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Standard Guide for Identification of Polymers (Excludes Thermoset Elastomers) in Computerized Material Property Databases¹

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1. Scope

1.1 This document is a guide for the identification of polymers in computerized material property databases. It establishes essential and desirable elements of identity data and provides a recommended format for entry of these fields into a computerized database.

1.2 Polymers include thermoplastics and thermosets. Homopolymers, copolymers, and thermoplastic elastomers are polymeric structures included in this guide, along with blends that are mixtures of structurally different polymers. [Thermoset elastomers (rubbers) are not included in the scope of this document.]

1.3 Polymers are the basis for commercial plastics or thermoplastic elastomers and their molding compounds, which may be formulated with modifiers, such as additives, fillers, and reinforcements.

NOTE 1—The classification of reinforced polymers and polymer matrix composites has an overlapping *gray area*. (See [Appendix X1](#).)

2. Referenced Documents

2.1 ASTM Standards:

- D 256 Test Methods for Impact Resistance of Plastics and Electrical Insulating Materials²
- D 638 Test Method for Tensile Properties of Plastics²
- D 648 Test Method for Deflection Temperature of Plastics under Flexural Load²
- D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials²
- D 883 Terminology Relating to Plastics²
- D 1238 Test Methods for Flow Rates of Thermoplastics by Extrusion Plastometer²
- D 1566 Terminology Relating to Rubber³
- D 1600 Terminology for Abbreviated Terms Relating to Plastics²

D 4000 Classification System for Specifying Plastic Materials⁴

D 4066 Specification for Nylon Injection and Extrusion Materials⁴

D 4101 Specification for Propylene Plastic Injection and Extrusion Materials⁴

D 4549 Specification for Polystyrene Molding and Extrusion Materials (PS)⁵

D 4634 Specification for Styrene-Maleic Anhydride Materials (S/MA)⁵

2.2 ISO Standards:⁶

ISO 472: 1988 Plastics—Vocabulary

ISO 1043-1: 1987 Plastics—Symbols

3. Terminology

3.1 *Definitions*—For definitions of general terms used in this document, see *Compilation of ASTM Standard Definitions*.⁷

3.2 Database Definitions:

3.2.1 *attribute*—a property, characteristic, or quality of an individual item.

3.2.2 *field*—a subdivision of a record in a database.

3.2.3 *key*—a value that identifies a data record and is used to locate it in computer storage.

3.2.4 *record*—a logical subdivision of a data file or database. A record contains all the data associated with one entity in a database.

3.2.5 *segment*—a logical subdivision of a record. A segment contains one or more fields associated with one aspect of a record in a database.

3.3 Polymer Terminology:

3.3.1 *copolymer*—a polymer formed from two or more types of monomers. (See Terminology D 1566 [D 1566](#).)

3.3.1.1 *alternating copolymer*—an essentially linear copolymer in which two monomers are alternately sequenced in the polymer structure.

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² *Annual Book of ASTM Standards*, Vol 08.01.

³ *Annual Book of ASTM Standards*, Vol 09.01.

⁴ *Annual Book of ASTM Standards*, Vol 08.02.

⁵ *Annual Book of ASTM Standards*, Vol 08.03.

⁶ Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

⁷ Available from ASTM Headquarters, 1916 Race St., Philadelphia, PA 19103-1187.

3.3.1.2 *block copolymer*—an essentially linear copolymer in which there are repeated sequences of polymeric segments of different chemical structure. (See Terminology D 883D 883.)

3.3.1.3 *graft copolymer*—a copolymer in which polymeric side chains have been attached to the main chain of a polymer of different structure. (See Terminology D 883D 883.)

3.3.1.4 *random copolymer*—an essentially linear copolymer in which the monomers are randomly sequenced in the polymer structure.

3.3.1.5 *terpolymer*—a polymer formed from three monomer species. (See Terminology D 1566D 1566.)

Discussion: The terms bipolymer, terpolymer, and quaterpolymer can be used as needed to more precisely denote the monomer content of copolymers.

3.3.2 *elastomer*—a macromolecular material (high molecular weight polymer) that at room temperature returns rapidly to approximately its initial dimensions and shape after substantial deformation by a weak stress and release of the stress. (See Terminology D 883D 883.)

3.3.3 *homopolymer*—a polymer resulting from polymerization involving a single monomer. (See Terminology D 883D 883.)

3.3.4 *monomer*—a low-molecular weight substance consisting of molecules capable of reacting with like or unlike molecules to form a polymer. (See Terminology D 883D 883.)

3.3.5 *plastic*—a material based on one or more organic polymers of large molecular weight, which may or may not contain modifiers (additives, fillers, and reinforcements, Table 1), which is solid in its finished state, and which, at some stage in its processing into finished articles, can be shaped by flow. (Adapted from Terminology D 883D 883.)

3.3.6 *thermoplastic*—a plastic that repeatedly can be softened by heating and hardened by cooling through a temperature range characteristic of the plastic, and that in the softened state can be shaped into articles by molding or extrusion. (See Terminology D 883D 883.)

