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IPC/JPCA-6801

Terms and Definitions,
Test Methods, and Design
Examples for Build-Up/High
Density Interconnect (HDI)
Printed Wiring Boards

IPC/JPCA-6801

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A joint standard developed by IPC and JPCA

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Terms and Definitions, Test Methods, and Design Examples for Build-Up Printed Wiring Boards

Developed by the HDI Committee of the Japan Printed Circuit Association (JPCA) and adopted by the HDI Committee (D-40) of IPC

Users of this standard are encouraged to participate in the development of future revisions.

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Terms and Definitions, Test Methods, and Design Examples for Build-Up/High Density Interconnect (HDI) Printed Wiring Boards

1 SCOPE

This standard specifies printed wiring boards (PWBs) manufactured by the build-up process used primarily for electronic equipment (hereinafter build-up/high density interconnect (HDI) PWBs). The build-up/HDI PWB, as referred to herein, is defined as the printed board that is built up progressively with the conductor layers and insulating layers using techniques such as plating and printing. The build-up/HDI PWBs include substrates for semiconductor packages.

2 APPLICABLE DOCUMENTS

The following are documents referenced in this standard.

JIS 8 7729 Erichsen Cupping Testers

JIS C 0010 Environmental Testing Part 1: General and Guidance

JIS C 5603 Terms and Definitions for Printed Circuits

JIS K 5400 Testing Methods for Paints

JIS K 7100 Standard Atmospheres for Conditioning and Testing of Plastics

JIS K 7127 Testing Method for Tensile Properties of Plastic Films and Sheets

JIS K 7209 Testing Methods for Water and Boiling Water Absorption of Plastics

3 DEFINITIONS OF STRUCTURES AND TERMS

The structures and terms used in this document are defined as follows.

3.1 Structures Names of structures and parts of the build-up printed boards are defined in Figure 3-1. For the names other than those defined herein, see the related standards (i.e., JIS C 5603). Other examples of structural elements and parts are shown in Figure 3-2, Figure 3-3, and Figure 3-4.

3.2 Terms and definitions

3.2.1 General

3.2.2 Planer Board A substrate on which bare chips and surface- and insertion-mount components are mounted. After being mounted with these components, the substrate

is no longer heated for mounting on other planar boards. It generally includes motherboards, daughter cards, etc.

3.2.3 Module Board A substrate on which bare chips and surface-mount components are mounted. After being mounted with these components, the substrate is expected to be mounted on other planar boards with heat.

3.3 Design

3.3.1 Build-Up Via/Microvia The general term for vias in build-up layers of build-up/HDI PWBs. It is a structure interconnecting electrically top and bottom conductors with a hole formed in the insulating layer and made conductive by plating or conductive paste printing.

3.3.2 Conformal Via A type of build-up via in which the conductor layer of a uniform thickness is formed conforming to the shape of a hole in the insulating layer.

3.3.3 Filled Via A type of build-up via in which the interior of the via is filled with a conductive material (see Figure 3-5).

3.3.4 Stacked Via A via formed by stacking one or more build-up vias/microvias on a build-up via/microvia that provides an interlayer connection between three or more conductive layers (see Figure 3-6).

3.3.5 Skip Via A via that directly connects conductive layers of build-up/HDI layers that are not adjacent with each other.

3.3.6 Hole-Plugged Base Via A plated-through hole (PTH) that is formed on the base of a build-up/HDI printed base-via board and is filled with a filler.

3.3.7 Via Top Land A land on the external layer side of a via (see Figure 3-2).

3.3.8 Via Bottom Land A land on the internal layer side of a via (see Figure 3-2).

3.3.9 Landless Via A via in which the land diameter is designed to be less than or equal to the via diameter (see Figure 3-7).



