IEC 61189-2-805

Edition 1.0 2024-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Test methods for electrical materials, printed boards and other interconnection structures and assemblies –
Part 2-805: X/Y CTE test for thin base materials by TMA

Méthodes d'essai pour les matériaux électriques, les cartes imprimées et autres structures d'interconnexion et ensembles –
Partie 2-805: Essai à faible CDT X/Y par TMA pour matériaux de base minces

IEC 61189-2-805:2024-04(en-fr)

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CONTENTS

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TEST METHODS FOR ELECTRICAL MATERIALS, PRINTED BOARDS AND OTHER INTERCONNECTION STRUCTURES AND ASSEMBLIES –

Part 2-805: X/Y CTE test for thin base materials by TMA

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The text of this International Standard is based on the following documents:

Draft	Report on voting
91/1755/CDV	91/1782/RVC

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 61189 series, published under the general title *Test methods for electrical materials, printed boards and other interconnection structures and assemblies*, can be found on the IEC website.

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TEST METHODS FOR ELECTRICAL MATERIALS, PRINTED BOARDS AND OTHER INTERCONNECTION STRUCTURES AND ASSEMBLIES –

Part 2-805: X/Y CTE test for thin base materials by TMA

1 Scope

This part of IEC 61189 defines the method to be followed for the determination of the X/Y coefficient of thermal expansion of thin electrical insulating materials via the use of a thermomechanical analyser (TMA). This method is applicable to materials that are solid for the entire range of temperature used, and that retain sufficient rigidity over the temperature range so that so that irreversible indentation of the specimen by the sensing probe does not occur.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

4 Test specimens

4.1 Preparation

The test specimen shall be between 0,01 mm and 0,5 mm thick. The effective length of the sample clamped in the fixture shall be 8 mm and the recommended length of the sample is 60 mm, The sample width shall be 4 mm.

NOTE The test results will vary based upon the layup used, the resin to glass ratio and the ultimate cure of the laminated stack.

4.2 Number

One specimen shall be prepared unless noted otherwise for each direction X and Y.

4.3 Form

The test specimen shall be cut to the specified size using appropriate procedures and equipment to minimize thermal shock and mechanical stress. The edges shall be smooth and without tears.

4.4 Conditioning

The specimens shall be preconditioned by baking for one hour ± 15 minutes.

After removal from the oven, the specimens shall be allowed to cool to room temperature in a desiccator or drying cabinet capable of maintaining an atmosphere less than 30 % RH at 23 °C.

5 Apparatus and materials

a) Thermomechanical analyzer (TMA) capable of detecting dimensional change to within ± 0,002 50 mm margin over the specified temperature range. It is desirable to have a TMA comprised of a data acquisition and analysis system as well as the thermal cell. The TMA shall have an environmental chamber capable of holding pure flush gas and an ultimate temperature of 350 °C.

b) Drying chamber air circulating oven capable of maintaining 105 ± 2 °C.

c) Desiccator of low humidity drying cabinet capable of maintaining less than 30 % relative humidity at 23 °C.

d) Specimen preparation: Etching system capable of complete removal of the metallic cladding.

6 Procedure

a) Metal-clad samples shall be tested without the cladding. Etch and dry the samples using appropriate procedures and equipment.

b) Calibrate of the TMA instrument should be carried out according to the manufacturer's instructions.

c) Remove the specimen from the desiccator and place the specimen using the thin film fixture clamp of the TMA stage. The first test should be with the sample oriented in the "X" direction.

