



Designation: D4349 – 22

## Classification System and Basis for Specification for Polyphenylene Ether (PPE) Materials<sup>1</sup>

This standard is issued under the fixed designation D4349; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope\*

1.1 This classification system covers the basic polymers and copolymers known as polyphenylene ethers and polyphenylene oxides, as well as filled, modified, and reinforced versions. Recycled materials are included in this standard as Class 5 of Table PPE.

NOTE 1—The addition to the natural polymer or copolymer of pigments, colorants, or other additives can cause the final composition to no longer meet the requirements specified for the natural polymer or copolymer.

NOTE 2—The preferred abbreviation for polyphenylene ether is PPE, as noted in Terminology [D1600](#).

1.2 This classification system and subsequent line callout (specification) are intended to provide a means of calling out plastic materials used in the fabrication of end items or parts. It is not intended for the selection of materials. Material selection should be made by those having expertise in the plastic 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 costs involved, and the inherent properties of the material other than those covered by this standard.

1.3 There may be other requirements necessary to identify particular characteristics important to specific applications. These are to be specified by using the suffixes described in Section 5.

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

NOTE 3—There is no known ISO equivalent to this standard.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization 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.*

<sup>1</sup> 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. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

[D256](#) Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

[D618](#) Practice for Conditioning Plastics for Testing

[D638](#) Test Method for Tensile Properties of Plastics

[D648](#) Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position

[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

[D1600](#) Terminology for Abbreviated Terms Relating to Plastics

[D3892](#) Practice for Packaging/Packing of Plastics

[D4000](#) Classification System for Specifying Plastic Materials

[D5630](#) Test Method for Ash Content in Plastics (Withdrawn 2022)<sup>3</sup>

[D7209](#) Guide for Waste Reduction, Resource Recovery, and Use of Recycled Polymeric Materials and Products (Withdrawn 2015)<sup>3</sup>

[E29](#) Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

#### 2.2 Underwriters Laboratories:

[UL 94](#) Standards for Tests for Flammability for Parts in Devices and Appliances<sup>4</sup>

#### 2.3 ISO Standards:<sup>5</sup>

[ISO 3451-1](#) Plastics—Determination of ash—Part 1: General methods

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>4</sup> Available from Underwriters Laboratories (UL), 2600 N.W. Lake Rd., Camas, WA 98607-8542, <http://www.ul.com>.

<sup>5</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

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

### 3. Terminology

3.1 The terminology used in this classification is in accordance with Terminologies **D883** and **D1600**.

3.2 The polyphenylene ether materials will be designated PPE as specified in Terminology **D1600**.

### 4. Classification

4.1 Polyphenylene ether-based materials are classified into groups according to their compositions. These groups are subdivided into classes and grades, as shown in Basic Property Table PPE.

NOTE 4—An example of this classification system is as follows:  
The specification ASTM D4349 PPE 0223 would indicate:

|     |   |                                         |
|-----|---|-----------------------------------------|
| PPE | = | polyphenylene ether,                    |
| 02  | = | polystyrene-modified material (Group),  |
| 2   | = | flame retarded (Class Description), and |
| 3   | = | requirements given in Table PPE.        |

4.1.1 Reinforced, filled, and lubricated versions of PPE materials are classified according to the reinforcement used and the nominal level, by weight percent, of the reinforcement. The grade is identified by a single letter that indicates the filler or reinforcement used and two digits that indicate the nominal quantity in percent by weight. Thus, a grade containing 15 % glass reinforcement would be indicated by PPE0110 G15. This callout indicates:

PPE = polyphenylene ether \_\_\_\_ as found in Terminology D1600,  
01 = unmodified (group),  
1 = general purpose (class),  
0 = other (grade), and  
G15 = 15 % glass reinforcement

The reinforcement letter designations and associated tolerance levels are shown in **Table 1**.

**TABLE 1 Reinforcement-Filler,<sup>A</sup> Symbols,<sup>B</sup> and Tolerances**

| Symbol | Material                                                    | Tolerance                                          |
|--------|-------------------------------------------------------------|----------------------------------------------------|
| C      | Carbon and graphite                                         | ±2 %                                               |
| D      | Alumina trihydrate                                          | ±2 %                                               |
| E      | Clay                                                        | ±2 %                                               |
| F      | Cellulose                                                   | ±2 %                                               |
| G      | Glass                                                       | ±2 %                                               |
| H      | Aramid                                                      | ±2 %                                               |
| J      | Boron                                                       | ±2 %                                               |
| K      | Calcium carbonate                                           | ±2 %                                               |
| L      | Lubricants<br>(for example: PTFE, graphite)                 | Depends upon material and process—to be specified. |
| M      | Mineral                                                     | ±2 %                                               |
| N      | Natural organic<br>(for example: cotton, sisal, hemp, flax) | ±2 %                                               |
| P      | Mica                                                        | ±2 %                                               |
| Q      | Silica                                                      | ±2 %                                               |
| R      | Combinations of reinforcements and/or fillers               | ±3 %                                               |

<sup>A</sup>Ash content of filled and/or reinforced materials is to be determined using either Test Method **D5630** or ISO 3451-1 where applicable.

<sup>B</sup>Additional symbols will be added to this table as required.

