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IPC-TM-650
TEST METHODS MANUAL

Number	
2.4.8	
Subject	
Peel Strength of Metallic Clad Laminates	
Date	Revision
12/94	**C**
Originating Task Group	
MIL-P-13949 Test Methods Task Group (7-11b)	

1.0 Scope This test method is designed to determine the peel strength of metallic cladding when tested in the following conditions, ''as received,'' after thermal stress, and after exposure to processing chemicals; and to evaluate the base laminate material after the peel strength test is completed for degradation due to the conditioning.

2.0 Applicable Documents

IPC-TM-650

Method 2.4.8.1, Peel Strength, Metal Foil (Keyhole Method for Thin Laminates)
Method 5.8.3, Peel Strength Test Pattern

3.0 Test Specimens

3.1 Size and Configuration Specimens shall be 50.8 mm x 50.8 mm [2.0 x 2.0 in] by the thickness of the laminate. Cladding test strips shall be as specified (see 5.1.2).

3.2 Quantity and Sampling At least 2 specimens per clad side per each test condition (see 5.2) shall be taken at random from the laminate lot. They may be taken from samples used for other QA testing or inspection. One specimen per side shall be used for crosswise and one specimen per side for lengthwise testing.

4.0 Apparatus or Material

4.1 Tensile Tester A tensile strength tester equipped with a load cell, capable of measuring to the nearest 0.0045 kg [0.01 lbs], and light load wire or chain and clamp at least 457 mm [18.0 in] long (its weight is included in the load cell calculation). The clamp jaws must cover the entire width of each peel strip. Any equipment or apparatus having the described accuracy, precision, and reproducibility may be used.

4.2 Solder Pot A solder bath or pot capable of maintaining solder at the specified temperature when measured 25.4 mm [1.0 in] below the surface. Type Sn60 or Sn63 solder shall be used.

4.3 Specimen Hold-down A suitable hold-down clamping system equivalent in performance as that defined in IPC-TM-650, Method 2.4.8.1.

4.4 Chemicals A minimum of two ounces of the following processing solutions:

4.4.1 Organic chemical stripper, such as Methylene Chloride, or equivalent

4.4.2 Sodium Hydroxide 10 gr/liter

4.4.3 Boric Acid 30 gr/liter and Sulfuric Acid 10 gr/liter

4.4.4 Organic degreaser, such as isopropyl alcohol, or equivalent.

4.5 Hot fluid bath, capable of being maintained at the specified temperature, when measured 25.4 mm [1.0 in] below the surface.

4.5.1 Dow Silicone Fluid No. 704, or equivalent.

4.6 Dow Silicone Grease, Compound 4, or equivalent.

4.7 Data Collection For qualification testing, a recording system capable of permanent data retention must be incorporated into the test apparatus.

4.8 Etching system capable of complete removal of metallic cladding.

4.9 Measuring device capable of measuring from 0.000 to 12.7 mm [0.5 in] to within ± 0.0025 mm [0.0001 in].

4.10 Etch Resist Materials or Systems

4.10.1 Platers tape, or equivalent, to act as etch resist for strip formation of the specified widths (see 5.2.1.1, 5.2.2.1, and 5.2.3.1).

4.10.2 Photoresist system (printing, developing, and stripping).

5.0 Procedure

5.1 Specimen Preparation

5.1.1 Cut the specimens from the laminate sample. Specimens shall be taken no closer than 25.4 mm [1.0 in] from the edge of the laminate sheet as manufactured.

5.1.2 Specimens shall be prepared with at least four resist strips of the width specified (see 5.2.1.1, 5.2.2.1, 5.2.3.1), etched, cleaned and processed using standard industry practices and equipment. For qualification and referee testing the specimen shall be photoimaged in accordance with the artwork shown in Method 5.8.3 of IPC-TM-650 except that tab ends are optional. Specimens shall be etched so that the conductor strips on one specimen are in one direction per Figure 1. Double clad laminate shall have each side tested using separate specimens. The opposite side cladding shall be either fully removed or left fully clad. For referee testing the cladding on the opposite side shall remain. Separate specimens for both the warp and fill directions are required for each side.

5.1.3 Thin specimens may be provided with support by bonding them to a rigid substrate base, or may be tested with the aid of the keyhole fixture (see Figure 2). For referee testing of laminates less than 0.51 mm [0.020 in], the specimens shall be bonded to a rigid substrate or laminate.

Note: Peel values can be affected by the adhesive used to bond the specimen to the rigid substrate. It is imperative that the best adhesive be found for the type of materials being bonded to least influence the true peel strength value.

5.1.4 For referee testing and qualification, specimens shall be preconditioned by baking at 125°C [257°F] for 4 ± 0.5 hours.

5.2 Measurements

5.2.1 Condition A Peel Strength: As Received

5.2.1.1 A minimum of two 3.18 mm [0.125 in] test strips per specimen shall be peeled. For qualification testing four 3.18 mm [0.125 in] strips per specimen shall be peeled.

5.2.1.2 Adjust the measurement system to compensate for the weight of the wire and clamp.

5.2.1.3 Peel the test strip back at the tab end (if present) no more than 12.7 mm [0.5 in]. Attach the clamp to the peeled back end of the test strip.

5.2.1.4 Fasten specimen with hold down fixture so that an unencumbered vertical pull can be exerted. The end of the test strip should be in a vertical position ready for testing. The wire connecting the clamp to the tensile tester must be free to pull vertically within ± 5° angle.

