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.

Designation: D6772/D6772M – 22

Standard Test Method for Dimensional Stability of Sandwich Core Materials[1]

This standard is issued under the fixed designation D6772/D6772M; 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 test method covers the determination of the sandwich core dimensional stability in the two plan dimensions.

1.2 *Units*—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, the 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 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]

C271/C271M Test Method for Density of Sandwich Core Materials
D883 Terminology Relating to Plastics
D3878 Terminology for Composite Materials
D5229/D5229M Test Method for Moisture Absorption Properties and Equilibrium Conditioning of Polymer Matrix Composite Materials
E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E456 Terminology Relating to Quality and Statistics

3. Terminology

3.1 *Definitions*—Terminology D3878 defines terms relating to high-modulus fibers and their composites, as well as terms relating to sandwich constructions. Terminology D883 defines terms relating to plastics. Terminology E456 and Practice E177 define terms relating to statistics. In the event of a conflict between terms, Terminology D3878 shall have precedence over the other terminologies.

3.2 *Symbols:*

3.2.1 *CV*—coefficient of variation statistic of a sample population for a given property (in percent)

3.2.2 L_i— initial (pre-test) measured dimension

3.2.3 L_f—post-heating measured dimension

3.2.4 S_{n-1}—standard deviation statistic of a sample population for a given property

3.2.5 x_I—test result for an individual specimen from the sample population for a given property

3.2.6 $\bar{x}$—mean or average (estimate of mean) of a sample population for a given property

4. Summary of Test Method

4.1 This test method consists of placing a small piece of sandwich core material in an elevated temperature environment for a specified period of time. After cooling, the dimensional changes in the planar dimensions are measured and compared to the initial measurements taken prior to thermal exposure, both immediately after heating and after re-conditioning. A typical honeycomb core specimen is shown in Fig. 1.

5. Significance and Use

5.1 Sandwich panel cores may change planar dimensions when heated. This phenomenon can be associated with the effects of heating upon the core material itself, as well as changes in core moisture content resulting from the heating cycle. It is prudent to know if this may be problematic with regard to the intended final part dimensions.

[1] This test method is under the jurisdiction of ASTM Committee D30 on Composite Materials and is the direct responsibility of Subcommittee D30.09 on Sandwich Construction.

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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.

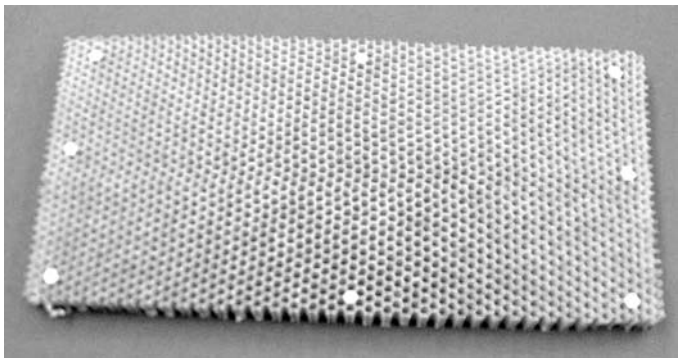

FIG. 1 Dimensional Stability Specimen

5.2 This test method provides a standard method of characterizing the dimensional stability of sandwich core materials for design properties, material specifications, research and development applications, and quality assurance.

5.3 Factors that influence dimensional stability of sandwich core materials and shall therefore be reported include the following: core material, methods of material fabrication, core geometry, core thickness, core thickness uniformity, cell wall thickness, specimen geometry, specimen preparation, heating and cooling environments (including temperatures and humidity levels), and specimen conditioning (both prior to and after heating).

6. Interferences

6.1 *Material and Specimen Preparation*—Poor material fabrication practices and damage induced by improper specimen machining are known causes of high data scatter for sandwich cores. Important aspects of sandwich core specimen preparation that contribute to data scatter include the existence of joints, voids or other core discontinuities, out-of-plane curvature, and surface roughness.

6.2 *Core Geometry*—Core-specific geometric factors that affect dimensional stability include core cell size, uniformity of core cell geometry, core cell wall thickness, core cell wall thickness uniformity, core thickness, and core thickness uniformity.

