



Designation: D 4101 – 82 (Reapproved 1988)^{e1}

AMERICAN SOCIETY FOR TESTING AND MATERIALS
1916 Race St., Philadelphia, Pa. 19103

Reprinted from the Annual Book of ASTM Standards, Copyright ASTM
If not listed in the current combined index, will appear in the next edition.

Standard Specification for Propylene Plastic Injection and Extrusion Materials¹

This standard is issued under the fixed designation D 4101; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (e) indicates an editorial change since the last revision or reapproval.

^{e1} NOTE—Section 1.3 was added editorially October 1988.

INTRODUCTION

This specification is not intended for the selection of materials but only as a means to call out plastic materials to be used for the manufacture of parts. The *selection* of these materials is to be made by personnel with expertise in the plastics field where the environment, inherent properties of the materials, performance of the parts, part design, manufacturing process, and economics are considered.

1. Scope

1.1 This specification covers propylene plastic materials suitable for injection molding and extrusion. Polymers consist of propylene homopolymer, propylene copolymers, and propylene-elastomer compounded with or without the addition of impact modifiers (ethylene-propylene rubber, polyisobutylene rubber, and butyl rubber), colorants, stabilizers, lubricants, or reinforcements.

1.2 The values stated in SI units are to be regarded as the standard.

NOTE 1—The properties included in the specification are those required to identify the compositions covered. There may be other requirements necessary to identify particular characteristics important to specific applications. These will be agreed upon between the user and the supplier by using the suffixes as given in Section 4.

1.3 The following precautionary caveat pertains only to the test method portion, section 12 of this specification: *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

D 256 Test Methods for Impact Resistance of Plastics and Electrical Insulating Materials²

D 257 Test Methods for D-C Resistance or Conductance of Insulating Materials^{2,3}

D 618 Methods of Conditioning Plastics and Electrical Insulating Materials for Testing⁴

D 638 Test Method for Tensile Properties of Plastics⁴

D 647 Practice for Design of Molds for Test Specimens of Plastic Molding Materials⁴

D 648 Test Method for Deflection Temperature of Plastics Under Flexural Load⁴

D 759 Practice for Conducting Physical Property Tests of Plastics at Subnormal and Supernormal Temperatures⁵

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials⁴

D 792 Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement⁴

D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer⁴

D 1505 Test Method for Density of Plastics by the Density-Gradient Technique⁴

D 1531 Test Method for Relative Permittivity (Dielectric Constant) and Dissipation Factor of Polyethylene by Liquid Displacement Procedure³

D 1600 Abbreviations of Terms Relating to Plastics⁶

D 1898 Practice for Sampling of Plastics⁷

D 2565 Practice for Operating Xenon Arc-Type (Water-Cooled) Light Exposure Apparatus With and Without Water for Exposure of Plastics⁷

D 2584 Test Method for Ignition Loss of Cured Reinforced Resins⁷

D 3012 Test Method for Thermal-Oxidative Stability of Propylene Plastics, Using a Biaxial Rotator⁷

E 29 Recommended Practice for Indicating Which Places of Figures Are to Be Considered Significant in Specified Limiting Values⁸

G 23 Practice for Operating Light- and Water-Exposure

¹ This specification is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.12 on Olefin Plastics. Current edition approved March 23, 1982. Published April 1982.

² Annual Book of ASTM Standards, Vols 08.01 and 09.02.

³ Annual Book of ASTM Standards, Vols 10.01 and 10.02.

⁴ Annual Book of ASTM Standards, Vol 08.01.

⁵ Discontinued, see 1982 Annual Book of ASTM Standards, Part 35.

⁶ Annual Book of ASTM Standards, Vols 08.01 and 08.04.

⁷ Annual Book of ASTM Standards, Vol 08.02.

⁸ Annual Book of ASTM Standards, Vol 14.02.

TABLE PP Detailed Requirements for Unreinforced Propylene Plastics (Natural Color Only)

