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IPC-TM-650
TEST METHODS MANUAL

Number	
2.3.2	
Subject	
Chemical Resistance of Flexible Printed Board Materials	
Date	Revision
12/07	**G**
Originating Task Group	
Flexible Circuits Test Methods Subcommittee (D-15)	

1 Scope To determine the effect of chemicals used in printed board fabrication on metal-clad and bare flexible dielectric materials. Caution: This test method uses hazardous chemicals to generate data. The person implementing this test method should refer to the appropriate Material Safety Data Sheet or equivalent for each chemical for safe operation.

2 Applicable Documents

IPC-TM-650 Method 2.4.9, Peel Strength, Flexible Printed Wiring Materials

IPC-TM-650 Method 2.4.18.3, Tensile Strength, Elongation and Modulus

3 Test Specimens

3.1 Method A - Metal-Clad Dielectric The test specimen **shall** consist of a size commensurate with the peel strength test fixture and have an etched conductor pattern in accordance with Figure 1.

Figure 1 Chemical Resistance Test Pattern

(A) Overall size: nominally 25 mm x 200 mm [approximately 1 in x 8 in]
(B) Conductor width and length: 0.5 mm* x 190 mm [approximately 0.02 in x 7.5 in]
(C) Left end conductor tab length and width: nominally 13 mm x 6 mm [approximately 0.5 in x 0.25 in]

***NOTE:** It is critical that the widths of the immersed and non-immersed segments of the copper trace be within ± 0.03 mm [± 0.0012 in] of each other.

3.2 Method B - Bare Dielectric The test specimens **shall** consist of nominal 12.7 mm ± 0.25 mm) x 200 mm [approximately 0.5 in x 8 in] strips of bare dielectric.

4 Test Equipment and Chemicals

4.1 Necessary equipment to produce printed wiring by the etched foil process using good commercial practices.

4.2 Timing Device A watch or other suitable device that is accurate to within ± 1 second per hour and capable of discerning increments of 1 second.

4.3 Dimension Measuring Device A micro-rule or equivalent optical system capable of measuring a dimension of 225 mm [approximately 9 inches], accurate and precise to 25 µm [0.0010 in].

4.4 Thickness Measuring Device A micrometer or equivalent capable of measuring up to 25 mm [approximately 1 in] thickness, accurate and precise to 10 µm [0.0004 in].

4.5 Test Specimen Cutter Thwing-Albert JDC Precision Cutter or equivalent. The test specimen cutting device **shall** be capable of cutting a film strip 12.7 mm ± 0.25 mm [0.500 in ± 0.010 in] wide over the length of the test specimen. It is imperative that the cutting edges be kept sharp and free from visible scratches or nicks. The use of striking dies is not recommended because of poor and inconsistent test specimen edges. (This detail is copied from TM-650, Method 2.4.18.3, Section 4.3. For further information, contact the manufacturer of the cutting equipment chosen.)

4.6 Tensile Tester Instron Model 4501 Tensile Tester with a 0.2 kN load cell (or equivalent tensile tester). The testing machine **shall** be equipped with a load cell whose compliance is a maximum of 2% of the test specimen extension within the range being measured. Digital, as opposed to analog, self-calibrating load cells are preferred, since they eliminate the need for calibration and potential error associated with calibrating analog load cells using external weights. The testing machine must be equipped with a device for continuously recording the tensile load and the amount of the separation of the grips; both of these measuring systems should be accurate to ± 2%. The rate of separation of the grips **shall** be accurate to ± 0.1% and capable of adjustment from approximately 0 to 50 mm/minute [approximately 0 to 2 in/minute] (for more detail on tensile and elongation testing, see IPC-TM-650, Method 2.4.18.3).

4.7 Test Chemicals The following chemicals are to be used. After immersion in each chemical, the specimen **shall**

be rinsed for one (1) minute minimum to five (5) minutes maximum in its own dedicated deionized (DI) water rinse which is maintained at 55 °C ± 5 °C [131 °F ± 9 °F].

a) Etchant Solution: An aqueous solution of 450 grams ± 4.5 grams Cupric Chloride Dihydrate [$CuCl_2.2H_20$] (CAS 10125-13-0) and 150 ml ± 2 ml Reagent Grade (36.5-38%) Hydrochloric Acid [HCl] (CAS 7647-01-0) with a specific gravity of 1.155 - 1.164 [19° - 21° Baum?] diluted in one liter of water, 55 °C ± 5 °C [131 °F ± 9 °F].

b) Stripper Solution: An aqueous solution of 5.0% Potassium Hydroxide [KOH] (CAS 1310-58-3) with the equivalent of 0.5% Monoethanolamine [$HO(CH_2)_2NH_2$] (CAS 141-43-5) and 0.5% Propylene Glycol Monobutyl Ether [$CH_3CH(OH)CH_2O(CH_2)_3CH_3$] (CAS 5131-66-8), 55 °C ± 5 °C [131 °F ± 9 °F] or an equivalent commercial stripper solution.

c) Acid Cleaner: 2N Sulfuric Acid [H_2SO4] (CAS 7664-93-9), 23 °C ± 2 °C [73.4 °F ± 3.6 °F]

d) Organic Cleaner: 70% ± 5% Isopropanol [$(CH_3)_2CHOH$] (CAS 67-63-0), 23 °C ± 2 °C [73.4 °F ± 3.6 °F]

4.7.1 Other Chemicals Other specified chemicals may be added where the customer/supplier have specific process requirements. A list of fluids or chemicals may be specified where the end product circuit will be subjected to specific environments, such as: fuels, cleaning solvents, etc.

