glass Base, Polytetrafluorethylene Resin, Flame Retardant, For Microwave Application, Copper Clad	MIL-P-13949/14
Plastic Sheet, Laminated, Metal Clad (For Printed Wiring), General Specification For	MIL-P-13949F (1) SUPP 1
Plastic Sheet, Laminated, Metal-CLAD (For Printed Wiring Boards), Base Material GB, Glass Base, Epoxy Resin, Heat Resistant, Copper Clad (0.031 in. and Over)	MIL-P-13949/2A
Plastic Sheet, Laminated, Metal-Clad (For Printed Wiring Boards), Base Material GR, Glass Base, Polytetrafluoroethylene Resin, Flame Retardant, For Microwave Applications, Copper-Clad	MIL-P-13949/7C
Plastic Sheet, Laminated, Metal-Clad (for Printed Wiring Boards), Base Material GX, Glass Base, Polytetrafluoroethylene Resin, Flame Retardant, For Microwave Application, Copper-Clad	MIL-P-13949/9B
Plastic Sheet, Laminated, Metal-clad (For Printed Wiring boards), Base Material, GF, Glass Base, Epoxy Resin, Flame Retardant, Copper-Clad	MIL-P-13949/4B
Plastic Sheet, Base Material GT, Blass Base, Polytetrafluoroethylene Resin, Flame Retardant, Copper Clad	MIL-P-13949-88
Plastic Sheet, Base Material PX, Paper Base, Epoxy Resin, Flame Retardant, Copper Clad	MIL-P-13949/1
Plastic Sheet, Laminated, ;Materials (For Printed jWiring boards), GF Base Matrial, Glass Cloth, Resin Preimpregnated (B-Stage)	MIL-P-13949/12
Plastic Sheet, Laminated, metal Clad (For Printed Wiring Boards Base Material GH, Glass Base, Epoxy Resin, heat Resistant & Flame Retardant, Copper Clad (0.031 in & Over)	MIL-P-13949/5A
Plastic Sheet, Laminated, Metal Clad (For Printed Wiring Boards), Base Material GP, Glass Base, Polytetrafluoroethylene Resin, Flame Retardant, Copper Clad	MIL-P-13949/6C
Plastic Sheet, Laminated, metal Clad (For Printed Wiring boards), Base Material Gy, Glass Base, Polytetrafluorethylene Resin, Flame Retardant, For Microwave Application, Copper Clad	MIL-P-13949/14
Plastic Sheet, Laminated, metal CLad (For Printed Wiring) General Specifications For	MIL-P-13949F (2) SUPP1
Plastic Sheet, Laminated, Metal-Clad (for Printed Wiring Boards), Base Material GB, Glass, Base, Epoxy Resin, Heat Resistant, Copper Clad	MIL-P-13949/2A
Plastic Sheet, Laminated, metal-Clad (For Printed Wiring boards), Base Material GR, Glass Base, Polytetrafluorethylene resin, Flame Retardant, For Microwave Application, Copper-clad	MIL-P-13949/7C
Plastic Sheet, Laminated, Metal-Clad (For Printed Wiring Boards), Base Material GF, Glass Base, Epoxy Resin, Flame Retardant, Copper-Clad	MIL-P-13949/4B