Group	Description	Class	Description	Grade	Description	Flow Rate, ^A ASTM D 1238, Condition L g/10 min	Density, max, ASTM D 1505 or D 792	Tensile ^B Strength at Yield, ASTM D 638 min ^C MPa	Secant ^C Modulus of Elasticity in Bending, ASTM D 790 min ^G MPa	Izod Impact ^D Resistance at 23°C, ASTM D 256 min ^H J/m	Unnotched Impact ^E Resistance at -18°C, ASTM D 256 (Modified) min ^H J/m	Deflection ^F Temperature at 455 kPa Stress, ASTM D 648 min °C
1	Homopolymer	1	General purpose	1	...	0.3 max	0.910	30(G)	1 200(G)	32(H)	300(H)	95
				2	...	>0.3-1.0	0.910	30	1 200	27	250	90
				3	...	>1.0-3.0	0.910	30	1 200	25	200	85
				4	...	>3.0-10	0.910	30	1 200	25	200	80
				5	...	>10-20	0.910	30	1 200	20	150	80
				6	...	>20-40	0.910	28	1 200	16	100	75
				7	...	>40-100	0.910	25	1 200	14	50	75
				8	...	>100	0.910	25	1 200	12	50	70
		2	Nucleated	0	Other							
				1	...	>1.0-3.0	0.915	33	1 300	27	200	100
				2	...	>3.0-10	0.915	33	1 300	21	200	100
				3	...	>10-30	0.915	33	1 300	16	160	100
		0	Other	0	Other							
				0	Other							
				0	Other							
2	Copolymer	1	General purpose	1	...	...	0.910	28	1 100	25	210	80
				2	...	...	0.910	25	900	30	270	80
				3	...	...	0.910	24	900	64	270	75
				4	...	...	0.910	21	760	80	320	75
		0	Other	0	Other							
				0	Other							
				0	Other							
		1	Impact modified	1	...	...	0.910	24	900	50	270	80
				2	...	...	0.910	24	850	80	530	75
				3	...	...	0.910	23	850	90	800	75
3	Impact modified	1	...	4	...	...	0.910	21	760	110	1 070	70
				5	...	...	0.910	20	700	160	1 330	70
				6	...	...	0.910	18	620	270	1 330	70
				7	...	...	0.910	17	620	430	1 330	70
		0	Other	0	Other							
				0	Other							
				0	Other							
		1	Elastomer	1	...	...	0.905	14	300	...	...	...
				2	...	...	0.905	10	140	...	...	...
				0	...	...						
4	Elastomer	1	...	0	Other							
				0	Other							
0	Other	0	Other	0	Other							

^A Nominal flow rate is as supplied by the manufacturer of the material. Allowable tolerance $\pm 30\%$ per individual lot.

^B Test specimens are Method D 638, Type I tensile bars and shall be tested at 51 mm/min.

^C Test specimens are nominal 3.2 by 12.7-mm cross section with a 50.8-mm span. Use Method I, Procedure A, and select the stress corresponding to 1 % strain for the secant calculation.

^D Test specimens are nominal 3.2 mm in thickness and are cut from center section of Method D 638, Type I tensile bar.

^E Test specimens are nominal 3.2 by 12.7-mm cross section and are cut from center section of Method D 638, Type I tensile bar.

^F Test specimens are nominal 3.2 by 12.7-mm cross section and shall be unannealed.

^G MPa $\times 145 =$ psi.

^H J/m $\times 18.73 \times 10^{-3} =$ ft-lbf/in.

Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials⁹

2.2 Military Standard:

MIL-STD-105 Sampling Procedure and Tables for Inspection by Attributes¹⁰

2.3 DOT Standards:

Federal Motor Vehicle Safety Standard 302, Flammability of Interior Materials¹¹

2.4 Underwriters Laboratories:

UL 94 - Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances¹²

3. Classifications

3.1 Unreinforced propylene plastic materials are classified

into groups according to basic composition. These groups are subdivided into classes and grades, as shown in the Basic Property Table (Table PP).

NOTE 2—An example of this classification system is as follows. The designation PP 113 would indicate: PP = propylene plastic, as found in Abbreviations D 1600, 1 (group) = homopolymer, 1 (class) = general purpose, and 3 (grade) = with requirements given in Table PP.

3.1.1 To facilitate the incorporation of future or special materials not covered by the Basic Property Table, the "other/unspecified" category (0) for group, class, and grade is shown on the table with the basic properties to be obtained from Tables A or B, as they apply (see 3.3).

3.2 Reinforced versions of the propylene plastic materials are classified in accordance with Tables PP and A, where Tables PP and B specify the unreinforced material and Table A, the properties after the addition of reinforcements, pigments, fillers, or lubricants, at the nominal level indicated (see 3.2.1).

3.2.1 *Reinforcements and Additive Materials*—A symbol (single letter) will be used for the major reinforcement or combinations thereof, along with two numbers that indicate the percentage of addition by mass, with the tolerances as

⁹ Annual Book of ASTM Standards, Vols 08.03 and 14.02.

¹⁰ Available from Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120. Attention: NPFC 105.

¹¹ Available from U.S. Dept. of Transportation, National Highway Traffic Safety Administration, Office of Public Affairs and Consumer Participation, 400 7th St., S.W., Washington, DC 20590.

¹² Available from Underwriters' Laboratories, 333 Pfingston Rd., Northbrook, IL 60062.

TABLE A Detail Requirements^A Reinforced Propylene Plastics

Designation Order No.	Property	Cell Limits									
		0	1	2	3	4	5	6	7	8	9
1	Tensile strength, ASTM D 638, ^B min, MPa ^C	Unspecified	20	35	50	65	80	95	110	125	Specify value ^H
2	Secant (1 % strain) modulus of elasticity in bending, ASTM D 790, ^D min, MPa ^C	Unspecified	1000	2000	3000	4000	5000	6000	7000	8000	Specify value ^H
3	Izod impact, ASTM D 256, ^E min, J/m ^F	Unspecified	15	30	45	60	90	135	190	250	Specify value ^H
4	Deflection temperature at 455 kPa, ASTM D 648, ^G min, °C	Unspecified	80	95	110	130	150	170	190	210	Specify value ^H
5	To be determined	Unspecified	...	...	...	...	...	...	...	...	...