5.2.1.5 Start tester and apply force in the vertical direction at the rate of 50.8 mm [2.0 in]/minute, until at least a 25.4 mm [1.0 in] peel is completed (see Note 6.1).

5.2.1.6 Observe and record the minimum load as defined by Figure 1. Measure the actual width of the test strip and record with the minimum load.

5.2.1.7 If the full width of the test strip does not peel, the results shall be discarded and another strip tested.

5.2.2 Condition B Peel Strength: After Thermal Stress

5.2.2.1 A minimum of two 3.18 mm [0.125 in] test strips per specimen shall be peeled. For qualification testing four 3.18 mm [0.125 in] strips per specimen shall be peeled.

5.2.2.2 Apply a thin coating of silicon grease to specimens and float on solder maintained at 288°C ± 5.5°C [550°F ± 10°F] for 10 seconds, +1, -0.

5.2.2.3 Cool specimens to laboratory ambient temperature, Clean the grease off and perform steps 5.2.1.2 through 5.2.1.7.

5.2.3 Condition C Peel Strength: After Exposure to Processing Chemicals

5.2.3.1 A minimum of two 0.79 mm [0.032 in] test strips per specimen shall be peeled. For qualification and conformance four 0.79 mm [0.032 in] strips per specimen shall be used.

5.2.3.2 Immerse in organic stripper as specified in 4.4.1 for 75 ±5 seconds at 23 ±2°C [73.4 ±3.6°F].

5.2.3.3 Dry specimens 15 ± 5 minutes at 125 ± 5°C [257 ± 9°F].

5.2.3.4 Immerse in a solution of 10 gr/liter sodium hydroxide at 90 ± 5°C [194 ± 9°F] for 5 ±1 minutes.

5.2.3.5 Rinse in hot tap water at 50–55°C [122–131°F] for 5 ± 1 minutes.

5.2.3.6 Immerse for 30 ±5 minutes in a solution of 10 gr/liter sulfuric acid (sp. gr. 1.836) and 30 gr/liter boric acid solution at 60 ± 5°C [140 ± 9°F].

5.2.3.7 Rinse in hot water at 55 ± 5°C [131 ± 9°F] for 5 ± 1 minutes.

5.2.3.8 Dry for 30 ± 5 minutes at 125 ± 5°C [257 ± 9°F].

5.2.3.9 Immerse in a hot oil bath maintained at 220 ± 5°C [428 ± 9°F] for 40 ± 5 seconds.

5.2.3.10 Immerse in degreaser as specified in 4.4.4 at 23 ± 2°C [73.4 ± 3.6°F] for 75 ± 5 seconds to remove hot oil.

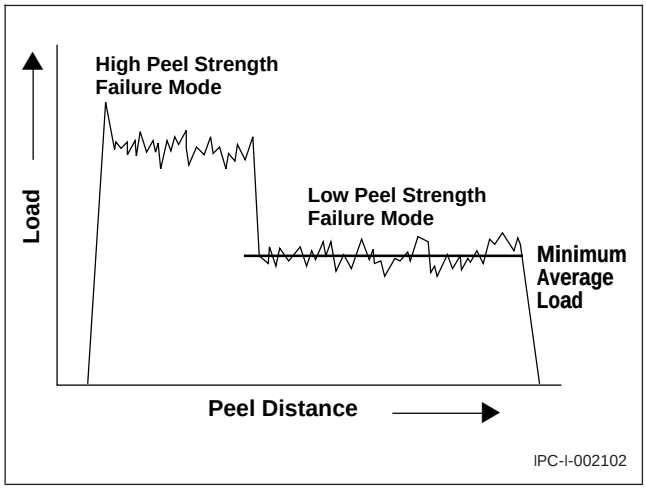

Figure 1 Multiple Failure Modes

5.2.3.11 Air dry specimens and perform steps 5.2.1.2 through 5.2.1.7.

5.2.4 Determination of Degradation Examine the specimens using normal or corrected 20/20 vision. Record and report the presence of any base laminate degradation, including loss of surface resin, discoloration, resin softening, delamination, blistering, propagation of imperfections, measling, crazing, or voids.

5.3 Calculation and Report

5.3.1 Calculate the peel strength as per the formula:

$$\text{lbs/in} = \frac{L_M}{W_S}$$

where:
L_M = Minimum Load
W_S = Measured width of peel strip

5.3.2 Record and report each individual peel strength value. Average the individual peel strength values for each side and each grain direction of the laminate sampling. For example, if the sampling plan calls for one specimen per side and per grain direction, there will be at least two values to be averaged from four different specimens.

5.3.3 Report any presence of laminate degradation as observed in 5.2.4

6.0 *Notes*

6.1 Test strip breakage may be caused by either a bond greater than the tensile strength of the foil, or foil brittleness. Where superior bond is shown (value at break above specification) the value at break may be used instead of minimum peel. The average reported shall indicate that the value is greater than average.

6.2 For metallic cladding less than one oz thickness, copper plating or solder coating may be used to build up to 0.035 ± 0.0035 mm [0.0014 ± 0.00014 in] to provide strip strength.

6.3 Environmental aspects of chemicals as specified in 4.4.1 and 4.4.4. Based on industry and government policies toward chemicals which are hazardous to worker health or of concern for ozone depletion, previous requirements for use of Methylene Chloride and 1,1,1 Trichloroethane have been replaced with equivalents.