Plastic Sheet, Laminated, metal-Clad (For Printed jWiring boards), Base Material GX, GlassBase, Polytetrafluorethylene Resin. Flame Retardant, For Mocrowave Application, Copper-Clad	MIL-P-13949/9B
Plastic, Cellulose-Acetate, Sheets and Film	MIL-P-14118
Plastic Film, Nonrigid, Transparent	MIL-P-14591D
Plastic Sheet and Strip (Polyolefin) (For Use in Ammunition)	MIL-P-14790
Cancelled (Superceded by MIL-I-24768/13, 14, 15, and 16)	MIL-P-15035C
Cancelled (Superceded by MIL-I-24768/1)	MIL-P-15037E
Cancelled (Superceded by MIL-I-24768/9)	MIL-P-15047C
Plastic Material, Unicellular (Sheets and Tubes)	MIL-P-15280H
Plastic Mix, Refractory, Fire Clay, Super Duty	MIL-P-15731D
Cancelled (Superceded by L-P-380)	MIL-P-16413
Cancelled (Superceded by L-P-349)	MIL-P-16414
Cancelled (Superceded by L-P-397)	MIL-P-16416
Plastic, Thermosetting, Pulp-Filled Preforms	MIL-P-16617B
Cancelled (Superceded by L-P-410)	MIL-P-17091
Plastic, Laminate, Decorative, High Pressure	MIL-P-17171D
Cellulose Acetate Sheet	MIL-P-17276
Plastic Laminates, Fibrous Glass Reinforced, Marine Structural	MIL-P-17549D
Insulation Sleeving, Flexible Silicone Rubber Coated Glass	MIL-P-18057A
Plastic Sheet, Vinyl, Flexible, Transparent, Optical Quality	MIL-P-18080A
Cancelled (Superceded by MIL-I-24768/2, 3)	MIL-P-18177C (1)
Plastic Material, Laminated Phenolic, For Bearings (Water or Grease Lubrication)	MIL-P-18324D
Plastic Sheet, Laminated, Glass Cloth Polytetrafluoroethylene Resin	MIL-P-19161A
Plastic Sheets, Polyethylene, Virgin and Borated, Neutron Shielding	MIL-P-19336C
Cancelled (Superceded by ASTM D1710)	MIL-P-19468A
Plastic Molding Material (Polystyrene Foam, Expanded Bead)	MIL-P-19644C
Plastic Material, Molding, Acrylic, Colored and White, Heat Resistant, For Lighting Fixtures	MIL-P-19735B

Specifications

Title	Specification #
Cancelled (Superceded by MIL-M-14)	MIL-P-19833B
Plastic Sheet, Acrylo-nitrite Butadiene Styrene Copolymer, Rigid	MIL-P-19904A
Plastic, Plastisol (For Coating Metallic Objects)	MIL-P-20689C
Cancelled (Superceded by L-P-391)	MIL-P-21105C
Plastic Sheet, Cellulose Acetate, Optical Quality	MIL-P-21094B
Cancelled (Superceded by ASTM D4549)	MIL-P-21347D
Cancelled (Superceded by L-P-385)	MIL-P-21470
Plastic Rods and Tubes, Polyethylene	MIL-P-21922B
Plastic Material, Cellular Polyurethane, Foam-in-place, Rigid 2 and 4 lbs. Per Cubic Foot	MIL-P-21929B
Cancelled (Superceded by L-P-512)	MIL-P-22035
