GB

NATIONAL STANDARD OF THE

PEOPLE'S REPUBLIC OF CHINA

ICS 81.040.01
N 64

GB/T 16920-2015

Replacing GB/T 16920-1997

Glass - Determination of coefficient of mean linear thermal expansion

玻璃 - 平均线热膨胀系数的测定

(ISO 7991:1987, NEQ)

Issued on: December 31, 2015 **Implemented on: July 01, 2016**

Issued by: General Administration of Quality Supervision, Inspection and Quarantine;

Standardization Administration of PRC.

Table of Contents

Glass - Determination of coefficient of mean linear thermal expansion

1 Scope

This standard specifies the method for determining the coefficient of mean linear thermal expansion of elastic solid glass.

This standard applies to the determination of the coefficient of mean linear thermal expansion of glass of various materials.

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) are applicable to this standard.

GB/T 1216 External micrometer

GB/T 21389 Vernier dial and digital display calipers

3 Terms and definitions

The following terms and definitions apply to this document.

3.1

Coefficient of mean linear thermal expansion

α (t_0; t)

Within a certain temperature interval, the ratio of the length change of the specimen to the temperature interval and the initial length of the specimen, expressed by the formula (1):

$$\alpha(t_0;\ t) = \frac{1}{L_0} \times \frac{L - L_0}{t - t_0} \qquad \cdots\cdots(1)$$

Where:

performance. The method is as shown in the calibration and verification of the performance test of instrument.

4.3 Heating furnace

The heating furnace shall be matched with the dilatometer device. The upper limit of temperature shall be about 50 °C higher than the expected determined temperature of transformation (t). The working position of the heating furnace as relative to the dilatometer shall have a reproducibility within 0.5 mm in the axial and radial directions.

Within the range of test temperature (i.e., the upper limit temperature is 150 °C lower than the highest expected transformation temperature t_g, at least the temperature difference between 300 °C and t_g is greater than 150 °C, and shall not be lower than 300 °C), throughout the determination interval of the entire specimen length, the furnace's temperature shall be constantly controlled within ±1 °C.

The heating furnace shall be able to meet the control requirements of 5 °C/min ± 1 °C/min. Within the range of the test temperature, the ideal rate of temperature rise is 5 °C/min ± 1 °C/min.

4.4 Temperature measuring device

In the temperature range of t_0 and t, it may be able to accurately determine the temperature of the specimen, the error is less than ±1 °C.

5 Test samples

5.1 Shape and size

The specimen is usually rod-shaped, the shape of which depends on the type of dilatometer used, the length L_0 shall be at least 5×10^5 times the resolution of the length measuring device of the dilatometer.

Note: For example, the specimen may be a round bar which has a diameter of 5 mm, length of 50 mm ± 1 mm; or according to the structure of the dilatometer, it may also be a square bar which has a section of 5 mm × 5 mm and a length of 25 mm ~ 100 mm. The specimen of other square or rectangular sections shall be able to ensure the accuracy and repeatability of the measurement (see Appendix A).

5.2 Preparation of specimen

Select the glass which has no defects such as stones, bubbles, and streaks. Use the mechanical cutting or hot working methods to prepare it into the shape and size required for the specimen, then make it annealed. The annealing

difference between the hot joint of the thermocouple and the specimen, the apparent temperature of the specimen shall plus the corrected value.

Note: The magnitude of this corrected value depends on the rate of temperature change as well as the rate of heat exchange between the heating furnace and the specimen. Fundamentally, the corrected value is to be determined by comparison with a constant temperature test.

6.4 Constant temperature test

At the initial temperature t_0, determine the position of the dilatometer. Use this reading as the zero point of the uncorrected amount of change of length ΔL_{meas} to be measured. Then rise the temperature of furnace to the selected end-point temperature t, keep the furnace's temperature constantly at ±2 °C. After 20 min, take the reading of ΔL_{meas} from the dilatometer.

Note: Although the temperature-rise test can determine the coefficient α (t_0; t) of various temperatures t during the test, if only one end-point temperature t is required, it shall give priority to the constant-temperature test, because this test may provide better accuracy.

7 Representation of results

7.1 Calculation of final length

From the measured length variable ΔL_{meas}, the corrected length L at the temperature t is calculated by the use of formula (2):

$$L = L_0 + \Delta L_{meas} + \Delta L_Q - \Delta L_B \qquad \cdots\cdots (2)$$

Where:

The correction terms ΔL_Q and ΔL_B are explained in 7.2 or 7.3, respectively.

7.2 Calculation of expansion of specimen-bearing device (ΔL_Q)

In the case of a single-pusher-type dilatometer, the correction term ΔL_Q in the formula (2) is the thermal expansion of the portion (length = L_0) of the specimen-bearing device which is located near the specimen at a temperature of t_0.

In the case of a differential-pusher-type dilatometer, the correction term ΔL_Q is the thermal expansion of the standard bar. The standard bar has a same length as the sample, which is L_0 at the temperature of t_0.

In either case, the correction term ΔL_Q is calculated by the use of formula (3):

$$\Delta L_Q = L_0 \alpha_Q (t_0 ; t) \qquad \cdots\cdots (3)$$

determination of glass. It shall repeat the blank test each time when performing the test of instrument performance in accordance with clause 7.

7.4 Calculation of coefficient of average linear thermal expansion

To calculate the coefficient of average linear thermal expansionα (t_0; t), substitute the measured values of L_0 and ΔL_{meas}, the correction value as established in accordance with 6.2 and 6.3, the measured value of t_0, the t value (if it is the temperature-rise test, use the corrected value) into the formula (4):

$$\alpha(t_0;t)=\frac{1}{L_0}\times\frac{\Delta L_{meas}+\Delta L_Q-\Delta L_B}{t-t_0} \qquad \cdots\cdots(4)$$

Calculate α (20 °C; 300 °C) of two specimens (5.3). It may also determine α (20 °C; 200 °C), α (20 °C; 100 °C) or α (20 °C; 400 °C), respectively, as needed. If α (20 °C; t) < 10 x 10^{-6} K^{-1}, take two significant digits; if α (20 °C; t) ≥ 10 x 10^{-6} K^{-1}, take 3 significant digits.

If the deviation of the results of the two specimens is not more than 0.2 × 10^{-6} K^{-1}, take the arithmetic mean. Otherwise, use the other two specimens to repeat the test.

8 Test of instrument performance

In order to check whether the entire test device is operating normally, use the standard materials to make samples, follow the provisions of clause 5 and clause 6 to perform test and calculation; the coefficient of average linear thermal expansion of the standard samples is a known standard value.

It is recommended to use the following standard materials:

- Sapphire standard glass;
- Alumina ceramic standard sample;
- American standard reference material 731 borosilicate glass (NIST SRM 731);
- Pure platinum rods;
- Quartz glass that has been annealed in accordance with 5.2.

The shape and size of the standard sample shall be similar to the shape and size of the sample that is typically tested in the test device.

It shall be ensured that the thermal expansion characteristics of the standard material are not altered by the test. If the standard material is glass, it shall be

This is an excerpt of the PDF (Some pages are marked off intentionally)

------ The End ------