



Designation: D3531/D3531M – 24

Standard Test Method for Resin Flow of Carbon Fiber-Epoxy Prepreg¹

This standard is issued under the fixed designation D3531/D3531M; 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 test method covers the determination of the amount of resin flow that will take place from carbon fiber-epoxy prepreg material (fabric, tape or sheet) under given conditions of temperature and pressure.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.2.1 Within the text, inch-pound units are shown in brackets.

1.3 *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.*

1.4 *This international standard was developed in accordance with the Suppliers of Advanced Composite Materials Association (SACMA) recommended method for Determining the Resin Flow of Preimpregnated “B” Staged Materials.*

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.*

2. Referenced Documents

2.1 ASTM Standards:²

D883 Terminology Relating to Plastics

¹ This test method is under the jurisdiction of ASTM Committee D30 on Composite Materials and is the direct responsibility of Subcommittee D30.03 on Constituent/Precursor Properties.

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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.

D3878 Terminology for Composite Materials

3. Terminology

3.1 *Definitions*—Terminology D3878 defines terms relating to high-modulus fibers and their composites. Terminology D883 defines terms relating to plastics. In the event of a conflict between terms, Terminology D3878 shall have precedence over other standards.

3.2 Symbols:

3.2.1 RF —resin flow

3.2.2 W_f —weight of the prepreg specimen prior to flow test

3.2.3 W_2 —weight of the specimen assembly prior to heating

3.2.4 W_3 —weight of the specimen assembly after heating

3.2.5 W_4 —weight of the prepreg specimen after flow test

4. Summary of Test Method

4.1 Test Method I:

4.1.1 Weigh a specimen consisting of two plies a minimum size of 50 mm [2.0 in.] square, oriented in a 0°/ 90° crossply configuration, and sandwiched between separator cloth, bleeder material and release film.

4.1.2 Unless otherwise specified by the test requestor to use another temperature, the following conditions (A or B) are used. The specimen assembly is placed in a platen press heated to either temperature A, 120 °C $\pm$ 3 °C [250 °F $\pm$ 5 °F], or temperature B, 175 °C $\pm$ 3 °C [350 °F $\pm$ 5 °F] or another specified temperature. The press is closed to provide a pressure of 700 kPa $\pm$ 70 kPa [100 psi $\pm$ 10 psi]. The pressure is held for 15 min or until the resin gels.

4.1.3 The cooled specimen assembly is removed and the resin that has flowed to the edges of the specimen is removed and the specimen reweighed. The change in weight is expressed as a percent of the original weight and reported as percent flow.

4.2 Test Method II:

4.2.1 Weigh a specimen consisting of four plies 100 mm [4.0 in.] square from across the width of the material, oriented in a 0°/90° crossply of the principal reinforcement axis, and sandwiched between separator cloth, bleeder material and release film.

4.2.2 The specimen assembly is placed in a platen press preheated to the temperature required for the resin system or a specified temperature. The press is closed to the pressure required by specification for the resin system or a specified pressure. The pressure is held for five minutes past the gel time.

4.2.3 The cooled specimen assembly is removed and the resin that has flowed to the edges of the specimen is removed and the specimen reweighed. The change in weight is expressed as a percent of the original weight and reported as percent flow.

4.3 If no test method is specified, test shall be performed in accordance with Test Method I.

5. Significance and Use

5.1 This test method is used to obtain the resin flow of carbon fiber-epoxy prepreg tape, fabric or sheet material. It is suitable for comparing batches of material of supposedly the same characteristics and also for comparative evaluation of materials produced by different vendors using different resin-fiber combinations.

5.2 Composite parts are laminated from prepreg material at various pressures and temperatures. Production process design will require a flow test be run at a temperature and a pressure close to that of the actual processing conditions. All methods of measuring resin flow are dependent on the size and geometry of the specimen. This test method uses the smallest quantity of material that will give reproducible results.

5.2.1 The percent resin flow of a single fiber and resin system at a temperature and pressure varies with the volatile content, degree of advancement of epoxy resin, and with the resin content of the prepreg tape, fabric or sheet.