Insulation Sleeving, Electrical, Flexible, Low Temperature	MIL-P-22076A
Cancelled (Superceded by ASTM D4066)	MIL-P-22096B
Plastic Sheet and Film, Teflon (TFE)	MIL-P-22241B
Cancelled (Superceded by MIL-P-22241)	MIL-P-22242
Plastic Film, Polyester, Polyethylene Coated (For I.D. Cards)	MIL-P-22270
Plastic Tubes and Tubing, Polytetrafluorethylene, (Tfefluorocarbon Resin), Heavy Walled	MIL-P-22296B
Cancelled (Superceded by MIL-I-24204)	MIL-P-22324A
Plastic Sheet, Vibration Damping (Type MI-d2)	MIL-P-22581B (1)
Cancelled (Superceded by L-P-390C)	MIL-P-22748A
Plastic Coating Compound, Strippable - Electroplating	MIL-P-23242B
Plastic Sheets, Virgin & Borated Polyethylene	MIL-P-23536A
Plastic Tiles, Vibration Damping	MIL-P-23653C
Plastic Sheet, Cast, Acrylic, Shipboard Application (Illumination and Signal Lighting)	MIL-P-24191C
Plastic Material, Cellular Polyurethane, Rigid, Void Filler, Pour-in-Place, Large Scale and Installation Of	MIL-P-24249
Plastic Material, Unicellular, Sheet, Elastomeric	MIL-P-24333
Plastic Sheet, Laminated, Thermosetting Electrical-Insulating Sheet, Polyester Glass-mat Grade Gpo N-1 (Classes 130, 155, 180)	MIL-P-24364/1 (2)
Plastic Sheet, Laminated, Thermosetting, Electrical Insulating Sheet, Polyester Glass-mat Grade Gpo-n3	MIL-P-24364/3 (1)
Plastic Sheet, Laminated, Thermosetting, Electrical Insulating Sheet, Glass Mat	MIL-P-24364 (1)
Plastic Sheet, Acrylic, Modified, Laminated	MIL-P-25374A
Plastic Material, Heat Resistant, Low Pressure Laminated Glass Fiber Base, Polyester Resin	MIL-P-25395A
Plastic Material, Glass Fiber Base-epoxy Resin, Low Pressure Laminated	MIL-P-25421B
Plastic Material, Phenolic Resin, Glass-fiber Base, Laminated	MIL-P-25515C
Plastic Materials, Silicone Resin, Glass Fiber Base, Low Pressure Laminated	MIL-P-25518B
Plastic, Sheets and Parts, Modified Acrylic Base, Monolithic, Crack Propagation Resistant	MIL-P-25690A
Plastic Materials, Asbestos Base, Phenolic Resin, Low or High Pressure Laminates	MIL-P-25770A
Polyurethane Foam, Rigid or Flexible, for Packaging	MIL-P-26514F
Plastic Tubes and Tubing, Polyethylene	MIL-P-26692
Plastic Sheet, FEP Fluorocarbon Unfilled, Copper-Clad	MIL-P-27538
Tape, Anti-Seizing, Teflon (TFE)	MIL-P-27730A
Plastic Strip, Denture Trial Pack	MIL-P-36464
Plastic Strip, Dental Surface Protection, Mouthguard	MIL-P-36895
Plastic Material, Pressure Sensitive Adhesive, For Aerospace Identification and Marking	MIL-P-38477A