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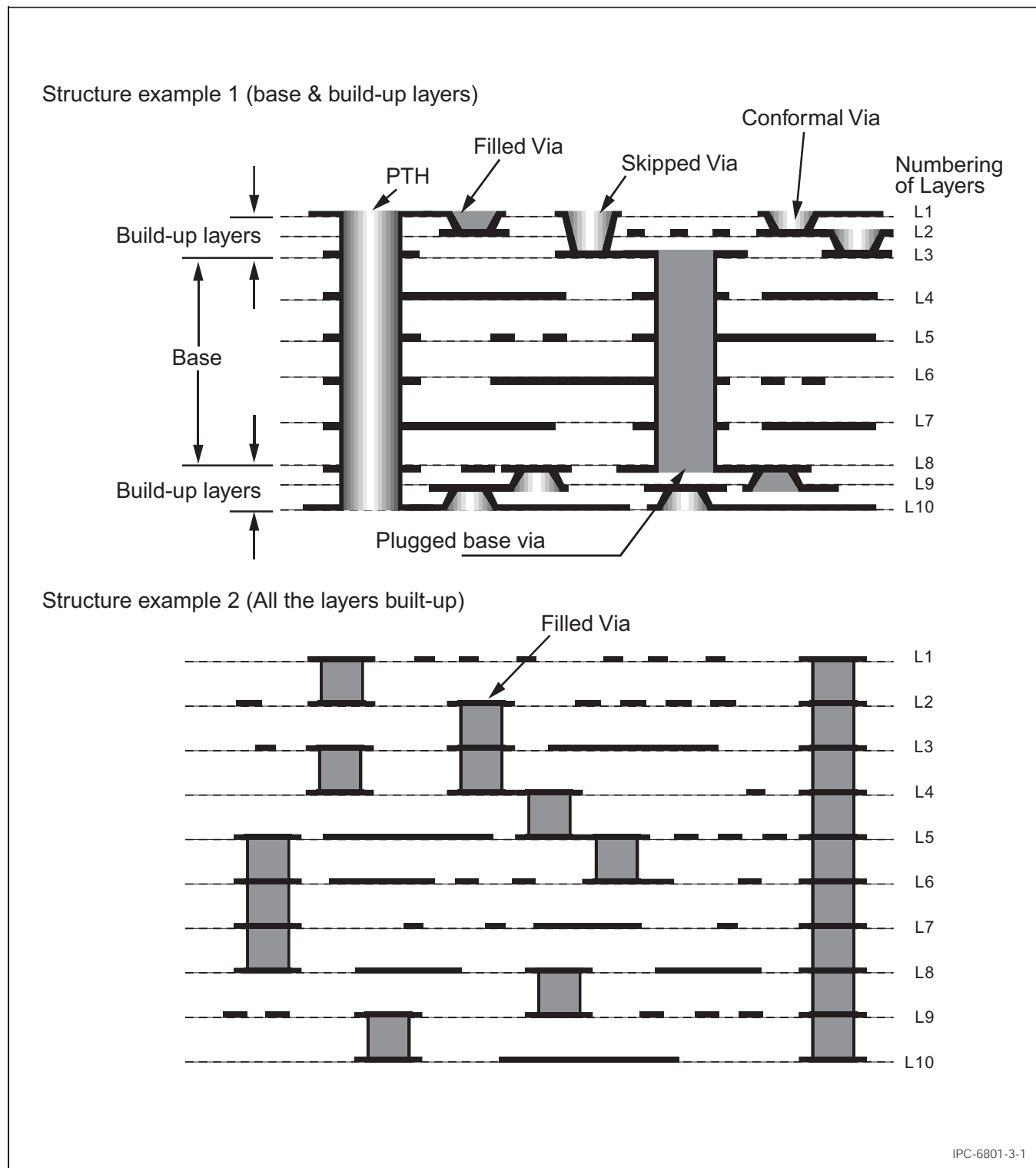


Figure 3-1 Structure Examples

3.4 Manufacturing

- 3.4.1 Laser Via** A via formed by the laser process.
- 3.4.2 Photo Via** A via formed by the photo process.
- 3.4.3 Stud Via** A via formed with a conductive stud.

3.5 Testing and Inspection

- 3.5.1 Via Bottom Trench** A neck of plating formed at the bottom of a via (see Figure 3-8).
- 3.5.2 Acceleration Factor (AF)** The ratio of stress in reliability testing and normal operating condition.

