Designation: D8349 – 21

Standard Classification System for and Basis of Specifications for Thermoplastic Joining Interface Materials for Creation of Joints Between Different Materials for the Production of End Items or Parts that are Intended to be Disassembled and/or Reassembled[1]

This standard is issued under the fixed designation D8349; 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.

1. Scope

1.1 This classification system covers thermoplastic materials, used as joining materials, for the creation of joints between similar or dissimilar materials, to produce finished products or parts that are intended to be disassembled and/or reassembled.

1.2 This class of materials enables disconnection of the different parts or layers of a products for refurbishing, repair and full recovery and recycling of the joined materials, for instance at the end of life of the product(s), enabling the reuse of valuable resources, and hence reducing adverse impact on the environment.

1.3 The properties included in this classification system are those required to identify the materials covered. It is possible that there are other requirements necessary to identify particular characteristics important to specialized applications. One way of specifying them is by using the suffixes as given in Section 5.

1.4 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 is best 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 classification system.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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—Application examples are fully recyclable mattresses and floor coverings. These products can be disassembled into its different parts, by using heat, for refurbishing, repair and full recovery and recycling of the joined materials at the end of the product's life.

1.7 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D618 Practice for Conditioning Plastics for Testing

D883 Terminology Relating to Plastics

D1600 Terminology for Abbreviated Terms Relating to Plastics

D3418 Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry

D3892 Practice for Packaging/Packing of Plastics

D4000 Classification System for Specifying Plastic Materials

D5279 Test Method for Plastics: Dynamic Mechanical Properties: In Torsion

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

[1] This test method 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.

2.2 *ISO Standards:*[3]

ISO 2555 Plastics—Resins in the liquid state or as emulsions or dispersions—Determination of apparent viscosity using a single cylinder type rotational viscometer method

3. Terminology

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

4. Classification

4.1 Thermoplastic polymers used as joining interface for the creation of joints are classified into groups in accordance with their material chemical structure. These groups are subdivided into classes by melting point (Table 2) and further subdivided into grades as shown in Table 3 Property requirements.

4.1.1 There are no callout-lines included in this standard. A designation, a callout-line, is drawn up by using Tables 1-3 as 'building blocks' (see Tables 1-3 and Example 1 (Fig. 1)).

NOTE 2—Drawing up callout lines by using Tables 1-3 as 'building blocks' implies that addition of new callout lines is not necessary anymore. In case of addition of a new material type, only the new material type needs to be added to Table 1. Table 3 is expected to accommodate a range of polymer types. However, future types of Joining Interface Materials may require addition of another Table 'Grade—Property Requirements' for that specific polymer type.

4.1.2 To facilitate the incorporation of future or special materials, the category unspecified (0) is shown in the Table 1.

5. Suffixes

5.1 When additional requirements are needed that are not covered by the basic requirements or cell-table requirements, they shall be indicated through the use of suffixes.

5.2 A list of suffixes can be found in Classification D4000 (Table 3) and can be used to indicate additional requirements as appropriate. Additional suffixes will be added to that classification system as test methods and requirements are developed and requested.

6. General Requirements

6.1 Basic requirements from the property or cell tables are always in effect unless superseded by specific suffix requirements, which always take precedence.

6.2 The thermoplastic Joining Interface Material shall be conform to the requirements specified herein.

7. Detail Requirements

7.1 The materials shall conform to the requirements in Tables 1-3 and suffix requirements as they apply.

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

TABLE 1 Group—Thermoplastic joining interface material

JIM Group	Abbreviation		Block
	ISO	ASTM	
1	TP	TPES	Thermoplastic Polyester
0	Unspecified	—	Unspecified

TABLE 2 Class—Melting Point Classification Value[A]

Test method	Unit	Cell Limits	
		'000'	'Value, ± 2 °C'
ASTM D3418	°C	Not specified	Specify value

[A] See 11.1, determination of the melting temperature (Tm), for specific test conditions and supplementary instructions.

7.2 For the purpose of determining conformance, all specified limits for a specification (line callout) based on this classification system are absolute limits, as defined in Practice E29.

7.3 With the absolute method, an observed value or a calculated value is not rounded off, but is to be compared directly to the specified limiting value. Conformance or nonconformance is based on this comparison.

8. Sampling

8.1 Sampling shall be statistically adequate to satisfy the requirements of 12.4.

8.2 A batch or lot shall be constituted as a unit of manufacture as prepared for shipment and can consist of a blend of two or more "production runs."

9. Specimen Preparation

9.1 The material shall be dried according to the instructions of the material supplier. If no drying conditions are specified it is recommended that the TPES material be dried 8 - 24 hours at 80 °C - 120 °C in an oven prior to testing.

9.2 Note that drying at higher temperatures might change the properties of some materials. For the determination of the properties in Table 2 and Table 3 the moisture content after drying shall be equal or less than 0.02 % moisture

10. Conditioning

10.1 Conduct the tests in the standard laboratory atmosphere of 23 °C and 50 % relative humidity.

11. Test Methods

11.1 *Determination of Melting Temperature (Tm) and Crystallization Temperature (T-crystallization)*—The melting temperature shall be determined according to Test Method D3418 using the following specific test conditions and supplementary instructions.