3.3.7 *thermoset*—a plastic that, after having been cured by heat or other means, is substantially infusible and insoluble (see Terminology D 883D 883). (Also, it is a crosslinked (cured) thermosetting material).

3.3.8 *thermosetting*—pertaining to polymerizable material or plastic, shapable by flow before curing; but, after curing to a crosslinked solid by heat or other means, it becomes substantially infusible and insoluble. (Adapted from Terminology D 883D 883.)

3.3.9 *polymer*—a substance consisting of molecules characterized by the repetition (neglecting ends, branch junctions, and other minor irregularities) of one or more types of monomeric units. (IUPAC 1971) (As referenced in Terminology D 883D 883.)

3.3.10 *resin*—in a broad sense any polymer that is a basic material for plastics. (See Terminology D 883D 883.)

4. Significance and Use

4.1 This guide describes the types of fields which are essential to uniquely identify a polymer in a computerized database. Further desirable fields are also defined, and still others might be added. The purpose is to facilitate efficient storage and retrieval of information with a computer and to

TABLE 1 Common Polymer Modifiers^A

No Modifier	
Modifier	
Unknown/Proprietary	
Additive, Functional	Filler
Accelerator	Powder/Particulate
Antistatic Agent	Calcium carbonate
Antioxidant	Clay
Blowing Agent	Kaolin
Char Former	Silica
Conductivity Improver	Talc
Carbon black	Wood flour
Graphite fiber	Flake
Metal Powder	Aluminum
Colorant	Mica
Dye	Microspheres
Pigment	Glass beads
Coupling Agent	Glass, hollow
Curing Agent	Phenolic, hollow
Catalyst	Reinforcement
Hardner	Fiber
Flame Retardant	Aramid
Aluminum trihydrate	Carbon/Graphite
Antimony oxide	Cotton flock
Friction/Wear Improver	Glass
Graphite	Mineral
Molybdenum disulfide	Polyester (PET)
PTFE powder	Steel
Heat Stabilizer	Flake
Interfacial Agent	Mica
Mold Release Agent	Particulate
Nucleation Agent	Carbon black
Plasticizer	Fumed silica
UV Stabilizer	Mineral

^AModifiers can be multi-functional, a single modifier can affect several properties. Carbon black, for example, can be a colorant, a UV stabilizer, a thermal conductivity improver, an electrical conductor, and a reinforcing agent. (Specialty grades are available to optimize each function.)

allow meaningful comparison of property data from different sources. Such comparison of property data is most useful if all the essential information for polymer identification is present. Comparison may still be possible when some information is omitted, but the value of the comparison may decrease.

4.2 The content and completeness of any database depends on its specific purpose. A single organization may include substantial detail in its database, but a database used by several organizations may include less detail because of commercial and other considerations. Comparisons of property data from multiple sources will be expedited and uncertainty reduced if uniformity is followed in the polymer identification information of these databases.

4.3 Until international guidelines are firmly established, the redundancy of including competing polymer identification systems needs to be tolerated in guidelines. ASTM and ISO have similar competing polymer identification documents that will have to be harmonized to achieve optimum intercommunication. Other identification systems must also have consideration.

4.4 The guidelines and data format presented here may be equally valid for other, noncomputerized situations, where identification of polymeric material is desired.

5. Guidelines

5.1 The fields and segments listed in Table 10 are recommended for polymer identification.



Documents

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TABLE 2 Examples of Standardized Family Names and Abbreviated Terms for Polymers^A

Abbreviated Term	Polymer Family Names Terminology D 1600D 1600-91a	Polymer Family Names Classification D 4000D 4000-89
ABA	Acrylonitrile-butadiene-acrylate	Acrylonitrile-butadiene/acrylate ^B
ABS	Acrylonitrile-butadiene-styrene plastics	Acrylonitrile-butadiene/styrene ^B
EP	Epoxy, epoxide	(same)
FEP	Perfluoro(ethylene-propylene) copolymer	(same)
HDPE	High density polyethylene plastics	(none)
IPS	Impact resistant polystyrene ^{CD}	Impact polystyrene ^{CD}
LDPE	Low density polyethylene plastics	(none)
LLDPE	Linear low density polyethylene plastics	(none)
PA	Polyamide (nylon)	(same)
PAN	Polyacrylonitrile	(none)
PBT	Poly(butylene terephthalate)	(same)
PC	Polycarbonate	(same)
PC + PBT	Polycarbonate + poly(butylene terephthalate)	(none)
PDAP	Poly(diallyl phthalate)	(same)
PEBA	Polyether block amide	(same)
PEI	Polyeth(erimide) (<i>sic</i>) ^D	Polyether-imide ^D
PF	Phenol-formaldehyde resin ^D	Phenol-formaldehyde ^D
PMP	Poly(4-methylpentene-1)	(same)
POM	Poly(oxymethylene) and polyacetal	(same) and (acetal)
PP	Polypropylene ^D	Poly(propylene plastics) ^D
PPE + IPS	Polyphenylene ether + impact resistant polystyrene	(none)
PS	Polystyrene	(same)
PSU	Polysulfone	(same)
PVAC	Poly(vinyl acetate)	(same)
PVC	Poly(vinyl chloride)	(same)
SI	Silicone plastics	(same)
S/MA ^E	Styrene-maleic anhydride plastic	(same)
SMA + IPS ^E	Styrene-maleic anhydride + impact resistant polystyrene	(none)
SMS	Styrene/ α -methylstyrene plastic ^{DF}	tyrene/ α -methylstyrene ^{DF}
TEEE	Thermoplastic elastomer, Ether-Ester ^D	Thermoplastic elastomer, ether-ester ^D
TEO	Thermoplastic elastomer, Olefinic ^D	Thermoplastic elastomer-olefinic ^D
TES	Thermoplastic elastomer, Styrenic ^D	Thermoplastic elastomer-styrenic ^D
TPES	Thermoplastic polyester ^D	Thermoplastic polyester (general) ^D
TPUR	Thermoplastic polyurethane	(same)
TSUR	Thermoset polyurethane	(none)
UF	Urea-formaldehyde resin ^D	Urea-formaldehyde ^D
UP	Unsaturated polyester	(same)