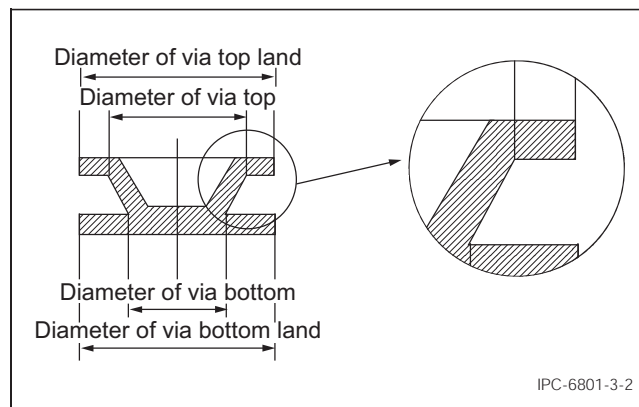


Figure 3-2 Names of Via Parts

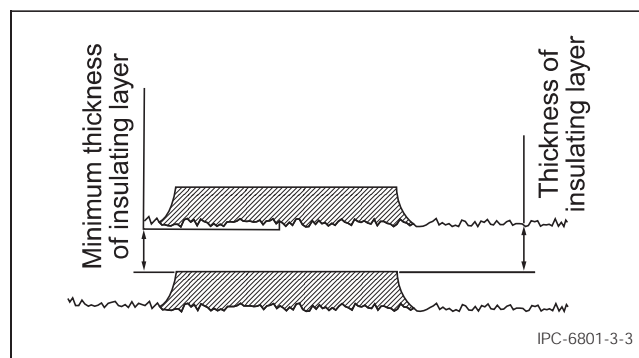


Figure 3-3 Thickness of Insulating Layer in Build-Up Part

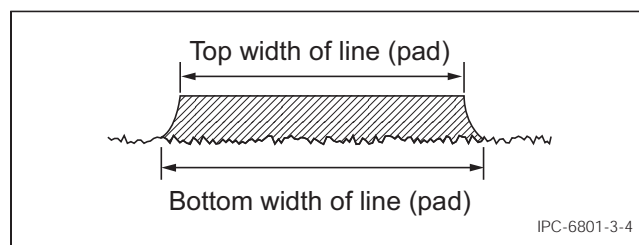


Figure 3-4 Dimensions of Line/Pad

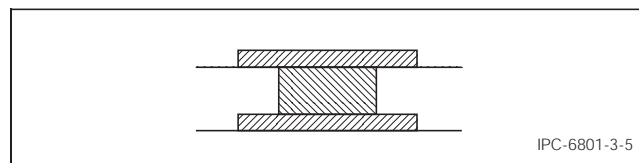


Figure 3-5 Filled Via

4 TEST METHODS FOR BUILD-UP/HDI MATERIALS

4.1 Coefficient of Thermal Expansion - Thermomechanical Analyzer (TMA) Method

4.1.1 Purpose This method is used to determine the thermal coefficient of expansion of resin materials used for the build-up (HDI) layer of build-up (HDI) printed boards.

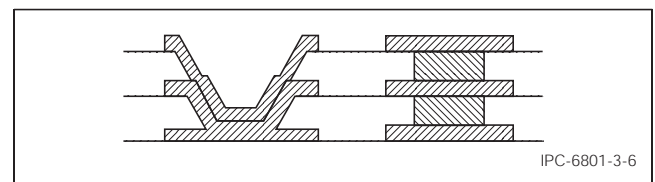


Figure 3-6 Stacked Vias

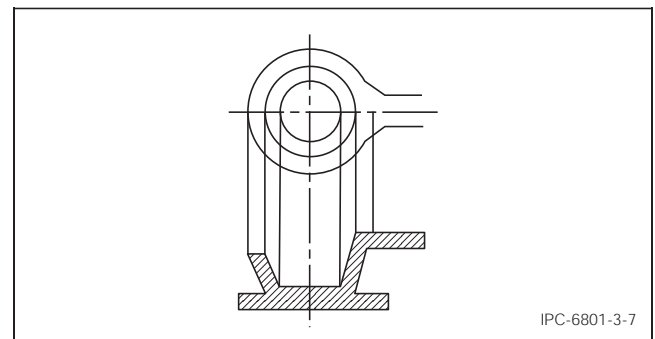


Figure 3-7 Landless Via

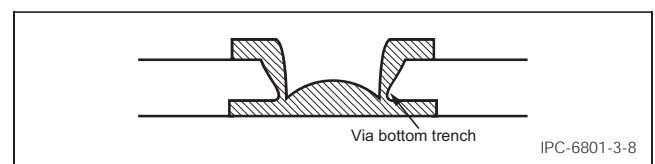


Figure 3-8 Via Bottom Trench

4.1.2 Test Specimen

4.1.2.1 Resin Material In a form of film.

4.1.2.2 Size 5 mm [0.2 in] wide x 20 mm [0.787 in] long.

4.1.2.3 Thickness Nearly equal to the thickness of product (**shall** be less than +100%); e.g., when the thickness of a build-up layer is 50 μm [1.97 mil], the thickness of the specimen **shall** be 50 μm [1.97 mil] to 100 μm [3.937 mil].

