General Characteristics of Polymers

polymer	Date developed (marketed)	Solubility	Flame test (copper wire)	Characteristics	Uses	Brand names
acetal resin	1959	Soluble in dimethylformamide, benzyl alcohol. Insoluble in methanol, diethyl ether, aliphatic hydrocarbons	blue mantle with yellow flame and formaldehyde smell; no soot	very high tensile strength and stiffness; high chemical and abrasion resistance	mechanical parts (gears, bushings), automotive parts, communication equipment, videocassettes, cosmetic containers, latches, pipes, and plumbing parts.	Delrin [DuPont]; Celcon [Celanese];
acrylonitrile butadiene styrene	1948	Resistant to water, salts and oils. May be degraded by oxidizing acids and many organic solvents (aromatics, ketones, and alcohols).	slow burning with smoke	inexpensive, strong, resilient and difficult to break	used for appliances, automobile parts and fittings, telephones, radios, televisions, pipes and conduits, luggage, boats, toys, and bottles.	Abson; Cycolac
casein	1897	Insoluble in water and acids, but contact with water, acids, and alkalis may cause crazing.	flame=yellow with gray smoke and burnt milk odor	becomes hard and insoluble when treated with formaldehyde	buttons, beads, buckles, combs, fountain pens, umbrella handles, cutlery handles, and knitting needles; often pigmented to simulate ivory, horn, or tortoise shell.	Lactoid (England in 1904); Aladdinite (U.S. in 1919); Galalith (Deut.); Galalite (It.); Erinoid (Br.); Syrolit (Ire.); Karolith; Kyloid; Ameroid; Dorcasine; Casolith
cellulose acetate	1910s	soluble in furfuryl alcohol, acetonitrile	flame = dark yellow, mauve blue with sparks and vinegar odor	plasticizers may migrate to surface leaving an oily film; degrades in sunlihgt, heat and high humidity	lacquers, photographic film, transparent sheeting and as fibers.	Celanese [British Celanese]; Kodacel [Eastman Kodak]
cellulose acetate butyrate	1938 (1932)	soluble in acetone, methylene chloride	flame=dark yellow, with vinegar and vomit odor		photographic film, varnishes and moldings	Tenite; Urex; Hercose C; Ester EAB-171
cellulose nitrate	1832 (1838)	soluble in ketones and esters. Insoluble in water, ethanol and hydrocarbons	flame=intense white	birefringent; burns with a bright, violent flame; smells of nitrogen oxides	clear lacquer, fabric dope, adhesives, high-gloss paints	Parkesine; Celluloid; Xyloidine; Durofix [Rawlplug]; Duco cement [DuPont]; UHU Hart [Linger & Fischer, Germany]; Zapon-lack [Dulux]; HMG [H.Marcel Guest]
chlorinated rubber	1918	soluble in toluene, ethylene dichloride. Insoluble in aliphatic and alcohols. Resistant to acids and alkalis.	flame=green	servicable temperature range = -35 to 100	used primarily in the 1930s -60s for paints, varnishes, adhesives, inks and paper coatings; still used for waterproof paints on floors and swimming pools	Duroprene [ICI]; Parlon; Hypalon
cyanoacrylate resin	1941 (1958)	cured glue is slightly soluble in DMF or nitromethane. Soaking in acetone may decrease adhesion		ultraviolet light and contact with alkaline materials (glass and some stones) will accelerate the degradation process.	for gluing glass, ceramics and other hard materials. They also have medical and dental applications to suture skin and weld crowns	Super Glue Gel [Loctite]; Krazy glue [Borden]; Super Attack [Loctite]; Zap; Eastman 910 [Eastman Chemical]; ELFY
epoxy resin	1939		flame=yellow; smells of phenol; self-extinguishing	high strength, good abrasion and chemical resistance, low water absorption, good dimensional stability	adhesive, fills, printed circuit boards, molded products and baked enamel surface coatings	Ablebond 342-1 [Ablestix]; Rutapox [Bakelite], Aradlite AY103/HY951 [Ciba Geigy]; Hxtal Nyl-1 [Conservation Materials]; Phillyseal (formerly Pliacre); Epon; CM Bond, Epotek; UHU