11.1.1 Sample size 5 to 10 mg. If applicable, grind the sample.

11.1.2 Close the cup as described in the DSC manual and check that the bottom of the sample cup is flat.

11.1.3 Place the cup in the oven of the DSC, next to the reference cup.

11.1.4 Start the temperature profile as listed below under a nitrogen atmosphere.

11.1.4.1 Start at 25 ºC

11.1.4.2 Increase the temperature to at least the expected Tm+20 °C with 5 ºC per min.

11.1.4.3 Keep the temperature at the selected temperature for 1 min.

11.1.4.4 Cool down to –50 ºC with 5 ºC per min.

TABLE 3 Grade—Property Requirements[A]

Property	Test Standard	Unit	Cell Limits									
			0	1	2	3	4	5	6	7	8	9
T-crystallization (range ±10 °C)	ASTM D3418	°C	Unspecified	60	65	70	75	80	85	90	100	Specify value
G* at 23 °C[B] (minimum)	ASTM D5279	MPa	Unspecified	20	40	60	80	100	120	150	180	Specify value
G* at 75 °C[B] (minimum)	ASTM D5279	MPa	Unspecified	1	10	20	30	40	50	75	100	Specify value
dlogG/dT, phase shift angle 30°[B] (maximum)	ASTM D5279	$°C^{-1}$	Unspecified	–0.60	–0.55	–0.50	–0.45	–0.40	–0.35	–0.30	–0.25	Specify value
Shear Viscosity (range ±15 Pa.s)	ISO 2555	Pa·s[C]	Unspecified	15	20	25	30	35	40	45	50	Specify value

[A] See Section 11, Test Methods, for specific test conditions and supplementary instructions.
[B] See 11.2, determination of the complex modulus G*.
[C] Test temperature JIM Group 1 (160 ± 2) °C.

11.1.4.5 Keep the temperature at –50 ºC for 1 min.

11.1.4.6 Increase the temperature to the selected temperature with 5 ºC per min.

11.1.4.7 Determine the Tm and Tc according to Test Method D3418.

11.2 *Determination of G* at 23 °C and 75 °C, and dlogG*/dT*—The G* at 23 °C, at 75 °C and the dlogG*/dT shall be determined according to Test Method D5279 using the following specific test conditions and supplementary instructions.

11.2.1 *Equipment:*

11.2.1.1 Rotation rheometer equipped with 8 mm Ø plate/plate measuring geometry.

11.2.1.2 Upper plate of the measurement system capable of being lowered down to a position of 0.5 mm above the bottom plate.

11.2.2 *Procedure:*

11.2.2.1 Place the polymer sample on the bottom plate at a temperature of at least Tm+20 °C, being sufficiently high to melt the sample completely (Note 3).

11.2.2.2 After an equilibration time of 1 min the molten sample is cooled down to –20 °C and subsequently heated up to the selected temperature, both at a rate of 4 °C/min

11.2.2.3 While cooling and heating, the sample is subjected to a small oscillatory shear deformation γ(t); amplitude γo = 0.001, frequency of 1 Hz.

Before the sample solidifies, the sample height is kept constant at 0.5 mm. When the sample solidifies, a continuous shrinkage is reflected by a Tensile Force F > 0 N.

At F >5 N the sample height control is (automatically) switched from 'constant height 0.5 mm' to 'constant compression 2 N' allowing the sample height to decline due to crystallization shrinkage.

The constant compression control is continued during the remaining cooling cycle and during the first part of the heating cycle. At the moment the complex modulus G* declines below a value of 2.107 Pa, the sample height control is (automatically) switched to 'constant height' to avoid the sample to be squeezed out of the plate/plate geometry at further increase of the temperature.

11.2.2.4 Measure the complex shear modulus G* as function of temperature during cooling and heating of the sample. The complex shear modulus G* at 23 °C and 75 °C is obtained from the heating curve. Reliable values for G* at 75 °C and dlogG*/dT are obtained if the G* is within the range of 5*103 Pa to 7*108 Pa.

NOTE 3—Increase the temperature if the measurement shows that the selected temperature has been too low.

11.3 *Determination of Shear viscosity*—The shear viscosity shall be determined in accordance with ISO 2555 at the specified temperature in Table 3.

11.4 The number of tests shall be consistent with the requirements of Section 8 and 12.4.

12. Inspection and Certification

12.1 Inspection and certification of the material supplied with reference to a specification based on this classification system shall be for conformance to the requirements specified herein.

12.2 Lot-acceptance inspection shall be the basis on which acceptance or rejection of the "lot" is made. The lot-acceptance inspection shall consist of the tests listed as they apply:

12.2.1 Melting point

12.2.2 Shear viscosity

12.3 Periodic-check inspection with reference to a specification based upon this classification system shall consist of the tests specified for all requirements of the material under the specification. Inspection frequency shall be adequate to assure the material is certifiable in accordance with 12.4.

12.4 Certification shall be that the material was manufactured by a process in statistical control, sampled, tested and inspected in accordance with this classification system and that the average values for the lot meet the requirements of the specification line callout.

NOTE 4—The ASTM publication, Manual on Presentation of Data and Control Chart Analysis, 7th Edition, stock number MNL7A, provides detailed information about statistical process control.

12.5 Reports of the test results shall be furnished when requested. The report shall consist of results of the lot acceptance inspection for the shipment and results of the most recent periodic check inspection.