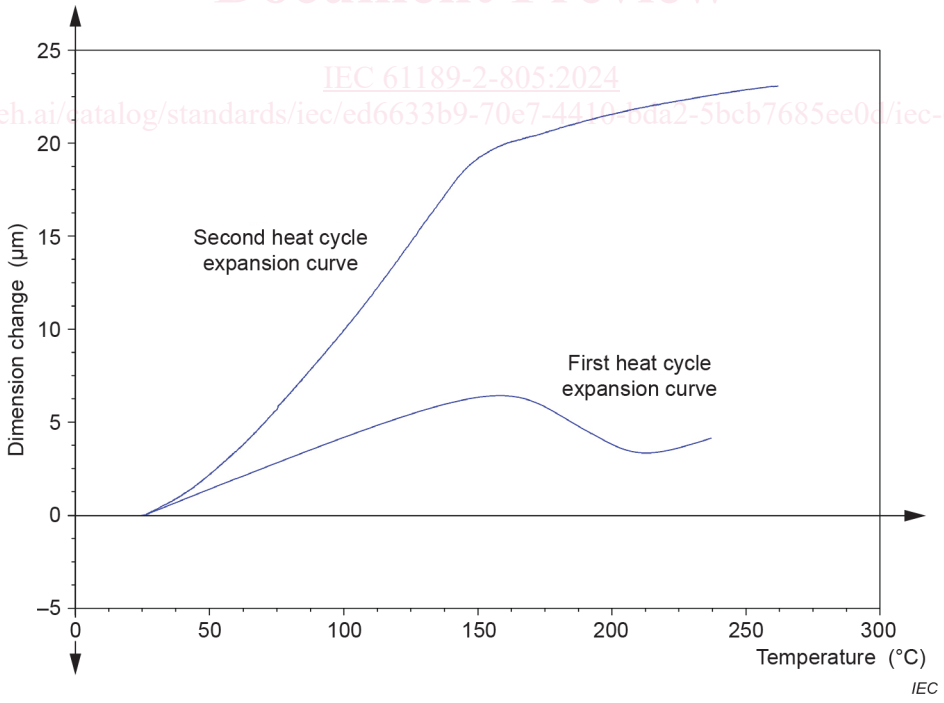

Figure 1 – TMA expansion curves: first heat cycles and second heat cycles

d) Apply 0,03 N of tension force and enclose the specimen.

e) Start a pure gas purge at the rate of 30 ml/min to 150 ml/min to the environmental chamber.

f) Start the temperature ramp (or scan) from room temperature or other specified temperature.

g) Depending on the sample preparation, two heating cycles may be required to obtain accurate CTE information. If the samples show unexpected shrinkage (see Figure 1), the two heat test method is required. If two heating cycles are needed, perform procedure h) i) and j), if just scan once, perform procedure j). The heating rate shall be conducted at 10 °C/ minute for both cycles.

h) The temperature excursion of the first scan shall be until a temperature of 20 °C above the glass transition temperature (Tg) is observed. Hold the temperature for a minimum of 5 minutes or until the thermal relaxation has stopped. Avoid holding the temperature for too long so as to avoid degradation of the specimen.

i) Cool the specimen to the initial temperature at 5 °C/min to 10 °C/min.

j) Repeat the procedure for the second heat cycle. The second heat cycle should end at the temperature as specified.

7 Evaluation

7.1 General

The TMA expansion curve should resemble the plot shown in Figure 2.

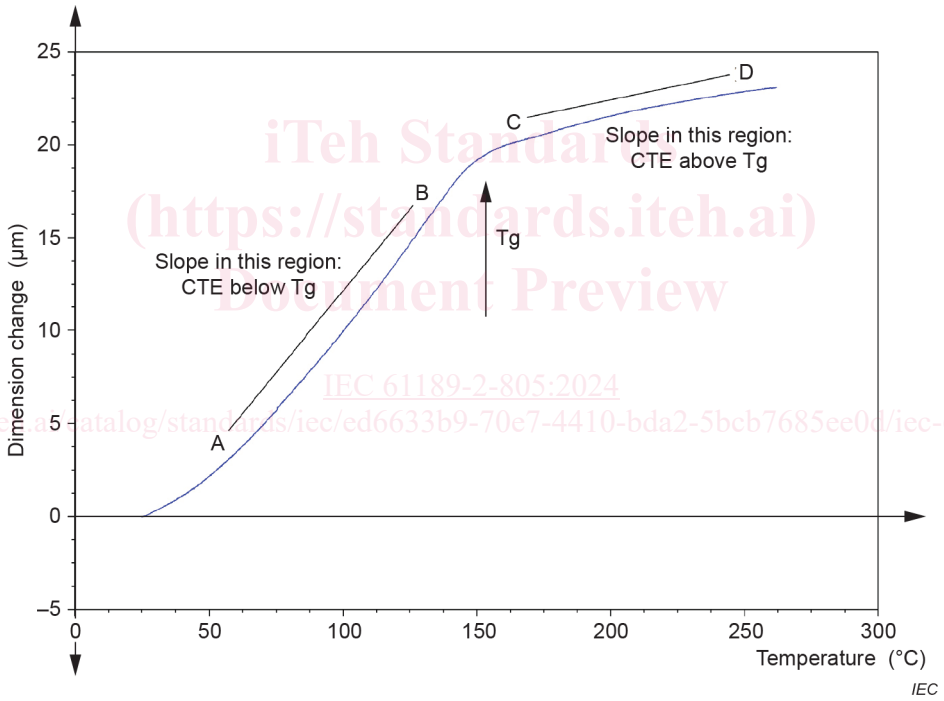

Figure 2 – TMA expansion curve

An ideal TMA curve has a linear section below the Tg and a linear section above the Tg. The software of the TMA may provide a more normalized result by averaging the data.