5 Procedures

5.1 Method A – Metal-Clad Dielectric

5.1.1 Test Specimen Preparation Prepare a minimum of six (6) test specimens [twice as many minimum as required for one set of tests, allowing for at least one repetition, if needed] in accordance with Figure 1 using standard commercial practices. Do not remove the etch resist. Measure the conductor width of the test specimen to ensure compliance with width requirements. Mark the halfway line for the subsequent dipping tests with a piece of platers tape or similar method on the nonpatterned side (back side) of each test specimen, in accordance with Figure 2.

5.1.2 Conditioning Condition each test specimen for 24 hours +1/-0 hours at 23 °C ± 2 °C [73.4 °F ± 93.6 °F] and 50% ± 5% relative humidity prior to testing.

5.1.3 Test Procedure

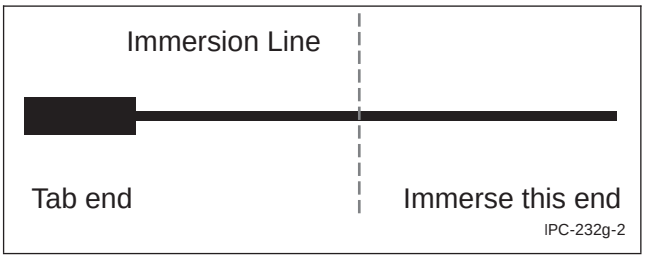

Figure 2 Chemical Resistance Test Pattern with Halfway Line Marking Example

5.1.3.1 Sequential Chemical Exposure Test Immerse three (3) test specimens for one minute [+10 seconds/-0 seconds] halfway into each of the specified chemicals. After immersion in each chemical, rinse each test specimen in the appropriate dedicated immersion DI water rinse which is maintained at 55 °C ± 5 °C [131 °F ± 9 °F] for one (1) minute minimum and five (5) minutes maximum. Use the sequence as follows:

1. Etchant Solution
2. Dedicated Etchant DI Immersion Rinse
3. Stripper Solution
4. Dedicated Stripper DI Immersion Rinse
5. Acid Cleaner
6. Dedicated Acid Cleaner DI Immersion Rinse
7. Organic Cleaner
8. Dedicated Organic Cleaner DI Immersion Rinse

Within fifteen (15) to thirty (30) minutes after completion of the sequential chemical exposure, observe for tackiness, blistering, bubbles, delamination, or swelling within the dielectric, blistering or delamination of the copper and dielectric, or change in color of dielectric. After sixteen (16) to twenty-four (24) hours, repeat the observations and peel the conductors for the immersed and non-immersed specimens, using the following procedure [see IPC-TM-650, Method 2.4.9 (Method A)].

Attach the test specimen to the free wheeling rotary drum test fixture with double-sided tape, cement and/or mechanical clamps. The referee attachment technique will be double-sided adhesive tape. Peel the conductor at a rate (crosshead speed) of 50.8 mm/minute [2.0 in/minute]. The peel load **shall** be between 15 - 85 percent of the range of the scale used on the testing machine.

5.1.4 Data Evaluation Record and report all discrepancies noted during the observation periods The peel load **shall** be

continuously recorded, and the recorded load for the entire length of peeled conductor **shall** be evaluated by averaging the chart recording values for each segment (immersed and non-immersed) of each test specimen. A minimum of 57.2 mm [approximately 2.25 in] **shall** be peeled for each segment, with the first 6.4 mm [approximately 0.25 in] to be disregarded. Compare the average peel strengths of the immersed segments of the three (3) test traces with those of the non-immersed segments of the same three (3) test traces, in accordance with the following formula:

$$\frac{\text{[Average Peel Strengths of three (3) immersed test trace segments]}}{\text{[Average Peel Strengths of three (3) non-immersed test trace segments]}} \times 100 = \%\ \text{of Original}^{\dagger}$$

†**NOTE:** Values may be higher than 100%, which may indicate chemical absorption.

5.2 Method B – Bare Dielectric

5.2.1 Test Specimen Preparation Cut twelve (12) test specimens, as per 3.2. This allows for at least one full repetition of tests, if needed.

5.2.2 Conditioning Condition each specimen for 24 hours at 23 °C ± 2 °C [73.4 °F ± 3.6 °F] and 50% ± 5% relative humidity prior to testing.

5.2.3 Test Procedure

5.2.3.1 Sequential Chemical Exposure Test Fully immerse three (3) test specimens for one (1) minute [+10 seconds/-0 seconds] into each of the specified chemicals on a sequential basis. After immersion in each chemical, rinse the specimen in the appropriate dedicated immersion DI water rinse which is maintained at 55 °C ± 5 °C [131 °F ± 9 °F] for one (1) minute minimum and five (5) minutes maximum. Use the sequence as follows:

1. Etchant Solution
2. Dedicated Etchant DI Immersion Rinse
3. Stripper Solution
4. Dedicated Stripper DI Immersion Rinse
5. Acid Cleaner
6. Dedicated Acid Cleaner DI Immersion Rinse
7. Organic Cleaner
8. Dedicated Organic Cleaner DI Immersion Rinse

Within fifteen (15) to thirty (30) minutes after completion of the sequential chemical exposure, observe for tackiness, blistering, bubbles, delamination, or swelling within the dielectric or change in color of dielectric. After sixteen (16) to twenty-four (24) hours, repeat the observations and determine the tensile strength and elongation using the procedure as described in IPC-TM-650, Method 2.4.18.3.

5.2.4 Data Evaluation Record and report all discrepancies noted during the observation periods. The evaluation is considered to have passed when the immersed specimens meet or exceed the minimum tensile strength and elongation requirements for the material under test. If the immersed test specimens do not pass, then the non-immersed specimens **shall** be tested for both tensile strength and elongation to verify that these parameters pass the requirements for the material under test. If the non-immersed test specimens do not pass, then the lot of bare dielectric, represented by the test specimens, **shall** be rejected.