6.3 *Environment*—Results are affected by the environmental conditions (including both temperatures and humidity levels) under which specimens are pre-conditioned, the elevated temperature exposure environment, the re-conditioning environment after heating, as well as the conditions under which the planar dimensional measurements are taken. Specimens tested in various environments can exhibit differences in dimensional stability.

7. Apparatus

7.1 *Micrometers and Calipers*—A micrometer having a flat anvil interface, or a caliper of suitable size, shall be used. The accuracy of the instrument(s) shall be suitable for reading to within 0.5 % of the sample length, width and thickness. For typical specimen geometries, an instrument with an accuracy of ±0.025 mm [±0.001 in.] is desirable for thickness measurement, whereas an instrument with an accuracy of ±0.25 mm [±0.01 in.] is desirable for length and width measurement.

7.2 *Balance or Weighing Scale*—An analytical balance or weighing scale is required that is capable of measuring the mass of the core material accurately to ±0.5 %.

7.3 *Oven*—An air-circulating oven is required that shall be capable of maintaining the required temperature to within ±3 °C [±5 °F].

8. Sampling and Test Specimens

8.1 *Sampling*—Test at least five specimens per test condition unless valid results can be gained through the use of fewer specimens, such as in the case of a designed experiment. For statistically significant data, consult the procedures outlined in Practice E122. Report the method of sampling.

8.2 *Test Specimens:*

8.2.1 *Core Thickness*—Standard test specimens shall utilize 13 mm [0.50 in.] thick core. When assessing dimensional stability characteristics of core used in specific sandwich constructions, it is recommended to test the actual core thickness used in the end application. Tests conducted using non-standard core thicknesses must be designated as such, with the core thickness reported with any test results.

8.2.2 *Core Planar Geometry*—Core test specimens shall be approximately 450 mm [18 in.] by 900 mm [36 in.] in the planar dimensions. For honeycomb cores, the planar dimension cross section is defined to be in the facing plane (in regard to the orientation that the core would be placed in a structural sandwich construction) and is perpendicular to the orientation of the cell walls. For honeycomb cores, the 450 mm [18 in.] dimension is the core's ribbon or *L* direction. Other dimensions can be used, but must be reported. Smaller specimens may be used if oven size is limited.

8.2.3 *Core Preparation and Machining*—Prepare the core material samples so that the facing plane surfaces are parallel to each other and perpendicular to the sides of the core. Take precautions when cutting specimens from large sheets of core material to avoid notches, undercuts, rough or uneven surfaces due to inappropriate machining methods. Record and report the core material specimen cutting preparation method.

8.2.4 If core material density is to be reported, samples used to determine density shall be obtained from the same sheet of core being tested. Density may be evaluated in accordance with Test Method C271/C271M.

8.3 *Labeling*—Label the test specimens so that they will be distinct from each other and traceable back to the sheet of origin, and will neither influence the test nor be affected by it.

9. Calibration

9.1 The accuracy of all measuring equipment shall have certified calibrations that are current at the time of use of the equipment.

10. Conditioning

10.1 Pre-test environmental conditioning requirements shall be specified by the test requestor. The recommended pre-test

condition is effective moisture equilibrium at a specific relative humidity as established by Test Method D5229/D5229M; however, if the test requestor does not explicitly specify a pre-test conditioning environment, no conditioning is required and the test specimens may be tested as prepared.

10.2 The pre-test specimen conditioning process, to include specified environmental exposure levels and resulting moisture content, shall be reported with the test data.

NOTE 1—The term "moisture," as used in Test Method D5229/D5229M includes not only the vapor of a liquid and its condensate, but the liquid itself in large quantities, as for immersion.

10.3 If no explicit pre-test conditioning process is performed, the pre-test specimen conditioning process shall be reported as "unconditioned" and the moisture content as "unknown."

10.4 Post-heating environmental conditioning requirements shall be specified by the test requestor. The recommended post-heating condition is moisture content equivalency to that after pre-test conditioning, which is obtained by re-conditioning the specimen in the same conditioning environment used for pre-conditioning for an equivalent duration. If the test requestor does not explicitly specify a re-conditioning environment, no re-conditioning is required.

10.5 The specimen re-conditioning process, to include specified environmental exposure levels, shall be reported with the test data.