Plastic Material, Cellular, Polystyrene (For Bouyancy Applications)	MIL-P-40619A
Thermoset Phenolic Resin Rod, Nylon Reinforced	MIL-P-43037
Plastic Molding Material, Polyester, Low Pressure Laminating, High Temperature Resistant	MIL-P-43038B
Plastic Molding Material, Pre-mix, Polyester, Glass Fiber Reinforced	MIL-P-43043C
Plastic Potting and Impregnating Material, Polybutene	MIL-P-43045B
Plastic Molding Material (Plotting and Impregnating), Polyethylene, Low Molecular Weight	MIL-P-43081B
Plastic Tubing (Flexible, Polyurethane Film)	MIL-P-43604A
Plastic Coating Compound, Strippable, Cold Dipping, 120ºF	MIL-P-45021B
Plastic Sheet, Rods, Tubes and Discs, Polychlorotrifluorethylene	MIL-P-46036B
Cancelled (Superceded by MIL-P-25515C)	MIL-P-46040A
Plastic Sheet, Flexible Vinyl	MIL-P-46041
Cancelled (Superceded by L-P-410)	MIL-P-46060
Plastic Embedding Compound, Epoxy Resin System	MIL-P-46067B
Plastic Filler Compound, Epoxy, For Honeycomb Panels	MIL-P-46094
Plastic Molding Material, Polyropylene, Glass Fiber Reinforced	MIL-P-46109C
Plastic Foam, Polyurethane (For Use in Aircraft)	MIL-P-46111C
Plastic Sheet & Strip, Polyimide	MIL-P-46112B
Plastic Molding and Extrusion Material, Polyphenylene Oxide	MIL-P-46115B
Plastic Molding and Extrusion Material, Polysulfone	MIL-P-46120A
Plastic Sheet and Coating Material, Para-xylylene Polymers	MIL-P-46121B
Plastic Molding Material and Plastic Extrusion Material, Polyvinylidene Fluoride Polymer and Copolymer	MIL-P-46122B
Plastic Molding and Extrusion Material, Ionmer Resins	MIL-P-46124B
Plastic Molding and Extrusion Material, Polyphenylene Oxide Modified	MIL-P-46129A
Plastic Molding and Extrusion Material, Polyphenylene Oxide, Modified, Glass Fiber Reinforced	MIL-P-46131B
Plastic Molding and Extrusion Material, Poly(aryl Sulfone Ether) Resin Thermoplastic	MIL-P-46133A
Plastic Molding and Extrusion Material, Acetal, Glass Fiber Reinforced	MIL-P-46137A
Plastic Sheet, Polycarbonate	MIL-P-46144B
Plastic Molding Material, Polyterephthalate Thermoplastic, Glass Fiber Reinforced	MIL-P-46161A
Plastic Laminates, Glass Reinforced (For Use in Armor Composites)	MIL-P-46166
Plastic, Sheet Molding Compound, Polyester, Glass Fiber Reinforced (For General Purpose Applications)	MIL-P-46169A
Plastic Molding and Extrusion Material, Polyamide Imide	MIL-P-46179
Plastic Molding Material, Polyamide (Nylon), Glass Fiber Reinforced	MIL-P-46180
Plastic Molding Material, Polyamide (Supertough Nylon)	MIL-P-46181