4.1.2.4 Curing Condition In accordance with the curing condition of the product specification (including UV irradiation, when required).

4.1.3 Test Equipment Thermomechanical analyzer (TMA).

4.1.4 Procedure

4.1.4.1 Preparation of Sample Fasten the sample film to the cramps of TMA. Be careful not to break the film.

4.1.4.2 Measurement

4.1.4.2.1 Measure the initial dimension of the sample (or fasten the film so that it may have a known dimension).

4.1.4.2.2 Anneal the sample to eliminate the residual stress. Raise the temperature at a rate of 10°C [50°F]/min from room temperature to the glass transition temperature (T_g) +10°C [50°F], and then cool down.

4.1.4.2.3 Apply a tensile load of 9.88×10^{-2} N ((10g) [0.353 oz])) to the sample, raise the temperature at a rate of 10°C [50°F]/min, cool down, and record the displacement.

4.1.4.2.4 Calculation Calculate the thermal expansion coefficient using Equation 1.

$$CTE = \frac{\Delta L/L_0}{\Delta T} \quad [\text{Equation 1}]$$

where:

CTE : Coefficient of thermal expansion

L_0 : Initial dimension of sample

ΔL : Displacement of sample

ΔT : Change in temperature

Calculate and report the CTEs, α_1 and α_2 , separately for the temperature below and above the T_g . A graph showing the displacement profile may be attached.

4.1.5 Notes

4.1.5.1 For easier preparation of the sample of a liquid insulating resin, apply the insulating resin on a releasable material (such as a fluororesin substrate, polypropylene plate, and releasable paper on a glass plate) according to the manner as in its product specification, then dry and cure it. When the insulating resin is in film form, peel the separation film and cure the resin film according to its product specification.

4.1.5.2 When cutting a sample into a long square, use a sharp blade on a heated plate (i.e., hotplate). In this manner, the sample can be cut out without breaking.

4.1.6 Remarks

4.1.6.1 The T_g referred to in this document **shall** be the one obtained by the TMA method.

4.1.6.2 The standard measuring environment for this test **shall** be in accordance with the standard conditions specified in JIS C 0010. Refer to JIS C 0010, JIS K 7127, and JIS K 5400.

4.2 Mechanical Properties

4.2.1 Purpose This method is used to determine the modulus of elasticity, tensile strength, and elongation at the break of the resin materials used for the build-up layer in build-up printed boards.

4.2.2 Test Specimen

4.2.2.1 Resin Material The resin material **shall** be in film form.

4.2.2.2 Size The size of the material **shall** be 10 mm [0.394 in] x 80 mm [3.15 in].

4.2.2.3 Thickness The thickness **shall** be nearly equal to the thickness of product ($\leq 100\%$; e.g., when the thickness of a build-up layer is 50 μm [1.97 mil], the thickness of the specimen **shall** be 50 μm [1.97 mil] to 100 μm [3.937 mil]).

4.2.2.4 Curing Condition The curing condition **shall** be in accordance with that of the product specification (including UV irradiation, when required).

4.2.3 Test Equipment

Tensile tester

Temperature controlled test chamber

4.2.4 Procedure

4.2.4.1 Preparation of Sample Fasten the sample film to the clamps of the tensile tester. Be careful not to break the film.

4.2.4.2 Measurement

4.2.4.2.1 Adjust the interval between clamps of tensile tester to 60 mm [2.36 in], or measure the clamp interval.

4.2.4.2.2 Stretch the sample at the rate of 0.0830 mm/sec [3.267 mil/sec] (5.0 mm/min [0.197 in/min]).

4.2.4.2.3 Measurement **shall** be made under the normal conditions and at 85°C [185°F]. When possible, measurement **shall** also be made at 105°C [221°F] and 125°C [257°F].

4.2.4.3 Calculation

$$E = \frac{\Delta\sigma}{\Delta\epsilon} \quad (\text{Equation 2})$$

$$a = \frac{F}{A} \quad (\text{Equation 3})$$

$$\epsilon = \frac{L-L_0}{L_0} \times 100 \quad (\text{Equation 4})$$

where:

E : Longitudinal modulus of elasticity

σ : Stress at break

ϵ : Elongation at break

$\Delta\sigma$: Change in stress



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$\Delta\epsilon$: Change in displacement
 F : Load at break
 A : Section area of sample
 L_o : Initial length of sample (initial cramp interval)
 L : Sample length at break

4.2.5 Notes When preparing the sample, refer to 4.5.1.

4.2.6 Remarks The normal condition for this test **shall** be in accordance with the standard conditions in JIS C 0010. See also JIS C 0010, JIS K 7127, and JIS K 5400.

