



*THE INSTITUTE FOR
INTERCONNECTING
AND PACKAGING
ELECTRONIC CIRCUITS*

IPC-DD-135

Qualification Testing for Deposited Organic Interlayer Dielectric Materials for Multichip Modules

IPC-DD-135

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A standard developed by the Institute for Interconnecting
and Packaging Electronic Circuits

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- Show relationship to DFM & DFE
- Minimize time to market
- Contain simple (simplified) language
- Just include spec information
- Focus on end product performance
- Include a feed back system on use and problems for future improvement

Standards Should Not:

- Inhibit innovation
- Increase time-to-market
- Keep people out
- Increase cycle time
- Tell you how to make something
- Contain anything that cannot be defended with data

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The material in this standard was developed by the Deposited Dielectric Task Group (C-13a) of the Multichip & Related Technologies Committee (C-10) of the Institute for Interconnecting and Packaging Electronic Circuits.



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

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Acknowledgment

Any Standard involving a complex technology draws material from a vast number of sources. While the principal members of the IPC

Deposited Dielectric Task Group of the IPC Multichip Module & Related Technologies Committee are shown below, it is not possible to include all

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Qualification and Performance of Deposited Organic Interlayer Dielectric Materials for Multichip Modules (MCM-D)

1.0 SCOPE

1.1 Scope This standard has been written for deposited organic interlayer dielectric materials under evaluation for MCM-D applications. The standard and test methods have been written without bias towards any particular class of materials.

1.2 Purpose This standard enables a vendor to evaluate dielectric materials and express their properties in a uniform format. In addition, guidelines are given for reporting specimen processing history. It is hoped that this will facilitate communication between material vendors and module manufacturers and prevent the dissemination of misleading or invalid data.

The data resulting from these test methods are for the comparison and/or differentiation of materials and are not intended to predict performance of a material in a particular application. See 4.1 for limitations.

1.3 Classes This standard provides three classes of dielectric performance to reflect increasing levels of sophistication, functional performance requirements and testing severity.

Class 1 — One layer of deposited dielectric material. The properties of these materials are to be reported following exposure to the manufacturer's recommended cure cycle.

Class 2 — Four layers of deposited dielectric material. The properties of these materials are to be reported following four exposures to the manufacturer's recommended cure cycle. For materials which do not require a thermal cure, the properties are to be reported following a 4 hour exposure to 250°C in a specified atmosphere.

Class 3 — Eight layers of deposited dielectric material. The properties of these materials are to be reported following eight exposures to the manufacturer's recommended cure cycle. For materials which do not require a thermal cure, the properties are to be reported following an 8 hour exposure to 250°C in a specified atmosphere.

2.0 APPLICABLE DOCUMENTS

2.1 IPC — IPC Test Methods Manual, IPC-TM-650, Test Methods:

2.5.5.8 Low Frequency Dielectric Constant and Loss Tangent

2.4.24.2 Glass Transition Temperature (Organic Films) – DMA Method

2.4.24.3 Glass Transition Temperature (Organic Films) – TMA Method

2.4.41.2 In-Plane Coefficient of Thermal Expansion, Organic Films

2.4.41.3 Volumetric Thermal Expansion, Polymer Coatings on Inorganic Substrates

2.4.50 Thermal Conductivity

2.3.40 Thermal Stability

2.4.18.3 Tensile Strength, Elongation, and Modulus

2.4.22.2 Substrate Curvature: Silicon Wafers with Deposited Dielectrics

2.4.1.6 Adhesion, Polymer Coating

2.3.26.2 Mobile Ion Content of the Film

2.2 ASTM

ASTM D 823 Test Methods for Producing Films of Uniform Thickness of Paint, Varnish and Related Products on Test Panels

ASTM D 4708 Standard Practice for Preparation of Uniform Free Films of Organic Coatings

ASTM D 618 Standard Practice for Conditioning Plastics and Electrical Insulating Materials for Testing