ethyl cellulose		soluble in esters, alcohols, aromatic hydrocarbons, chlorinated hydrocarbons. Insoluble in water and glycerol		forms a tough, flexible, transparent film that is very wear resistant	food containers; hot-melt adhesives, inks, and as protective coatings for paper and textiles	Ethulose [Hercules]; Ethocel [Dow]; Ethylcellulose [Aqualon]

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polymer	Date developed (marketed)	Solubility	Flame test (copper wire)	Characteristics	Uses	Brand names
fluorocarbon			non-flammable	Servicable temperature range = -20 to 200; very good heat and chemical resistant	examples of fluorocarbon polymers are polytetrafluoroethylene (Teflon®), polyvinylidene fluoride, and fluorinated ethylene propylene	Teflon
hydroxyethyl cellulose	1930s	soluble in water, ethylene glycol. Insoluble in ethyl ether		discolors and becomes insoluble with thermal aging	used as an emulsifier, stabilizer, thickener and film former in many types of solutions such as foods, cosmetics, paints and glazes. It is also used as a sizing agent and consolidant	Natrosol [Aqualon]; Cellosize [Union Carbide]; Tylose H [Hoechst]
hydroxypropyl cellulose		soluble in cold water, ethanol, acetone and many organic solvents. Insoluble in hot water		good photochemical stability, it has poor thermal stability and discolors with age	emulsifier, stabilizer, thickener, and film former in foods, cosmetics, paint removers, paints and glazes; also used as a sizing agent for paper and consolidant for leather.	Klucel [Hercules]
melamine formaldehyde	1933	decomposed by acids	self-extinguishing; fishy odor	cure to a hard, durable glossy film that isresistant to chemicals and heat	decorative homeware, circuit breakers, paints and enamels	Arigal C; Melmac; Formica [Formica]; amino resin Basofil [BASF]
methyl cellulose	1930s	Soluble in cold water, ethylene glycol. Insoluble in hot water, ethyl ether		good stability with negligible discoloration or weight loss	used in sizing pape, as an adhesive in textile and paper conservation, as a poulticing material	Methocel [Dow]; Polycell; Tylose® MB [Hoechst]; Glutolin; Sicho-Zell; Cellothyl; Syncelose; Celevac; Cellumeth; Hydrolose; Nicel; Culminal [Aqualon]; Methofas® [ICI, England]
nylon (polyamide)	1930s	resistant to alkalis, and insoluble in most organic solvents. Soluble in hot phenols, cresols and mineral acids	self-extinguishing; flame=yellow with blue mantle and odor of burnt hair	good impact, tensile and flexural strengths, elasticity, and wear resistance as well as low water absorption	fibers, paints, films, foams, and molded parts	Akulon; Caprolan: Celon; Durethan; Nylon 66; Nylon #66; fiber 66: Tynex; Rilsan®;
phenol formaldehyde resin	1907 (1909)	soluble in alkalis, decomposed by acids	low burning rate; phenolic odor	inexpensive, good chemical and heat resistance, darkens in sunlight; may corrode copper and brass as it degrades	fibers, adhesives, plywood, textile sizing, leather processing, paper strengthening, foams, chemical resistant coatings, printed circuit boards	Bakelite
polycarbonate	1956	dissolves in ketones, aromatic and chlorinated solvents. Attacked by alkalis, ammonia and amines	self-extinguishing; flame=orange yellow with sweet phenolic odor and soot	high dielectric strength, good mechanical properties; strong UV absorber	unbreakable windows, bank screens, police shields, helmet visors, and household appliances	Lexan [1959; General Electric Co.]; Makrolon [1956; Bayer]; Solvex; Merlon [Mobay Chemical]; Panlite
polycyclohexanone	1930	soluble in turpentine, mineral spirit		oxidize with age to become brittle and less soluble.	picture varnishes and for retouching	Ketone Resin N [BASF]; MS2A [Laporte]; AW-2 [BASF]; Rembrandt Varnish [Talens]
