



Designation: D 4357 – 96

Standard Specification for Plastic Laminates Made from Woven-Roving and Woven- Yarn Glass Fabrics¹

This standard is issued under the fixed designation D 4357; 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 specification covers standard plastic laminates, their testing, and minimum property requirements, for the qualification of materials used to manufacture structural, semi-structural, or electrical composites of fiberglass woven-roving and woven-yarn fabrics. It covers, in part, plastic laminates designed for printed-circuit boards, which are specified in MIL-P-13949. It does not cover glass-reinforced plastic laminates for armor, which are specified in MIL-A-46166 and the companion MIL-A-46165 on input woven-roving glass fabric.

NOTE 1—Companion ASTM specifications on the input woven-roving glass fabrics and woven-glass fabrics are included in Section 2.

NOTE 2—This specification is one of a series to provide a replacement for ASTM Specification D 2150 and Military Specifications MIL-Y-1140 and MIL-C-19663.

NOTE 3—This specification may replace Military Specification MIL-C-9084 upon further examination as to the utility of Specification D 4357 in military procurement.

1.2 The following precautionary caveat pertains only to the test method portion, Section 8, of the specification: *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 and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 4—There is no similar or equivalent ISO standard.

2. Referenced Documents

2.1 ASTM Standards:

- D 123 Terminology Relating to Textiles²
- D 150 Test Methods for A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials³
- D 618 Practice for Conditioning Plastics for Testing⁴
- D 638 Test Method for Tensile Properties of Plastics⁴

¹ This specification is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.18 on Reinforced Thermosetting Plastics.

Current edition approved Nov. 10, 1996. Published May 1997. Originally published as D 4357 – 84. Last previous edition D 4357 – 85 (1990).

² Annual Book of ASTM Standards, Vol 07.01.

³ Annual Book of ASTM Standards, Vol 10.01.

⁴ Annual Book of ASTM Standards, Vol 08.01.

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

D 883 Terminology Relating to Plastics⁴

D 2150 Specification for Woven Roving Glass Fabric for Polyester-Glass Laminates⁵

D 2584 Test Method for Ignition Loss of Cured Reinforced Resins⁶

D 4029 Specification for Finished Woven Glass Fabrics⁷

D 4389 Specification for Finished Glass Fabrics Woven from Rovings⁷

2.2 Military Specifications:⁸

MIL-A-46165 Armor: Woven Glass Roving Fabrics

MIL-A-46166 Plastic Laminates, Glass Reinforced (For Use in Armor Composites)

MIL-C-9084 Cloth, Glass, Finished, for Resin Laminates

MIL-C-19663 Cloth, Woven Roving, for Plastic Laminates

MIL-C-9084C

MIL-P-13949 Plastic Sheet, Laminated, Metal Clad (for Printed Wiring Boards), General Specification for

MIL-Y-1140 Yarn, Cord, Sleeving, Cloth, and Tape-Glass

2.3 Military Standard:⁸

MIL-STD-105 Sampling Procedures for Inspection by Attributes

2.4 This plastic laminate specification will provide a substitute for the following military specifications:

MIL-R-7575 Resin, Polyester, Low Pressure Laminating

MIL-R-9299 Resin, Phenolic, Laminating

MIL-R-9300 Resin, Epoxy, Low Pressure Laminating

MIL-P-13949 Plastic Sheet, Laminated, Metal Clad (for Printed Writing Boards), General Specification for

MIL-R-21607 Resin, Polyester, Low Pressure Laminating, Fire Retardant

MIL-R-25506 Resin, Silicone, Low Pressure Laminating

3. Terminology

3.1 Definitions:

⁵ Discontinued, see 1986 Annual Book of ASTM Standards, Vol 08.02.

⁶ Annual Book of ASTM Standards, Vol 08.02.

⁷ Annual Book of ASTM Standards, Vol 07.02.

⁸ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

3.1.1 *fabric, woven, n*—a planar structure produced by interlacing two or more sets of rovings or yarns where the elements pass each other essentially at right angles and one set is parallel to the fabric axis (warp) and the other set is perpendicular to the axis (filling).

3.1.2 *roving, n*—a multiplicity of continuous fibers or filaments coated with a suitable sizing system and gathered together into an approximate parallel arrangement with little or no twist. The filaments may or may not be grounded into intermediate strands.