^A This table and this document are based on the latest issues of Terminology D 1600D 1600 and Classification D 4000D 4000 for standardization of polymer family names and their abbreviations, codes, or acronyms. Terminology D 1600D 1600 and Classification D 4000D 4000 contain more information than is given here, but they, obviously, are not in exact harmony as indicated by this table. Many differences are trivial, but some may require a decision of the database manager. Also see text paragraphs 5.2.1.3 and 5.2.1.4 and Terminology D 1600D 1600 for some proposed guidance.

^B This solidus use in Classification D 4000D 4000-89 is not understood. The listings were acrylonitrile/butadiene/styrene and acrylonitrile/butadiene/acrylate in Classification D 4000D 4000-87. Many changes from solidus to hyphen were made in Classification D 4000D 4000-89.

^C This material is also widely known as rubber modified polystyrene (see Specification D 4549D 4549).

^D This difference should be easily resolvable.

^E The unique use of the solidus in S/MA requires comment, since both Terminology D 1600D 1600 and Classification D 4000D 4000 are in agreement (standardized use in Specification D 4634D 4634-86 may be the reason?) Note that in the blend SMA + IPS the solidus between S and M has not been used in Terminology D 1600D 1600. A reconsideration of the solidus use in S/MA among Terminology D 1600D 1600, Classification D 4000D 4000 and Specification D 4634D 4634 could improve consistency.

^F This use of the solidus is based on a rule to avoid confusion with hyphens (-) by using a solidus.

**TABLE 3 Examples of Polymer Structural Descriptors
(Molecular-, Micro-, and Macro-Structures)**

Homopolymer	Low/high mold flow
Alternating copolymer	Amorphous polymer
Block copolymer	Semi-crystalline polymer
Graft copolymer	Nucleated polymer
Random copolymer	Interpenetrating polymer network
Isotactic polypropylene	Polymer blend
Terpolymer	Isotropic material
Cross-linked polymer	Biaxially stretched film
Thermoplastic elastomer	Cellular or foamed plastic
Liquid crystal polymer	Open/closed cell
Ultra high molecular weight	Flexible/rigid foam



TABLE 4 Examples of Polymer Application Descriptors

General purpose	Arc resistant
Improved impact	Chemically resistant
Flame retardant	Shock resistant
High strength	Weather resistant
Rigid	Insulator, electrical or thermal
Flexible	Conductor, electrical or thermal
Toughened	Food contact approved (Food and Drug Administration)
Easy molding (high melt flow)	UL listed
Heat stabilized	NEMA listed
Low wear/friction	Platable grade
Self lubricating	Injection molding grade
Abrasion Resistant	Extrusion grade

TABLE 5 Examples of Polymerization State

Polymerized
Thermoset C stage
Thermoplastic molding compound
Radiation cross-linked polyethylene
Graft copolymer, thermoplastic
Partially Polymerized
Gel
Thermosetting A-Stage
Thermosetting B-Stage
Polyethylene for radiation cross-linking
Prepreg, thermosetting
To Be Polymerized
Cyclic monomer (ring-opening), thermoplastic
Monomers/reactants (for RIM thermoplastic)
Monomers/reactants (for RIM thermoset)
2-part kit, thermosetting resin system
1-part thermosetting resin system

TABLE 6 Examples of Polymer Plastic Form

Formed (Molded/Extruded/Cast Material)
Part
Shape
Sheet/film
Cellular
To Be Formed (Molding/Extruding/Casting Material)
Pellets
Powder
Granules
BMC
rope
slug
log
1-part epoxy compound (frozen)
2-part casting compound
Polymer for Plastic Formulation
Solid
Liquid
Solution/Dispersion