^A It is recognized that detailed test values, particularly Izod impact, may not predict nor even correlate with performance of parts molded of these materials.

^B Test specimens are Method D 638, Type I tensile bars and shall be tested at 51 mm/min.

^C MPa × 145 = psi.

^D Test specimens are nominal 3.2 by 12.7-mm cross section with a 50.8-mm span. Use Method I, Procedure A, and select the stress corresponding to 1 % strain for the secant calculation.

^E Test specimens are nominal 3.2 mm in thickness and are cut from center section of Method D 638, Type I tensile bar.

^F J/m × 18.73 × 10⁻³ = ft·lbf/in.

^G Test specimens are nominal 3.2 × 12.7-mm cross section and shall be unannealed.

^H If specific value is required, it must appear on drawing or contract, or both.

TABLE B Detail Requirements^A Unreinforced Propylene Plastics

Designation Order No.	Property	Cell Limits									
		0	1	2	3	4	5	6	7	8	9
1	Tensile strength ASTM D 638, ^B min, MPa ^C	Unspecified	5	10	15	20	25	30	35	40	Specify value ^I
2	Secant (1 % strain) modulus of elasticity in bending, ASTM D 790, ^D min, MPa ^C	Unspecified	100	250	500	750	1000	1250	1500	1750	Specify value ^I
3	Izod impact, ASTM D 256, ^E min, J/m ^F	Unspecified	10	50	100	200	300	400	500	700	Specify value ^I
4	Deflection Temperature at 455 kPa, ASTM D 648, ^G min, °C	Unspecified	50	60	70	80	90	100	110	120	Specify value ^I
5	Flow rate, ^H ASTM D 1238, Condition L, g/10 min	Unspecified	0.3 max	>0.3–1.0	>1.0–3.0	>3.0–10	>10–20	>20–40	>40–100	>100	Specify value ^I

^A It is recognized that detailed test values, particularly Izod impact, may not predict nor even correlate with performance of parts molded of these materials.

^B Test specimens are ASTM D 638, Type I tensile bars and shall be tested at 51 mm/min.

^C MPa × 145 = psi.

^D Test specimens are nominal 3.2 by 12.7-mm cross section with a 50.8-mm span. Use Method I, Procedure A, and select the stress corresponding to 1 % strain for the secant calculation.

^E Test specimens are nominal 3.2 mm in thickness and are cut from center section of ASTM D 638, Type I tensile bar.

^F J/m × 18.73 × 10⁻³ = ft·lbf/in.

^G Test specimens are nominal 3.2 by 12.7-mm cross section and shall be unannealed.

^H Nominal flow rate is as supplied by the manufacturer of the material. Allowable tolerance ± 30 % per individual lot.

^I If specific value is required, it must appear on drawing or contract, or both.

tabulated below:

Symbol	Material	Tolerance
G	Glass reinforced —	
	<15 %	±2 percentage points
	>15 %	±3 percentage points
L	Lubricants (that is, graphite, silicone, and stearates)	By agreement between the supplier and the user
M	Mineral-reinforced —	
	<15 %	±2 percentage points
	>15 %	±3 percentage points
R	Reinforced-combinations/mixtures of reinforcements or other fillers/reinforcements	±3 percentage points Based on the total reinforcement

NOTE 3—This part of the system uses the type and percentage of additive to designate the modification of the base material. To facilitate this designation, the type and percentage of additive can be shown on the supplier's technical data sheet, unless it is proprietary in nature. If necessary, additional requirements shall be indicated by the use of the suffix part of the system as given in Section 4.

3.2.2 Specific requirements for reinforced, pigmented, filled, or lubricated propylene plastic materials will be shown

by a six-character designation. The designation will consist of the letter A or B and the five digits comprising the cell numbers for the property requirements in the order in which they appear in Tables A or B.

3.2.2.1 Although the values listed are necessary to include the range of properties available in existing materials, they should not be interpreted as implying that every possible combination of the properties exists or can be obtained.

3.2.3 When the grade of the basic materials is not known or is not important, the use of "0" grade classification will be used for reinforced materials in this system. (See Note 5.)

NOTE 4—An example of this classification system for a reinforced-propylene plastic material is as follows. The designation PP110M20A21130 would indicate the following, with the material requirements from Table A:

PP110	=	General-purpose propylene plastic homopolymer from Table PP,
M20	=	Mineral reinforced, 20 %,
A	=	Table A property requirements,
2	=	35 MPa tensile strength, min,
1	=	1000 MPa secant modulus of elasticity in bending, min.