10.6 If no explicit re-conditioning process is performed, the specimen re-conditioning process shall be reported as "unconditioned" and the moisture content as "unknown."

11. Procedure

11.1 *Parameters to be Specified Before Test:*

11.1.1 The specimen sampling method, specimen geometry, and conditioning travelers (if required).

11.1.2 The properties and data reporting format desired.

NOTE 2—Determine specific material property, accuracy, and data reporting requirements prior to test for proper selection of apparatus.

11.1.3 The environmental pre-conditioning and re-conditioning parameters.

11.2 *General Instructions:*

11.2.1 Report any deviations from this test method, whether intentional or inadvertent.

11.2.2 Following final core material specimen machining, but before conditioning and testing, measure the specimen length and width in the planar dimensions at three places. The thickness of the specimen shall be measured at four locations and recorded as the average of the four measurements. The accuracy of these measurements shall be within 0.5 % of the dimension. Measure the specimen length and width with an accuracy of ±0.25 mm [±0.010 in.]. Measure the specimen thickness with an accuracy of ±0.025 mm [±0.001 in.]. Record the dimensions to three significant figures in units of millimeters [inches]. If the specimen warps, it may be flattened while making the measurements.

11.2.3 Determine the mass of the specimen with an accuracy of ±0.5 %.

11.3 Condition the specimens as required. Store the specimens in the conditioned environment until test time, if the test environment is different than the conditioning environment. Record the total time that the specimens are exposed to the conditioning environment.

11.4 Following final specimen conditioning, but before testing, re-measure the specimen length, width, and thickness as in 11.2.2, and re-measure the specimen mass as in 11.2.3.

11.5 Mark the specimen in eight locations as shown in Fig. 1. For honeycomb core, it is recommended that the cells be potted with a resin at the eight locations and then marked (see Fig. 2). Recommended dimensional locations for the eight markings are shown in Fig. 3.

11.6 Measure the dimensions between the marked locations with an accuracy of ±0.25 mm [±0.010 in.]. Make three measurements in one direction and three measurements in the other direction, as shown in Fig. 3.

11.7 Preheat the oven to 175 ± 3 °C [350 ± 5 °F] and place the specimen flat on a wire-mesh-type shelf. Other temperatures may be used but must be reported.

11.8 After 90 min exposure in the oven, remove the specimen from the oven and allow to cool in the specified re-conditioning environment.

11.9 When the specimen is at room temperature, re-measure the six dimensions as in 11.6 and record as the immediate post-heating dimensions. The immediate post-heating dimensional changes reflect the combined effects of heating and drying upon the core dimensional stability.

11.10 Re-condition the specimen in the same conditioning environment used to pre-condition the specimen, for at least the same total time recorded in 11.3.

11.11 Re-measure the six dimensions as in 11.6, and record as the final post-heating dimensions. The final post-heating dimensional changes reflect the effects of heating upon the core, as the final moisture content should approximate the pre-conditioned moisture content.

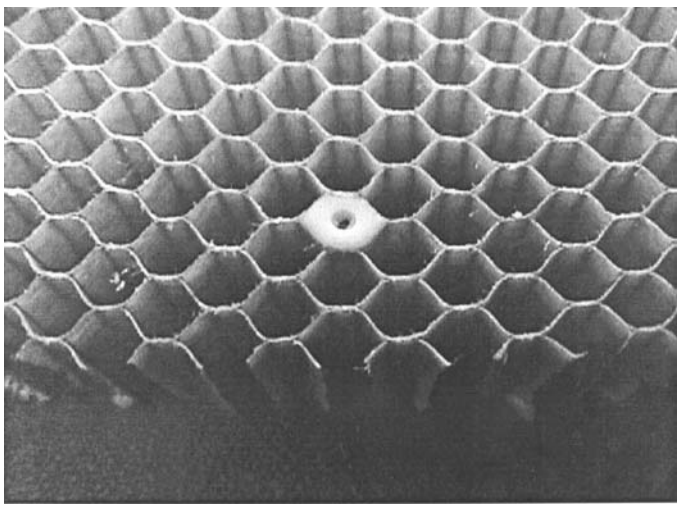

FIG. 2 Potted Honeycomb Cell