

Method for

# Determination of the coefficient of mean linear thermal expansion of glass

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# Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Laboratory Apparatus Standards Committee (LBC/-) to Technical Committee LBC/8, upon which the following bodies were represented:

- British Glass Industry Research Association
- Glass Manufacturers' Federation
- Society of Glass Technology

This British Standard, having been prepared under the direction of the Laboratory Apparatus Standards Committee, was published under the authority of the Board of BSI and comes into effect on 31 January 1989

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# National foreword

This British Standard has been prepared under the direction of the Laboratory Apparatus Standards Committee. It is identical with ISO 7991:1987 “Glass — Determination of coefficient of mean linear thermal expansion”, prepared by Subcommittee 5 of ISO/TC 48, Laboratory glassware and apparatus, of the International Organization for Standardization (ISO), with the active participation and approval of the United Kingdom.

**Terminology and conventions.** The text of the International Standard has been approved as suitable for publication as a British Standard without deviation. Some terminology and certain conventions are not identical with those used in British Standards; attention is drawn especially to the following.

The comma has been used as a decimal marker. In British Standards it is current practice to use a full point on the baseline as the decimal marker.

Wherever the words “International Standard” appear, referring to this standard, they should be read as “British Standard”.

**Cross-references**

| International Standard | Corresponding British Standard                                                                                                                                            |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ISO 7884-8:1987        | BS 7034 <i>Viscosity and viscometric fixed points of glass</i><br>Part 8:1988 <i>Method for determination of (dilatometric) transformation temperature</i><br>(Identical) |

The Technical Committee has reviewed the provisions of IEC 584-1, to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard. The reference in 4.5 to IEC 584-1 is only an informative reference, but thermocouples complying with the following Parts of BS 4937 “International thermocouple reference tables” are suitable.

- Part 3:1973: *Iron/copper — nickel thermocouples. Type J;*
- Part 4:1973: *Nickel — chromium/nickel — aluminium thermocouples. Type K;*
- Part 6:1974: *Nickel-chromium/copper-nickel thermocouples. Type E.*

Manufacturing tolerances for types E, J and K thermocouples are given in BS 4937-20:1983 “Specification for thermocouple tolerances”.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

**Compliance with a British Standard does not of itself confer immunity from legal obligations.**

**Summary of pages**

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 8, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

## 1 Scope and field of application

This International Standard specifies a method for determining the coefficient of mean linear thermal expansion of glass in the elastic solid-like state, well below the transformation temperature (see ISO 7884-8).

This International Standard applies to all glasses of normal bulk-production compositions. It does not apply to fused silica, glass ceramics or other glasses of similarly low linear thermal expansion coefficients.

## 2 References

ISO 7884-8, *Glass — Viscosity and viscometric fixed points — Part 8: Determination of (dilatometric) transformation temperature*.

IEC Publication 584-1, *Thermocouples — Part 1: Reference tables*.

## 3 Definition

For the purposes of this International Standard, the following definition applies.

**coefficient of mean linear thermal expansion,  $\alpha(t_0; t)$**

the ratio of the change in length of a specimen within a temperature interval to that temperature interval, related to the initial specimen length

it is given by the following equation:

$$\alpha(t_0; t) = \frac{1}{l_0} \times \frac{l - l_0}{t - t_0} \quad \dots (1)$$

where

$t_0$  is the initial or reference temperature;

$t$  is the actual (constant or variable) specimen temperature;

$l_0$  is the length at temperature  $t_0$  of the specimen of glass under test (usually a rod made from the glass);

$l$  is the specimen length at temperature  $t$ .

for the purposes of this International Standard, the nominal reference temperature,  $t_0$ , is 20 °C; therefore the coefficient of mean linear thermal expansion is denoted by  $\alpha(20\text{ °C}; t)$

## 4 Apparatus

**4.1 Device for measuring the specimen length**, to an accuracy of 0,1 %.

**4.2 Push-rod dilatometer**, capable of determining changes in length of the specimen of  $2 \times 10^{-5} l_0$  (i.e. 2 µm per 100 mm).

The contact force of the extensometer should not exceed 1 N. That force shall act through contacts of planes with spherical faces the radii of curvature of which shall be not less than the rod diameter of the specimen. In some special assemblies (see Figure 1) parallel planes are needed.

The specimen-holding assembly shall ensure that the specimen is held firmly in position and shall prevent even small changes in its alignment with respect to the push-rod axis throughout the test (see examples given in the Annex).

If the specimen-holding assembly is made of vitreous silica, see the precautions given in 7.2.

From time to time, a performance test shall be carried out using a reference material (see clause 8).

**4.3 Furnace**, compatible with the dilatometer assembly, for temperatures up to 50 °C above the expected transformation temperature. The working position of the furnace relative to the dilatometer assembly shall be defined with a repeatability of 0,5 mm in both the axial and the radial directions.

Within the range of testing temperatures (i.e. up to temperatures about 150 °C below the highest expected transformation temperature,  $t_g$ , and at least up to 300 °C), the furnace shall be capable of maintaining a constant temperature to  $\pm 2\text{ °C}$  over the whole specimen length.

**4.4 Furnace control device**, suitable for the desired rate of increase in temperature up to  $(5 \pm 1)\text{ °C/min}$  within the test range (see 6.1) and for a cooling rate of  $(2 \pm 0,2)\text{ °C/min}$  for the annealing procedure according to 5.2.

**4.5 Temperature-measuring device** (e.g. a thermocouple of type E, J or K in accordance with IEC 584-1), capable of determining the temperature of the specimen to  $\pm 2\text{ °C}$  in the temperature range between  $t_0$  and  $t$ .