ASTM D 3386 Standard Test Method for Coefficient of Linear Thermal Expansion of Electrical Insulating Materials

ASTM D 3850 Standard Test Method for Rapid Thermal Degradation of Solid Electrical Insulating Materials by Thermogravimetric Analysis

ASTM D 882 Standard Test Methods for Tensile Properties of Thin Plastic Sheeting

ASTM D 1005 Standard Test Methods for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers



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ASTM D 2370 Standard Test Method for Tensile Properties of Organic Coatings

ASTM D 3330 Test Method for Peel Adhesion of Pressure-Sensitive Tape of 180° Angle

ASTM D 3359 Standard Test Methods for Measuring Adhesion by Tape Test

3.0 PREPARATION OF SPECIMENS FOR TEST

3.1 Scope This test method establishes a procedure for the preparation of uniform organic or metal coatings, describes the patterning of organic or metal coatings, and establishes a procedure for releasing films from substrates for use in determining the physical properties of the coatings.

3.2 Specimen Configuration Many polymers exhibit some amount of molecular orientation resulting in anisotropic properties, i.e., the properties are not the same in all directions. The degree of molecular orientation in polymer films is influenced by the method of film preparation (e.g., spin coating versus doctor blade) and the manner in which the film is processed. Films should be prepared using the same method and processing conditions that will be employed in the end-use application.

Table 1 indicates the recommended specimen configuration for the test methods of this standard.

Table 1 Specimen Configuration

Section	Test Method	Configuration
4.2.1	Electrical Properties	
4.2.1.1	Low Frequency Dielectric Constant/Loss Tangent	Coating/Film
4.2.1.2	Stability of Dielectric Constant to Moisture	Coating
4.2.1.3	Dielectric Strength	Coating
4.2.2	Thermal Properties	
4.2.2.1	Glass Transition Temperature	Film
4.2.2.2	In-Plane Thermal Expansion	Film
4.2.2.3	Volumetric Thermal Expansion	Film
4.2.2.4	Out-of-plane Thermal Expansion	
4.2.2.5	Thermal Conductivity	Coating
4.2.2.6	Thermal Stability	Film
4.2.3	Tensile Strength, Elongation and Modulus	Film
4.2.4	Substrate Curvature	Coating
4.2.5	Adhesion	Coating
4.2.6	Planarization	Coating
4.2.7	Mobile Ion Content	Film

3.3 Precautions This test method may involve the use of an OSHA designated hazardous substance. The following precautions should be observed.

3.3.1 Mercury Mercury is a toxic liquid metal with vapors that are extremely hazardous. Mercury must be used with adequate ventilation (in a hood), and all spills must be cleaned up immediately. Small amounts of spilled mercury can vaporize sufficiently at room temperature to exceed the TLV of the vapor. Wear gloves when handling mercury. Consult the manufacturer's MSDS for proper handling, disposal, and spill cleanup procedures.

3.3.2 HF Hydrogen fluoride (HF) is corrosive to the skin, eyes, and respiratory tract. Concentrated HF causes immediate burns but dilute HF solutions may cause redness, burning, or pain several minutes or even hours after exposure. Dilute HF burns can also be caused by skin contact with HF exposed process equipment. HF readily penetrates the skin causing destruction of deep tissue layers including bone. Unlike acids, which are rapidly neutralized, HF caused destruction may continue for days. HF may form potentially explosive hydrogen gas on contact with metals. HF must be used with adequate ventilation (in a hood). Wear protective clothing covering hands, face, and body when handling HF. Consult the manufacturer's MSDS for proper handling, disposal, and spill cleanup procedures.

3.3.3 HCl Hydrogen chloride (HCl) is a corrosive liquid and causes burns of the eyes and skin. It is a nose and throat irritant that causes coughing, burning in the throat, and choking. Hydrogen chloride may form potentially explosive hydrogen gas on contact with metals. HCl must be used with adequate ventilation (in a hood). Wear gloves when handling HCl. Consult the manufacturer's MSDS for proper handling, disposal, and spill cleanup procedures.