Plastic Molding & Extrusion material, Polyetherimide (PE)	MIL-P-46184
Plastic Material, Foamed Polyurethane For Encapsulating Electronic Components	MIL-P-46847A
Plastic Molding Material, Epoxy, Glass Fiber	MIL-P-46892A
Plastic, Sheet, Polyolefin, Spunbonded	MIL-P-47075
Plastic Laminates, Glass Fabric Base Epoxy Resin, Structural Shapes	MIL-P-47135
Plastic Bonded HMX (95/5) Powder (For Use in Ammunition)	MIL-P-50854
Plastic Sheet, Polypropylene Polyethylene Laminate Film	MIL-P-51402
Plastic Sheet, Vinyl, Flexible	MIL-P-51403
Plastic Sheets, Vinyl Chloride Polymer and Copolymer Flexible	MIL-P-51406
Plastic Sheet, Polyethylene Butene 1 Copolymer	MIL-P-51431
Plastic Molding and Extrusion Material, Polyethylene Butene 1 Copolymer, High Density	MIL-P-51431
Plastic Tube, Polyethylene Butene 1 Copolymer	MIL-P-51433
Thermoset Phenolic Resin Tube, Nylon Reinforced	MIL-P-52189
Cancelled (Superceded by A-A-56021)	MIL-P-55010A
Plastic Sheet and Laminates, Flexible, for Environmental Protective Storage and Shipping Systems	MIL-P-58102
Plastic Molding and Extrusion Material, Ethyl Cellulose, For Rocket Grain Inhibiting Materials	MIL-P-63462
Plastic Molding Material, Asbestos Phenlolic	MIL-P-81255A
Plastic, Molding Material, Polycarbonate, Glass Fiber Reinforced	MIL-P-81390
Plastic Sheets, Flexible, Weather Resistant, Heat Sealable, For Outdoor Storage Use	MIL-P-81598A
Plastic Material, Polyester Resin, Glass Fiber Base, Filament Wound Tube	MIL-P-82540
Plastic Film, Conductive, Heat Sealable, Flexible	MIL-P-82646
Plastic Molding Material, Glass Phenolic	MIL-P-82860
Plastic Sheet, Polycarbonate, Transparent	MIL-P-83310
Plastic Board (For Packaging Applications)	MIL-P-83668
Plastic Material, Cellular Polyurethane, Foam-in-place, Rigid (3 lbs. Per Cubic Foot Density)	MIL-P-83379A
Rubber, Fabricated Parts	MIL-R-3065D
Rope, Polyethylene	MIL-R-4874
Resin, Polyester, Low Pressure, Laminating	MIL-R-7575B
Resin, Polyester, Low Pressure, Laminating	MIL-R-7575C
Retainer, Packing, Hydraulic and Pneumatic, Tetrafluoroethylene Resin	MIL-R-8791
Resin Phenolic, Low Pressure Laminating	MIL-R-9299A
Resin Epoxy, Low Pressure, Laminating	MIL-R-9300A
Rubber, Shaft Covering Materials (For Marine Propeller Shafts)	MIL-R-15058G (2)
Rubber, Fluorosilicone Elastomer, Oil And Fuel Resistant, O Rings, Class 1, Grade 60	MIL-R-25988/3 (1)
Rubber, Fluorosilicone Elastomer, Oil And Fuel Resistant, O Rings, Class 1, Grade 80	MIL-R-25988/4 (1)