NOTE 5—This part of the system uses the type and percentage of additives, fillers, and reinforcements to designate the modification of the basic material. The types and percentages are sometimes shown on the supplier's technical data sheet. If necessary, additional control of these compositional variables can be accomplished using the suffix part of the system, Section 5.

NOTE 6—Materials containing reinforcements or fillers, or both, at nominal levels not in multiples of five are included in the nearest grade designation. For example, a material with a nominal glass fiber level of 33 % is included with Grade G35 as shown in **4.1.1**.

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

**TABLE PPE Requirements for Polyphenylene Ether (PPE) Materials**

NOTE 1—Values given are for natural materials only. Other colors can be different.<sup>A</sup>

| Group Description        | Class Description             | Grade Description | Heat Deflection, min               |                                     | Specific Gravity, ASTM D792, min | Tensile Strength, <sup>B, C</sup> D638, MPa, min | Flexural Modulus, <sup>B, C</sup> D790, MPa, min | Izod Impact, <sup>B, D</sup> D256, J/m, min |
|--------------------------|-------------------------------|-------------------|------------------------------------|-------------------------------------|----------------------------------|--------------------------------------------------|--------------------------------------------------|---------------------------------------------|
|                          |                               |                   | at 1.82 MPa, <sup>B</sup> D648, °C | at 0.455 MPa, <sup>B</sup> D648, °C |                                  |                                                  |                                                  |                                             |
| 01 Unmodified            | 1 general purpose             | 0 other           | E                                  |                                     |                                  |                                                  |                                                  |                                             |
|                          | 2 flame retarded <sup>F</sup> | 0 other           | E                                  |                                     |                                  |                                                  |                                                  |                                             |
|                          | 0 other                       | 0 other           | E                                  |                                     |                                  |                                                  |                                                  |                                             |
| 02 PS modified materials | 1 general purpose             | 1                 | 90                                 | N/A <sup>G</sup>                    | 1.03                             | 32                                               | 1750                                             | 265                                         |
|                          |                               | 2                 | 100                                | N/A <sup>G</sup>                    | 1.03                             | 38                                               | 1900                                             | 240                                         |
|                          |                               | 3                 | 100                                | N/A <sup>G</sup>                    | 1.03                             | 44                                               | 2150                                             | 185                                         |
|                          |                               | 4                 | 110                                | N/A <sup>G</sup>                    | 1.04                             | 55                                               | 2300                                             | 160                                         |
|                          |                               | 5                 | 130                                | N/A <sup>G</sup>                    | 1.05                             | 57                                               | 2300                                             | 160                                         |
|                          |                               | 0 other           | ...                                | ...                                 | ...                              | ...                                              | ...                                              | ...                                         |
|                          | 2 flame retarded <sup>F</sup> | 1                 | 67                                 | N/A <sup>G</sup>                    | 1.06                             | 36                                               | 2200                                             | 190                                         |
|                          |                               | 2                 | 80                                 | N/A <sup>G</sup>                    | 1.07                             | 40                                               | 2250                                             | 130                                         |
|                          |                               | 3                 | 85                                 | N/A <sup>G</sup>                    | 1.07                             | 48                                               | 2350                                             | 100                                         |
|                          |                               | 4                 | 105                                | N/A <sup>G</sup>                    | 1.07                             | 55                                               | 2350                                             | 160                                         |
|                          |                               | 5                 | 125                                | N/A <sup>G</sup>                    | 1.08                             | 60                                               | 2500                                             | 160                                         |
|                          |                               | 0 other           | ...                                | ...                                 | ...                              | ...                                              | ...                                              | ...                                         |
|                          | 0 other                       | 0 other           | ...                                | ...                                 | ...                              | ...                                              | ...                                              | ...                                         |
|                          |                               | 0 other           | ...                                | ...                                 | ...                              | ...                                              | ...                                              | ...                                         |
|                          |                               | 0 other           | ...                                | ...                                 | ...                              | ...                                              | ...                                              | ...                                         |
| 03 PA modified materials | 1 general purpose             | 1                 | N/A <sup>G</sup>                   | 145                                 | 1.05                             | 50                                               | 2000                                             | 170                                         |
|                          |                               | 2                 | N/A <sup>G</sup>                   | 155                                 | 1.05                             | 50                                               | 2000                                             | 160                                         |
|                          |                               | 3                 | N/A <sup>G</sup>                   | 170                                 | 1.05                             | 50                                               | 1800                                             | 530                                         |
|                          |                               | 4                 | N/A <sup>G</sup>                   | 180                                 | 1.05                             | 55                                               | 2000                                             | 185                                         |
|                          |                               | 5                 | N/A <sup>G</sup>                   | 195                                 | 1.05                             | 58                                               | 2200                                             | 160                                         |
|                          | 2 flame retarded <sup>F</sup> | 0 other           | ...                                | ...                                 | ...                              | ...                                              | ...                                              | ...                                         |
|                          |                               | 0 other           | E                                  | ...                                 | ...                              | ...                                              | ...                                              | ...                                         |
|                          |                               | 0 other           | ...                                | ...                                 | ...                              | ...                                              | ...                                              | ...                                         |
|                          |                               | 0 other           | ...                                | ...                                 | ...                              | ...                                              | ...                                              | ...                                         |
|                          |                               | 0 other           | ...                                | ...                                 | ...                              | ...                                              | ...                                              | ...                                         |