



IPC-TM-650 TEST METHODS MANUAL

1 Scope This test is designed to determine the glass transition temperature (T_g) and room temperature storage modulus (E') of dielectric materials used in High Density Interconnect (HDI) and Microvias by the use of dynamic mechanical analysis (DMA).

When testing a stand alone HDI dielectric layer, DMA will provide modulus as a function of temperature and glass transition for this layer. When DMA is used on built-up constructions, the data will be a complex curve representing the composite moduli and glass transitions.

Two methods are presented:

- Method A for thick specimens
- Method B for thin specimens (recommended for HDIS and Microvia dielectric layers).

For anisotropic materials (reinforced dielectrics), the x and y directions will have different modulus vs. temperature behavior. Anisotropic materials shall be tested in both the x and y directions.

2 Applicable Documents

2.1 ASTM Documents

E 1640 Test Method for Assignment of the Glass Transition Temperature by Dynamic Mechanical Analysis

D 4065 Standard Practice for Determining and Reporting Dynamic Mechanical Properties for Plastics

D 4092 Standard Terminology Relating to Dynamic Mechanical Measurements on Plastics

3 Test Specimen

3.1 Size

Method A Flexural bending geometry – thick specimens (>0.5 mm): Specimens shall be approximately 8 mm to 12 mm wide, 20 mm to 40 mm long, and 1 mm to 2 mm thick. The thickness shall be a minimum of 0.5 mm; for thicknesses <0.50 mm, use Method B. An aspect ratio of length/thickness = 10/1 or greater should be maintained. Exact specimen dimensions should be determined by the apparatus used.

Number 2.4.24.4	
Subject Glass Transition and Modulus of Materials Used in High Density Interconnection (HDI) and Microvias - DMA Method	
Date 11/98	Revision
Originating Task Group HDI Test Methods Task Group (D-42a)	

Method B Thin film tension geometry – thin specimens (<0.50 mm): Specimens shall be approximately 15 mm to 20 mm long and 2 mm wide. The minimum thickness is determined by the strength of the material; it should not break during testing. Exact specimen dimensions may be determined by the apparatus used.

3.2 All specimens should be fully cured according to manufacturer's recommendations. Thick specimens may be made by use of multiple lamination/cure cycles if required.

3.3 Unless otherwise specified, one specimen shall be tested, to be taken from a random location in the material in question.

4 Apparatus or Material

4.1 A DMA capable of determination of modulus to $\pm 1\%$ precision and $\tan \delta$ resolution of 0.01 over the specified temperature range. The DMA will preferably have computer data acquisition and analysis. The DMA must have an environmental chamber capable of having inert flush gas and capable of heating the specimen to at least 310°C .

4.2 Diamond blade or saw, sanding equipment, or equivalent to provide specimens of the size and edge quality required for Method A

4.3 Scissors, razor blades, or equivalent to provide specimens of size and edge quality for Method B

4.4 Air circulating oven capable of maintaining $105^\circ\text{C} \pm 2^\circ\text{C}$

4.5 Dessicator capable of an atmosphere $<30\%$ RH at 23°C

4.6 Etching system capable of complete removal of metallic cladding

5 Procedure

5.1.1 Metallic clad specimens shall be tested without the cladding. Etch and dry using appropriate procedures and equipment.

IPC-TM-650		
Number 2.4.24.4	Subject Glass Transition and Modulus of Materials Used in High Density Interconnection (HDI) and Microvias - DMA Method	Date 11/98
Revision		

5.1.2 Specimens shall be cut to the specified size using appropriate procedures and equipment to minimize thermal shock and mechanical stress. Method A specimens shall have their edges smooth and burr-free by means of sanding or equivalent (to allow the specimen to rest flat on the mounting stage). Method B specimens shall be rectangular, with their long edges parallel (to ensure good mounting in the film fixture). Method B specimens shall have smooth edges without nicks or tears.

5.1.3 Specimens shall be preconditioned by baking for one hour $\pm$ 15 minutes at 105°C, then cooled to room temperature in a dessicator.

5.2 Measurement

5.2.1 Apparatus Set-up

5.2.1.1 Install the Required DMA Clamp

Method A Install and calibrate the DMA with a bending geometry fixture/clamp.

Method B Install and calibrate the DMA with a thin film fixture/clamp.

5.2.1.2 Start the Experiment

Method A Measure the length, width, and thickness of the specimen to within at least +0.01 mm or preferably +0.005 mm. Clamp the specimen in the DMA fixture. Set the sample strain amplitude to operate within the linear viscoelastic range of the material. Strains <1% are recommended and are typically 0.1%. Program the sample temperature range. Enclose the specimen and fixture in the environmental chamber (furnace).

Method B Measure the length, width, and thickness of the specimen to within at least +0.01 mm or preferably +0.005 mm. Sample lengths of 10 mm to 20 mm are typical. Mount the specimen in the clamps of the film fixture according to the manufacturer's instructions. Apply tension force between 10 g and 50 g. A typical base force would be 20 g (see 6.5 for an explanation of the load criteria). Enclose the specimen and probe in the environmental chamber.

5.2.1.3 Provide an inert gas purge (helium or nitrogen) to the environmental chamber. Temperature calibration of the DMA must be performed under the same gas conditions.

5.2.2 Running the DMA Temperature Scan

5.2.2.1 Initial Temperature ($T_{initial}$)

- For specimens with T_g below or near room temperature, start the scan at least 20°C below the anticipated transition. This may require a DMA with subambient cooling control of the environmental chamber.
- For specimens with T_g greater than room temperature, start the scan at 30°C.

5.2.2.2 Sample Heating and Deformation Rate The specimen shall be run at 2°C/min and an oscillation frequency of 1 Hz.

5.2.2.3 Temperature Excursion Heat the specimen to at least 20°C greater than the T_g . This test is general in nature and data may be taken above T_g if required. There is no required upper temperature.

5.3 Evaluation

5.3.1 The DMA storage modulus should resemble the plot shown in Figure 1.

5.3.2 An idealized DMA curve has a linear section below the transition (glassy region below the temperature of T_g) and a stepwise drop through the glass transition region. These linear sections are used in calculating T_g by onset of the modulus drop (see Figure 1).

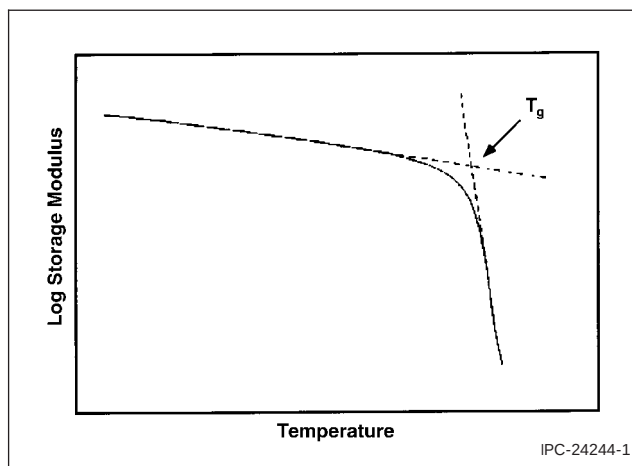


Figure 1 DMA Modulus Plot