Rubber, Fluorosilicone Elastomer, Oil and Fuel Resistant, O Rings, Class 3	MIL-R-25988/2 (1)
Rubber, Fluorosilicone Elastomer, Oil And Fuel Resistant, Sheets, Strips, Molded Parts, And Extruded Shapes	MIL-R-25988A (3)
Rubber, Fluorosilicone Elastomer, Oil and Fuel Resistant, O Rings, Class 1, Grade 70	MIL-R-25988/1A
Rubber, Hard (Ebonite), Natural Or Synthetic, Sheet, Strip, Rod, Tubing, and Molder Parts	MIL-R-45036D
Rubber, Sponge, Silicone, Closed Cell	MIL-R-46089B
Rubber, Silicone, Room Temperature Curing	MIL-R-47211 (1)
Rubber, Fluorocarbon Elastomer, High Temperature, Fluid, And Compression Set Resistant	MIL-R-83248 (2)

Specifications

Title	Specification #
Rubber, Fluorocarbon Elastomer, High Temperature, Fluid, And Compresison Set Resistant, O Rings, Class 1, 75 Hardness	MIL-R-83248/1A
Rubber, Fluorocarbon Elastomer, High Temperature, Fluid, And Compression Set Resistant, O Rings, Class 2, 90 Hardness	MIL-R-83248/2
Rubber, Silicone, High Strength, Cabin Pressure Seal Material, Diaphragm Type	MIL-R-83283
Rubber, Ethylene-propylene, General Purpose	MIL-R-83285
Rubber, Polyurethane, Castable, Humidity Resistant	MIL-R-83397A
Rubber, Ethylene-proplyene, Hydrazine Resistant	MIL-R-83412A
Rubber, Ethylene-propylene, Hydrazine Resistant, O Rings Sizes and Tolerances	MIL-R-83412/1
Rubber, Fluorocarbon Elastomer, Improved Performance At Low Temperature	MIL-R-83485 (1)
Rubber, Fluorocarbon Elastomer, Improved Performance At Low Temperatures, O Rings, Sizes And Tolerances	MIL-R-83485/1
Sandwich Construction, Plastic Resin, Glass Fabric Base, Laminated Facings & Honeycomb Core for Aircraft Structural Applications	MIL-S-9041A
Tape, Asbestos	MIL-T-4117A
Tape, Textile and Webbing, Textile, Reinforcing, Nylon	Mil-T-5038
Cancelled (Superceded by MIL-T-23594)	MIL-T-22742
Film Tape, Pressure Sensitive	MIL-T-23142B
Tape, Pressure Sensitive, Filament Reinforced, Plastic Film	MIL-T-43036B
Webbing, Textile, Nylon, Tubular	MIL-W-5625E
Wire, Electrical Polyetrafluoroethylene Insulated, Copper, 600 Volt	MIL-W-7139
Window, Observation, Acrylic Base, Anti-Electrostatic, Transparent (for indicating instrument)	MIL-W-80C
Fiberglass Yarn, Cord Sleeving, Tape & Cloth	MIL-Y-1140H
Plastic Coating Compound, Strippable (Hot Dipping)	QPL-149-12
Plastic-material, Laminated, Thermosetting, Electrical Insulation, Sheets, Glass Cloth, Silicone Resin	QPL-997-71
Plastic Material, Cellular Polyurethane, Rigid, Void Filler, Foam-in-place, Large Scale And Installation Of	QLP-2429 NOTICE 1