Examine all the specimens for signs of excessive loads, distortions, tears and other defects. If any defects or specimen irregularities are found, discard the specimen and start over.

The analysis shall be repeated on the Y specimen. In most modern TMA instruments, the calculations are handled by the system software.

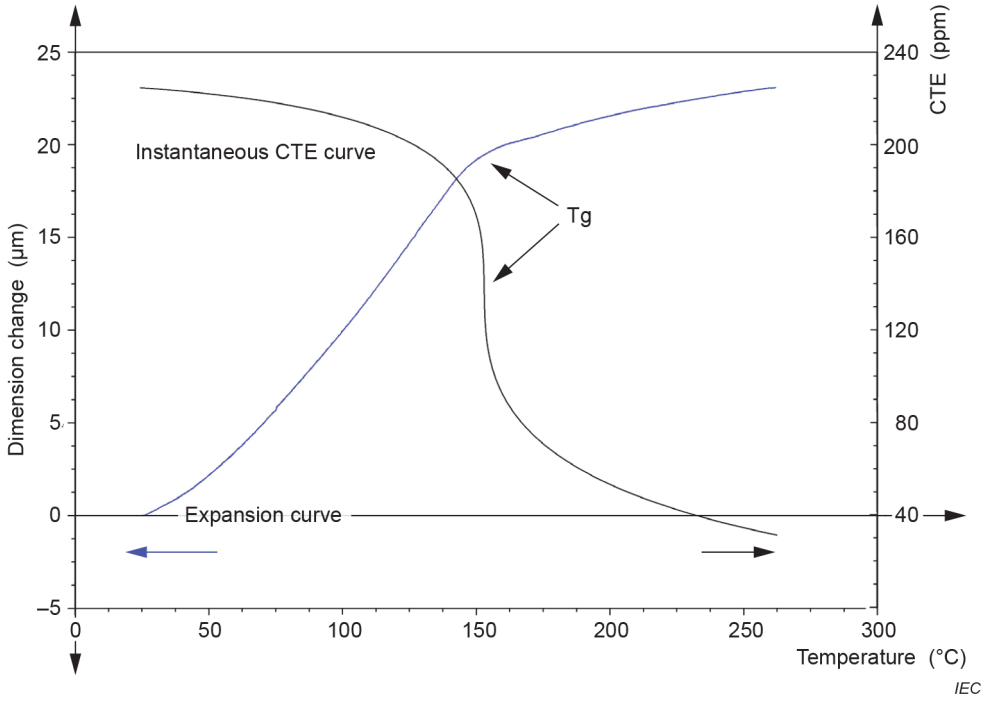

Figure 3 – TMA expansion curve and instantaneous CTE curve

7.2 Calculation of coefficient of thermal expansion curve

The average coefficient of thermal expansion α over the temperature interval of interest is calculated as follows:

a) CTE below glass transition

$$\alpha_{(B-A)} = \frac{(C_B - C_A)10^6}{L_0 (T_B - T_A)}$$

For most materials, this will be the range of 7 ppm to 50 ppm (reinforced) or 30 ppm to 150 ppm (unreinforced)

b) CTE above glass transition

$$\alpha_{(D-C)} = \frac{(C_D - C_C)10^6}{L_0 (T_D - T_C)}$$

For most materials, this will be the range of 50 ppm to 100 ppm (reinforced) or 150 ppm to 500 ppm (unreinforced). Any reinforced materials, where the reinforcement has negative CTE, will shrink rather than expand when heated above Tg of the resin.

T_A = temperature at point A in Figure 2;

T_B = temperature at point B in Figure 2;

T_C = temperature at point C in Figure 2;

T_D = temperature at point D in Figure 2;

L_0 = initial length or thickness;

C_A = dimensional change at point A in Figure 2;

C_B = dimensional change at point B in Figure 2;

C_C = dimensional change at point C in Figure 2;

C_D = dimensional change at point D in Figure 2.