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Plastics — Thermomechanical analysis (TMA) —

Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature

Plastiques — Analyse thermomécanique (TMA) —

Partie 2: Détermination du coefficient de dilatation thermique linéique et de la température de transition vitreuse

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 5, *Physical-chemical properties*.

This second edition cancels and replaces the first edition (ISO 11359-2:1999), which has been technically revised.

The main changes compared to the previous edition are as follows:

— the testing procedure has been revised with regard to test load and purge gas conditions;

— the evaluation of determination of the mean coefficient of thermal expansion with reference specimen has been specified more precisely;

— the document has been editorial revised.

A list of all parts in the ISO 11359 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Plastics — Thermomechanical analysis (TMA) —

Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature

1 Scope

This document specifies a test method, using thermodilatometry[1], for the determination of the coefficient of linear thermal expansion of plastics in a solid state by thermomechanical analysis (TMA). This document also specifies the determination of the glass transition temperature using TMA.

NOTE The coefficient of linear thermal expansion can be measured using various types of thermodilatometry apparatus. This document concerns only TMA apparatus.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 472, *Plastics — Vocabulary*

ISO 11359-1, *Plastics — Thermomechanical analysis (TMA) — Part 1: General principles*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472, ISO 11359-1 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
differential coefficient of linear thermal expansion
α
expansion, normalised to the reference length L_0 at room temperature, for any of the three dimensions at temperature T and at constant pressure p, given in reciprocal kelvins, by the following formula:

$$\alpha = \frac{(\mathrm{d}L)_p}{(\mathrm{d}T)_p} \times \frac{1}{L_0} = \frac{(\mathrm{d}L/\mathrm{d}t)_p}{(\mathrm{d}T/\mathrm{d}t)_p} \times \frac{1}{L_0}$$

where

L_0 is the reference length at room temperature T_0, in the axis of measurement;

L is the length at temperature T, in the axis of measurement;

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$\mathrm{d}L$ is the change in length over the time interval dt at constant pressure p;

$\mathrm{d}T$ is the change in temperature over the time interval dt at constant pressure p

3.2
mean coefficient of linear thermal expansion
$\bar{\alpha}$
expansion, normalised to the reference length L_0 at room temperature, for any of the three dimensions in a specified temperature interval ΔT at constant pressure, given in reciprocal kelvins, by the following formula:

$$\bar{\alpha} = \frac{\Delta L}{\Delta T} \times \frac{1}{L_0}$$

where

ΔL is the change in length of the test specimen between two temperatures T_1 and T_2;

L_0 is the reference length of the test specimen at room temperature in the axis of measurement;

ΔT is the change in temperature, equal to $T_2 - T_1$

Note 1 to entry: The determination is made over a temperature interval ΔT between T_1 and T_2. The representative temperature T_{rep} is given by

$$T_{rep} = \frac{T_1 + T_2}{2}$$

Note 2 to entry: By replacing the term "length" by "volume" in the formulae in 3.1 and 3.2, the coefficient of volumetric thermal expansion can be obtained.

4 Principle

The change in a dimension of a test specimen is measured as a function of temperature using a TMA apparatus to generate a TMA curve from which the coefficient of linear thermal expansion can be calculated.

5 Apparatus

The components of the TMA apparatus used for this document shall be as specified in ISO 11359-1 and shall also be capable of

a) operating in a compression mode or a tension mode or both, and

b) maintaining the specimen under a controlled atmosphere in accordance with ISO 291.

NOTE 1 Measurements on specimens of film or fibre are made in the tension mode.

NOTE 2 Typically, an atmosphere of dry air or an inert gas such as nitrogen is used.

6 Test specimens

6.1 Preparation

Test specimens shall be prepared in accordance with ISO 11359-1.

The standard test specimen is a rectangular specimen 5 mm to 10 mm in length and about 5 mm in width. However, specimens of other dimensions may be used by agreement between the interested

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