polyester	1946	soluble in ketones and chlorinated solvents	slow burning rate; flame=yellow; dense smoke, sweet smell	Inexpenxive, easy to fabricate, versatile, good chemical resistance	sheeting, films, autos and boats, pipping boxes	Fabrisil [Shelley]; PET
polyethylene glycol	1930s	soluble or miscible in water and most organic solvents		can remain tacky and attract dirt	solvents, plasticizers, consolidants	Carbowax [Union Carbide]; Polywax [Huls]

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polymer	Date developed (marketed)	Solubility	Flame test (copper wire)	Characteristics	Uses	Brand names
polyethylene vinylacetate				clear, tough, crack resistant and retain flexibility at low temperatures	paper coatings, shrink-wrap, and hot melt adhesives	Elvax [DuPont]; A-C Copolymr 400 [Allied]; Vinamul 3250 [Vinyl Products]; Mowilith DM155 [Hoechst]; Elvace 1874; Jade 834-403N [Aabbitt]
polyethylene, high density	1954	soluble in toluene. esistant to most other solvents except nitric and hydrochloric acids	slow burning rate; flame color=blue yellow; little smoke; odor =candles	inexpensive, tough, lightweight, good flexibility and chemical resistance	containers, packaging films, fibers, pipes, molded pieces, toys, bowls, and milk bottle crates	
polyethylene, low density	1933	soluble in dipropylene glycol and hot organic solvents. Resistant to nonoxidizing acids, alkalis, salt solutions.	slow burning rate; flame color=blue yellow; little smoke; odor =candles	compared to HDPE, LDPE is softer and more flexible butt also has lower tensile strength	sheeting, films, paper coatings, toys, bags and packaging materials	
polyimide		resistant to organic solvents	nonflammable		adhesives, binders, fibers; flame-retardant clothing	Vespel [DuPont]; P-84 [Inspec]
polyisoprene	1790s	soluble in aliphatic and aromatic solvents. Insoluble in acetone, diethyl ether	dark yellow sooty flame that smells of burnt rubber	servicable temperature range = -55 to 70		
polymethylacrylates (acrylic resins)	1901	soluble in mineral spirits, turpentine, aromatic hydrocarbons, chlorinated hydrocarbons, esters, and ketones	flame=blue mantle with yellow orange, smoky flame and acrid burnt fat odor	high optical clarity, excellent weatherability, food chemical resistance, Will craze when stressed.	paints, coatings, adhesives, fabrics, textile and leather finishes, windows, mounts, optical lenses, tailights, glazing, signs, glass-substitute,	Plexigum [Rohm & Haas]; Lucite [DuPont]; Paraloid [Rohm & Haas]; Elvacite [DuPont]; Plexiglas [Rohm & Haas]; Perspex; Magna [Bocour]; Liquitex [Permanent Pigments]; Shiva [Shiva]; Hyplar Acrylic Colors [Grumbacher]; Aqua-tec [Bocour]
polypropylene		soluble in some hydrocarbons, isoamyl alcohol. slightly soluble in toluene	slow burning; flame color=blue yellow; little smoke; odor =heavy	excellent stress and scratch resistance, good chemical and heat resistant, lightweight	toys, bottles, fishnets, pipe, clothing, vapor barrier films, road signs, molded parts, carpet, artificial grass, laminates, food packages, furniture, and photographic enclosures	Coroplast; Propylex; Herculon; Microfoam
polystyrene	1839 (1929)	soluble in most hydrocarbon solvents, oils, ketones, esters, inorganic acids	slow burning; flame=orange-yellow with dense smoke and flowery smell	inexpensive; good stability, stiffness, and impact strength; degrades in UV light	approved for contact with food; used in insulation, toys, appliances, cabinets, containers, and furniture	Styrofoam [Dow]; Luran; Styron; Lustrex; Fome-Cor; Algil [Polymers, Inc.]; Permene [Modglin Co.]; Shalon [Polymers, Inc.]; Polyfil [Mack Molding]; Durastran