5.2.2 As volatile content and degree of resin cure (advancement) change with time, this test method is useful in comparing the life of prepreg tape, fabric and sheet.

5.3 Method II has been introduced to match the test setup and procedure of SACMA SRM 22R-94: Determining the Resin Flow of Preimpregnated "B" Staged Material. This method should only be needed to conduct testing in a manner that aligns with the old SACMA method. Otherwise it is recommended to use Method I.

6. Interferences

6.1 This test method depends on platen force being supplied evenly to the specimen. For this to be done, the platen must load evenly across its surface and not point load to the point of initial contact. When bleeder materials are used on the top and bottom of the specimen, the effect of uneven pressure application is less pronounced than if no bleeder materials are used. Bleeders tend to minimize pressure effects, since if resin flows into the bleeder it will do so within a broad pressure range. Sometimes, platen pressure needs to be increased gradually to assure even loading.

6.2 The platen flatness must be sufficient for the specimen to load evenly. For this reason the specimen thickness should be at least five times the tolerance of platen flatness. Specimens that do not meet this requirement should have additional ply layers oriented as a repeating unit of the first two plies.

6.3 Ply orientation and coupon size directly affects reported flow. A specimen cut with a ply orientation of 45° will not have the same reported flow as a specimen cut with a ply orientation of 0°. This is because flow paths are hindered to a different degree based on the different coupon size and orientation.

6.4 Temperature should be even across the specimen and within the tolerance specified. Temperature influences resin viscosity, which effects flow rate.

6.5 Generally, larger coupon sizes reduce lateral flow since resin has further to travel to the edge of the specimen. Larger coupon sizes do not greatly influence horizontal flow (with bleeders). However, difficulty in coupon handleability increases with increasing coupon size. Also small coupon size of 50 mm [2.0 in.] square is felt to be the minimum coupon size. A maximum practical size is 100 mm [4.0 in.] square.

6.6 The matching of angles and footprint from one ply to the next is critical. Flow differences may be found if the ply layers do not superimpose on top of each other or are aligned with an angle bias.

6.7 It is recommended that the heated platens remain closed under pressure until resin gelation occurs. Shorter times may cause some of the flowed resin to associate back with the specimen rather than the bleeder cloth. Leaving the specimen in the press after gelation has no effect on flow results.

7. Apparatus

7.1 *Cutting Template*, square metal, 50 mm $\pm$ 1 mm by 50 mm $\pm$ 1 mm [2.0 in. $\pm$ 0.04 in. by 2.0 in. $\pm$ 0.04 in.], minimum.

7.2 *Cutting Template*, metal, 100 mm $\pm$ 1 mm by 100 mm $\pm$ 1 mm [4.0 in. $\pm$ 0.04 in. by 4.0 in. $\pm$ 0.04 in.], minimum.

7.3 *Cutting Knife*, single edge.

7.4 *Analytical Balance* capable of weighing to the nearest 0.001 g [0.000035 oz].

7.5 *Glass Bleeder Cloth*, Style 1581, Style 7781 or Style 7581 or equivalent fiberglass fabric (any weave of fiberglass fabric between 288.2 and 305.1) is acceptable.

7.6 *TFE-Fluorocarbon Coated, Woven Separator Cloth*,³ porous.

7.7 *Release Film* of 0.03 mm to 0.06 mm [0.001 in. to 0.002 in.] thickness polyester, aluminum, etc.

7.8 *Platen Press*, capable of being heated to 175 °C $\pm$ 3 °C [350 °F $\pm$ 5 °F] and capable of applying 4000 N [900 lbf] for Test Method I and 16 kN [3600 lbf] for Test Method II. Flat caul sheets or caul plates can be used to handle the assemblies in and out of the press.

8. Test Specimen

8.1 A minimum of three specimens shall be tested for each sample.

8.2 The test specimen shall consist of:

³ DuPont product TX-1040 or equivalent has been found satisfactory for this purpose.