



Designation: D5204 – 22

Standard Classification System and Basis for Specification for Polyamide-Imide (PAI) Molding and Extrusion Materials¹

This standard is issued under the fixed designation D5204; 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 (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This classification system covers polyamide-imide materials suitable for injection molding and extrusion.

1.2 The properties included in this classification system are those required to identify the compositions covered. It is possible that other requirements are necessary to identify particular characteristics important to specialized applications. The use of suffixes as shown in Section 5 is one way of specifying these requirements.

1.3 This standard allows for the use of recycled materials provided that specification requirements based upon this classification system are met.

1.4 This classification system and subsequent line call-out (specification) is intended to be a means of calling out plastics materials used in the fabrication of end items or parts. It is not intended for the selection of materials. Material selection needs to be made by those having expertise in the plastics field after careful consideration of the design and the performance required of the part, the environment to which it will be exposed, the fabrication process to be employed, the inherent properties of the material other than those covered by this classification, and the economics.

1.5 The values stated in SI units are to be regarded as the standard. (Reporting in inch-pound units is acceptable.)

1.6 The following precautionary caveat pertains only to the test methods portion, Section 11, of this classification system: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—There is no known ISO equivalent to this standard.

1.7 *This international standard was developed in accordance with internationally recognized principles on standard-*

ization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 ASTM Standards:²

D149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

D150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation

D256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

D257 Test Methods for DC Resistance or Conductance of Insulating Materials

D618 Practice for Conditioning Plastics for Testing

D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

D883 Terminology Relating to Plastics

D1525 Test Method for Vicat Softening Temperature of Plastics

D1600 Terminology for Abbreviated Terms Relating to Plastics

D1708 Test Method for Tensile Properties of Plastics by Use of Microtensile Specimens

D2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)

D3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials

D3892 Practice for Packaging/Packing of Plastics

D4000 Classification System for Specifying Plastic Materials

¹ This classification system is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

*A Summary of Changes section appears at the end of this standard

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

IEEE/ASTM SI-10 Standard for Use of the International System of Units (SI): The Modern Metric System

2.2 Military and Federal Specifications and Standards:³

MIL-P-46179A Plastic Molding and Extrusion Materials, Polyamide-Imide (PAI)

NOTE 2—MIL-P-46179A property requirements are the basis of Classification System D5204. The Department of Defense adopted Classification System D5204 on July 27, 1994, and canceled MIL-P-46179A.

2.3 SAE Specifications:⁴

AMS 3670C Bar, Rod, and Shapes Molded or Extruded from Polyamide-Imide Plastics Materials

AMS 3670/1C Bar, Rod, and Shapes Produced from Unfilled Polyamide-Imide

AMS 3670/2C Bar, Rod, and Shapes Produced from 20 % Graphite-3 % Polytetrafluoroethylene Filled Polyamide-Imide Material

AMS 3670/3C Bar, Rod, and Shapes Produced from 12 % Graphite-3 % Polytetrafluoroethylene Filled Polyamide-Imide Material

AMS 3670/4D Bar, Rod, and Shapes Produced from 30 % Glass Fiber Filled Polyamide-Imide Material

AMS 3670/5D Bar, Rod and Shapes Produced from 30 % Carbon Fiber Filled Polyamide-Imide Material

3. Terminology

3.1 The terminology used in this classification system is in accordance with Terminology D883 and D1600.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *polyamide-imide (PAI)*, *n*—a polymer that is composed of linkages of all random, or all block, or all alternating, or any combination thereof, amide and imide units in the structural backbone.

4. Classification

4.1 The polyamide-imide materials are designated PAI, as specified in Terminology D1600.

4.2 Polyamide-imide materials are classified into groups that are subdivided into classes and grades as shown in Table PAI.

4.2.1 An example of this classification system is as follows:

The designation PAI012L23 would indicate from Table PAI:

PAI = Polyamide-imide as found in Terminology D1600,

01 (Group) = Injection molding material,

2 (Class) = Wear resistance PAI, and

L23 (Grade) = Nominal 20 % graphite and 3 % PTFE with the requirements given in Table PAI.

4.2.2 To facilitate the incorporation of special materials not covered in Table PAI, the “other” category (0) for group, class, and grade is shown on the table with the basic properties to be obtained from Table A.

4.3 Use Table A to specify physical property requirements for other PAI materials. These properties are shown by a six-character designation. The designation consists of the letter A and the five digits comprising the cell numbers for the property requirements in the order as they appear in Table A.

4.3.1 Although the values listed are necessary to include the range of properties available in existing materials, not every possible combination of the properties exists or can be obtained.

4.3.2 A single letter is used to identify the grade and indicate the major reinforcement or combinations, or both, along with two digits that indicate the percentage of additive(s) by total mass. The reinforcement and additive letter designations and associated tolerance levels are shown in Table 1.

TABLE 1 Reinforcement-Filler Symbols and Tolerances

Category	Material	Tolerance
C	Carbon or graphite fiber reinforced	±3 percentage points
G	Glass fiber reinforced	±3 percentage points
L	Lubricants	±3 percentage points
M	Minerals	±3 percentage points
R	Combinations of reinforcements or fillers, or both	±5 percentage points

4.3.3 This part of the classification system uses the type and percentage of additive to designate the modification of the basic material. To facilitate this designation, the type and percentage of additive is frequently shown on the supplier’s technical data sheet. If necessary, additional requirements are indicated by use of the suffix part of the system, as given in Section 5.

4.3.4 Reinforced, filled, and lubricated versions of PAI materials that are not in Table PAI are classified in accordance with Tables PAI and A. Table PAI is used to specify the Group or group and class of PAI and Table A is used to specify the property requirements. An example of this classification system for a polyamide-imide material containing 40 % glass is as follows:

The designation PAI0130G40A61550

PAI0130 = polyamide-imide from Table PAI,

G40 = glass reinforced at 40 % nominal level,

A = Table A physical-property requirements,

6 = tensile strength, 172 MPa, min,

1 = elongation, 4 %, min,

5 = flexural strength, 269 MPa, min,

5 = flexural modulus, 11700 MPa, min, and

0 = unspecified property.

If no properties are specified, the designation would be PAI0130G40A00000.

5. Suffixes

5.1 When additional requirements are needed, based on application, that are not covered by the basic requirements (Table PAI) or cell-table requirements (Table A), they are indicated through the use of suffixes.

5.2 Use the suffixes found in Classification System D4000 (Table 3) for additional requirements as appropriate. Additional suffixes will be added to Classification System D4000 as test methods and requirements are developed and requested.

5.2.1 An example of this classification system using a suffix is as follows:

³ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://dodssp.daps.dla.mil>.

⁴ Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.