4.3 Water Absorption Property

4.3.1 Purpose The water absorption property of resin material is necessary in checking the baking and storage conditions before and during the packaging process. This method is used to determine the water absorption property of resin materials used for the build-up layer in build-up printed boards.

4.3.2 Test Specimen

4.3.2.1 Resin Material The resin material **shall** be in film form.

4.3.2.2 Size Size is arbitrary (provided that the mass is ≥ 100 mg [0.003527 oz]).

4.3.2.3 Thickness Nearly equal to the thickness of product (**shall** be $< +100\%$) (e.g., when the thickness of a build-up layer is $50\ \mu\text{m}$ [1.97 mil], the thickness of the specimen **shall** be $50\ \mu\text{m}$ [1.97 mil] to $100\ \mu\text{m}$ [3.937 mil]).

4.3.2.4 Curing Condition In accordance with the curing condition of the product specification (including UV irradiation, when required).

4.3.3 Test Equipment

Circulating hot-air drying chamber
 Desiccator
 Precision balance
 High-temperature and high-humidity chamber

4.3.4 Procedure

4.3.4.1 Preparation of Sample Dry the sample for two hours at 105°C in the drying chamber, cool in a desiccator to room temperature, and weigh it to the nearest 0.1 mg [3.527396e-006 oz]. Record the sample mass weighed as W_o .

Test A – Water Immersion Test

Immerse the sample in distilled water at 23°C [73.4°F] and weigh it after one, four, eight, 12, and 24 hours from the start of immersion. Continue weighing every 24 hours

after that. Wipe the sample with a dry cloth and immediately weigh it to the nearest 0.1 mg [3.527396e-006 oz]. Record the sample mass weighed as W_1 .

Test B – High-Temperature and High-Humidity Storage Test

Leave the sample standing in a high-humidity atmosphere of 85% RH at 85°C [185°F] and weigh it after one, four, eight, 12, and 24 hours from the start of exposure. Continue weighing every 24 hours after that. Take the sample out of the chamber, cool it down under the normal condition, wipe the sample with a dry cloth, and immediately weigh it to the nearest 0.1 mg [3.527396e-006 oz]. Record the sample mass weighed as W_1 .

4.3.4.2 Calculation Calculate the rate of water absorption using Equation 5. The rate of water absorption at 24-hour point is used as the standard value. The characteristics also may be represented graphically.

$$\text{Water absorption rate (\%)} = \frac{W_1 - W_o}{W_o} \times 100 \quad [\text{Equation 5}]$$

4.3.4.3 Presentation of Water Absorption Rate When a water absorption rate is presented, the test method used in evaluation **shall** also be described (see Figure 4-1).

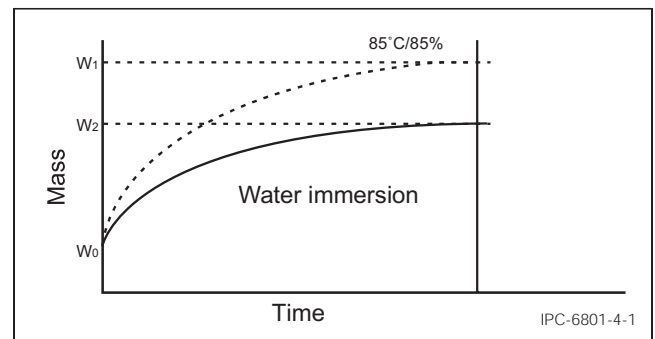


Figure 4-1 Water Absorption Characteristics

4.3.5 Remarks The standard measuring environment of this test **shall** be in accordance with “Standard Temperature and Humidity Condition: Class 2” of JIS K 7100. Refer to JIS K 5400 and JIS K 7100.

4.4 Drying Property

4.4.1 Purpose Drying property is necessary in checking the baking and storage conditions before and during the packaging process. This method is used to determine the drying property of resin material used for the build-up layer in build-up printed boards.