3.1.3 *strand, n*—an ordered, parallel assemblage of textile fibers having a high ratio of length to diameter and normally used as a unit intermediate in size between a single fiber and derived products, consisting of a multiplicity of strands, such as multi-end rovings, plied yarns, cords, braids, ropes, etc.

3.1.4 *yarn, continuous glass, n*—yarn made of filaments that extend substantially throughout the length of the yarns.

3.1.5 *yarn, glass-fabricated, n*—yarn containing two or more strands plied together.

3.1.6 *yarn, textured-glass, n*—yarns processed from continuous yarns in such a manner so as to induce bulk to the yarn by disorientation of the filaments.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *roving, woven, n*—a heavy, coarse, but drapable fabric woven from roving and having characteristically unequal bi-directional laminate strengths even with equal roving count in plain weave.

3.2.2 *yarn, woven, n*—a light, supple fabric, or cloth, woven from textile yarn, which, when in plain weave with uniform count and equal yarn numbers, has approximately equal laminate strengths in the warp and fill directions.

3.3 For definitions of other textile terms used in the specification, refer to Terminology D 123.

3.4 For definitions of other terms related to laminate properties, refer to Terminology D 883.

4. Classification

4.1 *Designation of Glass Woven-Roving Laminates*—The ASTM-type numbers assigned to glass woven-roving fabrics, which are characterized by their mass per unit area and fabric counts, are also used to designate the corresponding test laminates (see Table 1).

4.2 Glass woven-yarn fabrics for laminates are cleaned and after-finished in five basic types of sizing (coupling) systems. The five types of finishes are as follows:

4.2.1 *Type I*—Amino-silane.

4.2.2 *Type II*—Vinyl-silane.

4.2.3 *Type III*—Chrome complex.

4.2.4 *Type IV*—Acrylic-silane.

4.2.5 *Type V*—Epoxy-functional silane.

4.3 The grades of woven-glass-yarn fabric laminates shall be designated by fabric style numbers that are standard throughout the industry. Generally used style numbers are listed in numerical order in Tables 2 and 3.

4.4 Each type and grade of woven-glass fabric may be used with one or more classes of resin systems to produce plastic laminates. The six classes of resins are as follows:

4.4.1 *Class 1*—Polyester.

4.4.2 *Class 2*—Epoxy.

4.4.3 *Class 3*—Silicone.

4.4.4 *Class 4*—Phenolic.

4.4.5 *Class 5*—Vinylester.

TABLE 1 Minimum Average Flexural and Tensile Strengths for 3.17 mm (0.125 in.) Thick Polyester Laminates made with Woven-Roving Glass Fabrics of Plain Weave

ASTM TYPE	Woven Roving Nominal Average Mass/Weight ^B		Roving Count 25.4 mm (1 in.) min		Number of Plies in Laminate	Flexural Strength, MPa ^A /psi				Tensile Strength, MPa ^A /psi			
						Lengthwise		Crosswise		Lengthwise		Crosswise	
						dry	wet	dry	wet	dry	wet	dry	wet
1	441	13.0	10	4	8	410	280	170	100				
2	542	16.0	10	4	6	60 000	40 000	25 000	15 000				
3	831	24.0	5	4	4	380	210	240	140				
4	831	24.5	5	3	4	55 000	30 000	35 000	20 000				
5	...	22.0	5	3.5		340	210	280	210	260		210	
6	915	27.0	5	2.5	3 ^C	50 000	40 000	40 000	32 000	38 000		30 000	
7	610	18.0	7	6	5	340	210	240	140				
8	...	18.0	7	5		50 000	30 000	35 000	20 000				
9	745	22.0	5	4	4	50 000	30 000	35 000	20 000				
10	...	18.0	5	4		340	210	280	210				
11	610	18.0	4	4	5	50 000	30 000	35 000	20 000				
12	559	16.5	5	4		60 000	50 000	45 000	40 000				
13	711	21.0	4	4	4	70 000	55 000	50 000	40 000	40 000		32 000	
14	610	18.0	4	2.5	5								

^A Megapascal (MPa) rounded to the nearest ten (10).

^B Tolerance $\pm 10\%$.

^C The laminate thickness shall be 2.79 ± 0.254 mm (0.110 ± 0.010 in.) instead of 3.17 ± 0.254 mm (0.125 ± 0.010 in.) for this style only.