Plastic Film, Polyethylene, For Balloon Use	QPL-4640-4
Plastic Sheet, Acrylic, Heat Resistant	QPL-5425-14
Plastic, Acrylic Sheet, Modified	QPL-8184-12
Plastic Sheet, Laminated, Metal Clad (For Printed Wiring), General Specification For	QPL-13949-9
Plastic Sheet, Laminated, Thermosetting, Glass-cloth, Melamine-resin	QPL-P-15037-61
Plastic Material, Unicellular (Sheets and Tubes)	QPL-15280-9
Plastic Mix, Refractory (Superduty, Fire-clay)	QPL-15731-40
Plastic Sheet, Laminated, Thermosetting, Glass Fiber Base, Epoxy-resin	QPL-18177-89
Plastic Material, Laminated-phenolic, For Bearings (Water Or Grease Lubrication)	QPL-18324-30
Plastic Sheet, Laminated, Glass Cloth Polytetrafluoroethylene Resin	QPL-19161-20
Plastic Rods, Polytetrafluorethylene, Molded and Extruded	QPL-19468-36
Plastic, Plastisol Molding, Extruding, Coating and Dipping Compound	QPL-20689 NOTICE 1
Plastic Sheet, Laminated, Thermosetting, Paper-base, Epoxy-resin	QPL-22324-24
Plastic Tiles, Vibration Damping	QPL-23653-16
Plastic Sheet, Laminated, Thermosetting, Electrical Insulating Sheet, Glass Mat	QPL-24364 NOTICE 1
Plastic Sheet, Acrylic, Modified, Laminated	QPL-25374-4
Plastic, Sheets and Parts, Modified Acrylic Base, Monolithic, Crack Propagation Resistant	QPL-25690-1
Plastic Sheet, Flexible, Weather Resistant For Outdoor Storage Use	QPL-81598-3
Plastic Film, Conductive, Heat Sealable, Flexible	QPL-82646-1
Plastic Material For Use In Housings Of Motor Vehicle Lighting Devices	SAE J29-72
Rubber, Silicone	Z-Z-R-765B (1)

Comparative Pricing

Relative Cost of Thermoplastic Materials

COST RATIO (Based on Nylon Natural with a cost factor of 1.)	PRODUCT
1	NYLON - Natural
1.1	NYLON - Moly-filled
2.4	NYLON - Glass-filled
5.1	NYLON / KEVLAR® Fiber
2.3	NYLON 6 / 12
1.2	ACETAL
4.4	DELRIN® AF - Teflon®-filled
3.1	DELRIN® 500 CL - Lubricated
2.8	DELRIN® 570 - Glass-filled
1.7	POLYCARBONATE - Machine Grade
5.8	POLYCARBONATE - Glass-filled
1.8	POLYPHENYLENE OXIDE (PPO) - NORYL®
3.3	POLYSULFONE
4.6	POLYETHERIMIDE (PEI) - ULTEM®
3.2	THERMOPLASTIC ELASTOMER (TPE)
23.1	POLYETHERETHERKETONE (PEEK)
1.5	ABS- Natural
1.5	POLYBUTYLENE TEREPHTHALATE (PBT) - Thermoplastic Polyester
2.5	POLYURETHANE - Machine Grade
2.8	POLYURETHANE - Unfilled Opaque
8.6	POLYVINYLIDENE FLUORIDE (PVDF) - KYNAR®

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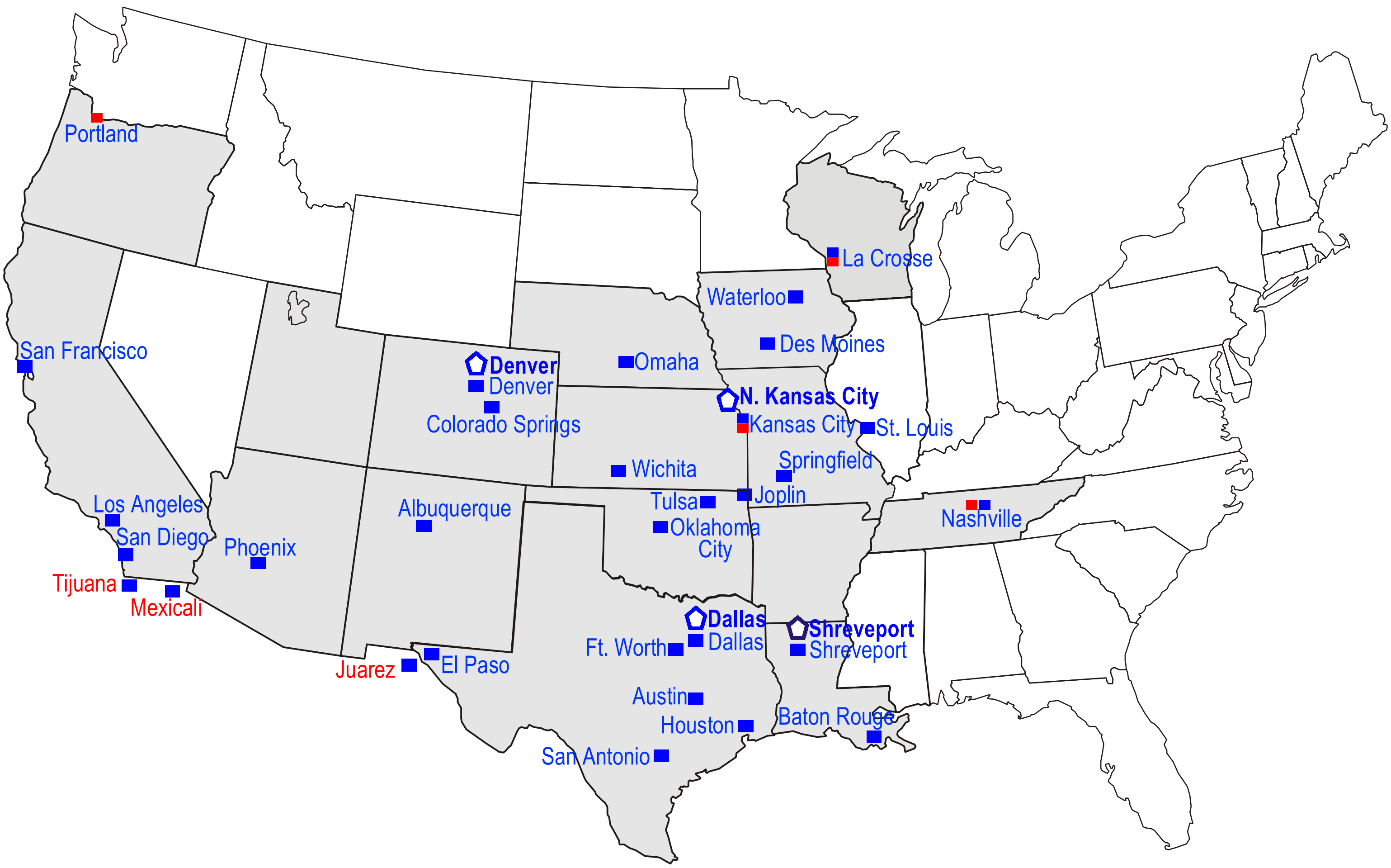

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