4.4.2 Test Specimen

4.4.2.1 Resin Material The resin material **shall** be in film form.



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4.4.2.2 Size The size of the material is arbitrary (provided the mass is >100 mg [0.003527 oz]).

4.4.2.3 Thickness Thickness **shall** be nearly equal to the thickness of product (<+100%; e.g., when the thickness of a build-up layer is 50 µm [1.97 mil] to 100 µm [3.937 mil], the thickness of the specimen **shall** be 50 µm [1.97 mil]).

4.4.2.4 Curing Condition The curing condition **shall** be in accordance with the curing condition of the product specification (including UV irradiation, when required).

4.4.3 Test Equipment

Circulating hot-air drying chamber

Precision balance

High-temperature and high-humidity chamber

4.4.4 Procedure

4.4.4.1 Preparation of Sample Let the sample absorb moisture for 24 hours at 85°C/85%RH in a high-temperature and high-humidity chamber, cool to room temperature, and weigh it to the nearest 0.1 mg [3.527396e-006 oz]. Record the sample mass weighed as W_1 .

4.4.4.2 Test Leave the sample standing at the constant drying temperature of 105°C [221°F] and weigh it after one, four, eight, 12, and 24 hours from the start of the drying procedure. Continue weighing every 24 hours after that. Take the sample out of the chamber, cool it down under normal conditions, and immediately weigh it. Record the sample mass weighed as W_2 . The measurement interval may be shortened in the region where the rate of weight change is high.

4.4.4.3 Calculation Calculate the drying rate using Equation 6. The drying rate at the 24-hour point is used as the standard value. The characteristics may also be represented graphically (see Figure 4-2).

$$\text{Dryness (\%)} = \frac{W_1 - W_2}{W_1} \times 100 \quad [\text{Equation 6}]$$

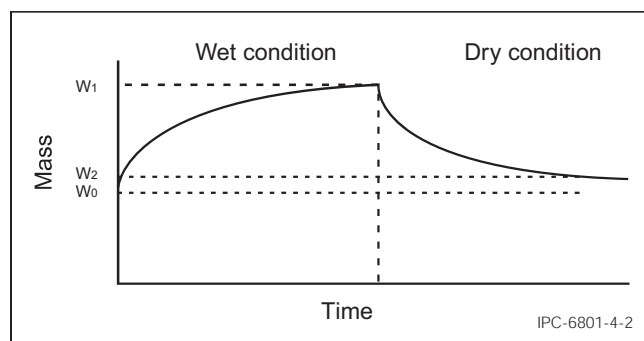


Figure 4-2 Drying Characteristics

4.4.4.5 Remarks The standard measuring environment of this test **shall** be in accordance with “Standard Temperature and Humidity Condition: Class 2” of JIS K 7100. Refer to JIS K 5400 and JIS K 7100.

4.5 Ionic Impurity

4.5.1 Purpose This test method is used to determine the ionic impurity content in resin material used for the build-up layer in build-up printed boards.

4.5.2 Test Specimen

4.5.2.1 Resin Material The resin material **shall** be in film form.

4.5.2.2 Size Size is arbitrary (approximately 150 mm [5.906 in] x 150 mm [5.906 in]).

4.5.2.3 Thickness The thickness is the same as that of the object product ($\leq 100\%$; e.g., when the thickness of a build-up layer is 50 µm [1.97 mil], the thickness of the specimen **shall** be 50 µm [1.97 mil] to 100 µm [3.937 mil]).

4.5.2.4 Curing Condition The curing condition **shall** be in accordance with the curing condition of the product specification (including UV irradiation, when required).

4.5.3 Test Equipment

Autoclave

Ion-chromatography - Atomic absorption spectrography, etc.

Stainless steel vessel, inner surface of which is coated with fluororesin

Deionized water (having conductivity of 0.05 µS/mm [µS/in] or lower)

4.5.4 Procedure

4.5.4.1 Insert one gram of cured film into 50 g [1.76 oz] of deionized water in a stainless steel vessel and put the vessel into an autoclave.

4.5.4.2 Extract ionic impurity for 24 hours in an atmosphere of 121°C and 100% RH.

4.5.4.3 Determine the extract by ion-chromatography or by atomic-absorption spectrography to obtain the ion concentration. The measurement **shall** be made on Cl^- , Na^+ , Br^- , organic acid, etc.

4.5.5 Remarks The standard environment of this test **shall** be in accordance with JIS C 0010. Refer to JIS C 0010.



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