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IPC-TM-650
TEST METHODS MANUAL

Number	
2.4.4.1	
Subject	
Flexural Strength of Laminates (at Elevated Temperature)	
Date	Revision
12/94	**A**
Originating Task Group	
MIL-P-13949 Test Methods Task Group (7-11b)	

1.0 Scope This test method is designed to determine the flexural strength of laminates of the thicknesses greater than, or equal to, 0.51 mm [0.020 in] by applying a specific load to a specified sized and shaped specimen at elevated temperature.

2.0 Applicable Documents

ASTM-D-790 Flexural properties of unreinforced and reinforced plastics and electrical and insulating materials.

IPC-TM-650

Method 2.3.6, Etching Ammonium Persulfate
Method 2.3.7, Etching Ferric Chloride
Method 2.3.7.1, Cupric Chloride Etching
Method 2.4.25, Glass Transition Temperature and Cure Factor by DSC

3.0 Test Specimens

3.1 Size and Configuration Dimensions of the specimens shall be as shown in Table 1. Edges of the specimens shall be free of fractures, delamination, or roughness by means of sanding or other equivalent means (do not radius the edges).

3.2 Quantity and Sampling Unless otherwise specified, four test specimens shall be cut from the lengthwise direction of the sample sheet or panel.

4.0 Apparatus or Material

4.1 Tester A standard tension and compression test apparatus, which can be operated at a constant rate of crosshead movement shown in Table 1. The error in the load measuring system shall not exceed ± 1%. The loading nose and supports shall have cylindrical surfaces. The radius of nose and support shall be at least in accordance with ASTM-D-790 (in order to avoid excessive indentation).

4.2 Test chamber designed to shroud the specimens, test jaws and movable shafts as an integral part of the tester, or equivalent. Chambers must be capable of maintaining the test temperature as shown in Table 2 to within ± 3°C [5.4°F].

4.3 Etching system capable of complete removal of metallic cladding.

4.4 Measuring devices capable of measuring specimen width to the nearest 0.025 mm [0.001 in] and specimen thickness to the nearest 0.0025 mm [0.0001 in].

5.0 Procedure

5.1 Specimen Preparation

5.1.1 When applicable, etch off all metallic cladding in accordance with accepted industry practices. For referee testing, etching shall be in accordance with 2.3.6, 2.3.7, or 2.3.7.1

5.1.2 Cut specimens to the size as shown in Table 1 and smooth the edges of specimens. Measure and record specimen width to the nearest 0.0025 mm [0.001 in], and thickness to the nearest 0.0025 mm [0.0001 in].

Table 1

	Specimen Dimensions		Test Parameters	
Nominal thickness[1] mm [inches]	**Width[2] mm [inches]**	**Length[3] mm [inches]**	**Span mm [inches]**	**Speed of testing mm [inches] per min.**
0.79 [0.031]	25.4 [1.0]	63.5 [2.5]	15.9 [0.625]	0.51 [0.020]
1.57 [0.062]	25.4 [1.0]	76.2 [3.0]	25.4 [1.0]	0.76 [0.030]
2.36 [0.093]	25.4 [1.0]	88.9 [3.5]	38.1 [1.5]	1.02 [0.040]
3.18 [0.125]	25.4 [1.0]	101.6 [4.0]	50.8 [2.0]	1.27 [0.050]
6.35 [0.250]	12.7 [0.5]	152.4 [6.0]	101.6 [4.0]	2.03 [0.080]

1.) Nominal thicknesses other than those listed shall be prepared and tested in accordance with the next greater nominal thickness.
2.) Width as cut and smoothed to within 5% of nominal shown.
3.) Length as cut (not necessary to smooth) to within 10% of nominal shown.

Table 2

Resin Type	Thickness	Test Temperature
Difunctional, tetrafunctional epoxies	ALL	125°C
Hot Strength Retention Epoxies High Temperature Epoxies	Up to 1.6 mm [0.063 inch] 1.6 mm [0.063 inch] and over	190°C 170°C
BT- epoxies Modified epoxies	ALL	170°C
Polyimide of T_g greater than 250°C[1]	ALL	204°C
Polyimides of T_g less than or equal to 250°C[1]	ALL	170°C
Cyanate Esters	ALL	204°C

[1] T_g measured by IPC-TM-650, Test Method 2.4.25

5.2 Measurement

5.2.1 Set tester for the required span and crosshead vertical speeds, as specified in Table 1.

5.2.2 Align the loading nose and supports so that the axis of the cylindrical surfaces are parallel, and the loading nose is midway between the supports.

5.2.3 Condition specimens within the test chamber, for one hour at the temperature specified (see Table 2, or the applicable specification).

5.2.4 Center the specimen on the supports with the long axis of the specimen perpendicular to the loading nose and supports and stabilize for 2 minutes at temperature.

5.2.5 Apply the load at the speed of testing from Table 1 until the specimen breaks. The load at breakage shall be recorded in pounds (P).

5.3 Calculation and Report

5.3.1 Calculate the flexural strength for each specimen using the formula below:

$$S = \frac{3PL}{2bd^2}$$

S = Flexural strength in Psi

P = Load at breakage (pounds)

L = Span, inch

b = Width of specimen

d = Thickness

5.3.2 Average the flexural strengths and record in psi.

5.3.3 The specimen thicknesses, average Psi, and test temperature shall be reported.

6.0 *Notes* None

6.1 Additional information and background useful to the performance of the test may be found in ASTM-D-790.