polyurethane	1937	attacked by aromatic solvents, chlorinated solvents, ozone, and nitrogen oxides	slow burning with bright flame and sharp odor (toxic fumes)	thermosetting (rigid) or thermoplastic (elastomeric); servicable temperature range = -50 to 70; excellent hardness, gloss, and resistance to weathering, abrasion, acids, and alkalis	elastomer, sealants, adhesives, films, furniture, mattresses, laminates, carpet cushions, upholstery, soundproofing, flotation devices, packaging, and filtration	Xylamon [Desowag]; Viacryl [Vianova]; Desmodur N75 [Bayer]; Perlon U [Germany]; Lycra [DuPont]
polyvinyl acetate	1912	soluble in benzene, chloroform, methanol, acetone, butyl acetate.	flame=dark yellow with acetic odor	odorless, tasteless, nontoxic, slow burning, lightweight, colorless	latex house paints, artists' media (since 1938), and common household white glues	Vinamul [Vinyl Products]; Mowilith [Hoechst]; Vinylite [Union Carbide]; AYAT [Union Carbide]; Elmers Glue-All [Borden]; Duratite White Glue [DAP]; Gelva [Solutia]; Rivit Glue; Polymer Tempera [Borden]

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polymer	Date developed (marketed)	Solubility	Flame test (copper wire)	Characteristics	Uses	Brand names
polyvinyl alcohol	1933	soluble in water and alcohols, resistance to organic solvents		elestomeric,	adhesive, films, finishes	Lamatec [Archival Aids]
polyvinyl butyral	1920	soluble in esters, ketones, alcohols and chlorinated hydrocarbons.	flame=yellow with blue mantle and rancid butter odor	tough, flexible, weather-resistant	used as shatterproof safety-glass interlayer	Butvar [Monsanto]; Mowital [Hoechst]; Rhovinal [Rhone-Poulenc]; Vinal
polyvinylchloride	1838 (1930)	soluble in aromatics, ketones, aldehydes and chlorinated solvents	self-extinguishing; flame=green/yellow/orange with acrid chlorine smell and smoke	resistant to ignition, corrosion and stains.	gramophone records, sheeting, gaskets, tubing, raincoats, waterproof coatings	Geon [B.F.Goodrich]; Koroseal [B.F.Goodrich]; Tygon; Vinagel; Elaston; Trovidur; Bexan [BX Plastics]; Bristrand [Polymers Inc.]; Pe-Ce-U [Farbenfabriken Bayer A.G.]
polyvinylidene chloride	1940s	discolors when exposed to alkalis	self-extinguishing; flame=green/yellow/orange with acrid chlorine smell and smoke	high strength and abrasion resistance, dimensionally stable, good durability	packaging, barrier films, fibers	Saran F310 [Dow]; Cryovac; Diurit; Pe Ce 120 [Casella Farbwerke, Germany]
polyxylylene	1950s	soluble in hot orthodichlorobenzene or hot choronaphthalene. Insoluble in most other chemicals.		excellent barrier properties agains gases and moisture,weather resistance is poor, deteriorates in UV light	as a coating to provide mechanical strength and flexibility	Parylene [Union Carbide]
siloxane	1940s	soluble in chloroform, heptane, benzene, diethyl ether. Insoluble in methanol, ethanol	burning rate = none to slow	Servicable temperature range = -60 to 200; good heat reistance	electrical appliances and boards, aerospace, gaskets, molds	
sodium carboxymethyl cellulose	1947	soluble I cold and hot water; insouble in most organic solvents	dust is flammable	good stability with negligible discoloration or weight loss	used commercially in detergents, food product and as size for textiles and paper	Bianose [Hercules]; CM cellulose; Cellulose Gum CMC 7HSP [Aqualon]; Cellofas® B-3500 [ICI]; Cellosize® CMC P-75-M [Union Carbide]; Tylose® C [Hoechst]
soluble nylon	1940s	Initially soluble in methanol and ethanol.		becomes insoluble and shrinks with age	used in the mid-20th century as an adhesive, coating and sizing agent to add strength to wet paper and consolidate friable pigments	Calaton [ICI, Britain]; Maranyl Nylon DV 45 [ICI]; Ultramid [BASF]; Elvamide [DuPont]
urea formaldehyde resin	1896 (1923)	soluble in water		degraded by heat, acids, and alkalis	foams, insulation, coatings (baked enamels) and adhesives (plywood, particle board)	Chinaglaze; Pollapas; Kaurit S