3.4 Apparatus

3.4.1 Deposition Equipment – Organic Films

3.4.1.1 Headway spin coater model EC101 with a PWM101 controller or equivalent equipment capable of controlling spin speed to 5 RPM.

3.4.1.2 FAS Technologies Inc. Extrusion Coating System or equivalent.

3.4.1.3 Integrated Technologies Incorporated Series PL 2000 Precision Spray Coating and Drying System or equivalent.

3.4.1.4 Carsten motor driven blade film applicator or equivalent.

3.4.1.5 Gardner applicator blades (knife or wound wire rod type) with fixed or adjustable clearances or equivalent.

3.4.2 Deposition Equipment – Metal Films

3.4.2.1 Vacuum deposition equipment.

3.4.2.2 Leybold-Heraeus sputtering equipment or equivalent.

3.4.2.3 Leybold-Heraeus evaporation equipment or equivalent.

3.4.3 Substrates

3.4.3.1 125 mm polished silicon wafers containing 1500 angstroms of thermally grown silicon oxide.

3.4.3.2 100 mm x 100 mm ceramic substrate (blank or metal coated).

3.4.3.3 125 mm diameter polished aluminum disks.

3.4.3.4 125 mm diameter glass or quartz disks.

3.4.3.5 125 mm diameter tin coated silicon wafer or metal disk.

3.4.3.6 Polished aluminum (or other metal) panels.

3.4.3.7 Glass plates.

3.4.3.8 PTFE panel.

3.4.4 Thickness Measurement Device Micrometer or equivalent thickness measurement device accurate and precise to 0.1 μm .

3.5 Procedure

3.5.1 Particulate Control Many test methods for determining the physical properties of polymers are sensitive to defects or particulates in the test specimens (e.g., measurement of tensile properties). The preparation of organic coatings should be conducted in a particulate free environment (e.g., laminar flow hood or clean room) to minimize particulate defects in the films.

3.5.2 Preparation of Uniform Coatings

3.5.2.1 Apply the test material using one of the coating methods listed in Column A of Table II to one of the substrates listed in Column B of Table II following the manufacturer's recommended procedure.

3.5.2.2 Process the coating according to the manufacturer's recommended procedures.

A: Coating Methods:	B. Substrates
Spin Coater	125 mm Polished Silicon Wafer
Automatic Extrusion Coater	100 x 100 mm Ceramic Substrate
Automatic Spray Coater	Polished Aluminum Disk
Motor Driven Blade Applicator	Glass or Quartz Disk
Hand Held Spray Gun	Tin Coated Disk
Hand Held Blade Applicator	Aluminum (or other metal) Panel
Vacuum Deposition	Glass Plate
Sputter	PTFE Panel
Evaporation	PTFE Panel

3.5.3 Patterning Techniques

3.5.3.1 The organic or metal coating can be patterned using one of the following techniques.

Wet Etch
Plasma Etch
RIE Etch
Laser Ablation
Photosensitive Material

3.5.3.2 Patterning may involve the use of organic photoresists or metal hard masks. Descriptions of how these materials were processed must be provided.

3.5.4 Release Methods

3.5.4.1 Buffered HF Solution

3.5.4.1.1 This release method can be used to remove films that have been coated on silicon wafers containing an oxide layer.

3.5.4.1.2 Score completely around the outside of the coated substrates approximately 3 mm ($\frac{1}{8}$ inch) in from the edge. A template (e.g., inverted funnel) can be used as a cutting aid.

3.5.4.1.3 Place several rubber bands around the coated substrate to prevent the film from floating away.

3.5.4.1.4 Place the coated substrates in a *Teflon® boat, leaving a space between each coated substrate. Be sure to write down the order of the coated substrates since the HF will remove any ink labeling on the backs of the coated substrates.

*Teflon® is a registered trademark of E.I. duPont de Nemours & Co.