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PEOPLE'S REPUBLIC OF CHINA**

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**Plastics - Thermoplastic materials - Determination of Vicat
softening temperature(VST)
(English Translation)**

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1 Scope

This document describes four methods for determining the Vicat softening temperature (VST) of thermoplastic materials.

- A50 method. load of 10 N, heating rate of 50 °C/h;
- B50 method. load of 50 N, heating rate of 50 °C/h;
- A120 method. load of 10 N, heating rate of 120 °C/h;
- B120 method. load of 50 N, heating rate of 120 °C/h.

The four methods specified in this document are applicable only to thermoplastics. The measured temperature is the temperature at which the thermoplastic material rapidly softens.

2 Normative references

The following documents, through normative references herein, constitute essential provisions of this document. For dated references, only the version corresponding to that date applies to this document; for undated references, the latest version (including all amendments) applies to this document.

GB/T 2035 Plastics - Terminology (GB/T 2035-2024, ISO 472:2013, NEQ)

GB/T 2918 Standard environment for conditioning and testing of plastic specimens (GB/T

2918-2018, ISO 291.2008, MOD)

GB/T 4990 Alloy wires of extension and compensating cables for thermocouples

GB/T 9352 Plastic - Compression moulding of test specimens of thermoplastic materials
(GB/T 9352-2008, ISO 293.2004, IDT)

GB/T 16839.1 Thermocouples - Part 1.EMF specifications and tolerances (GB/T
16839.1-2018, IEC 60584-1.2013, IDT)

GB/T 17037.1 Plastics - Injection moulding of test specimens of thermoplastic materials -
Part 1.General principles, and moulding of multipurpose and bar test specimens (GB/T
17037.1-2019, ISO 294-1.2017, MOD)

GB/T 17037.2 Plastics - Injection moulding of test specimens of thermoplastic materials -
Part 2.Small tensile bars (GB/T 17037.2-2020, ISO 294-2.2018, MOD)

GB/T 17037.3 Plastics - Injection moulding of test specimens of thermoplastic materials -
Part 3.Small plates (GB/T 17037.3-2003, ISO 294-3.2002, IDT)

GB/T 30121 Industrial platinum resistance thermometers and platinum temperature
sensors (GB/T 30121-2013, IEC 60751.2008, IDT)

GB/T 37426 Plastics - Test specimens (GB/T 37426-2019, ISO 20753.2018, MOD)

GB/T 39812 Plastics - Preparation of test specimens by machining (GB/T 39812-
2021, ISO 2818.2018, IDT)

GB/T 44535 Determination of linear dimensions of plastic specimens (GB/T 44535-
2024, ISO 16012.2015, MOD)

3 Terms and definitions

The terms and definitions defined in GB/T 2035, as well as the following terms and definitions, apply to this document.

3.1

Penetration

The depth to which the indenter tip penetrates the specimen.

Note: Expressed in millimeters (mm).

3.2

Load

The force applied to the specimen by the indenter.

Note: Expressed in Newtons (N).

3.3

Vicat softening temperature (VST)

The temperature at which the indenter penetrates the specimen surface to a depth of 1 mm under a specified load (3.2), using a selected uniform heating rate.

Note: Expressed in degrees Celsius (°C).

4 Principle

The temperature, at which a standard indenter penetrates the surface of a thermoplastic specimen to a depth of 1 mm under a certain load condition, is determined by uniform heating.

5.1 Device for generating penetration

The device consists of a rigid metal frame containing a rod, that can move freely in the vertical direction. A load plate is mounted at one end of the rod; the indenter is mounted at the other end. A support plate or other suitable load application device is mounted at the bottom of the metal frame, as shown in Figure 1 or Figure 2.

Figure 1 -- Schematic diagram of test equipment with heating device as liquid bath or powder fluidization bed

Figure 2 -- Schematic diagram of test equipment with heating device as direct contact heating device

The load rod and rigid metal frame should be made of rigid material with a low coefficient of thermal expansion. Vertical components shall have the same coefficient of thermal expansion to avoid errors in the specimen penetration reading, which is caused by changes in the length of these components during testing.

After manufacturing, repairing, or replacing the specimen holder, a blank test shall be performed on each metal holder, which has a rigid material with a low coefficient of thermal expansion and a thickness comparable to the test specimen. This test shall cover the actual operating temperature range of the test material; a correction term shall be assigned for each temperature. If the correction term is greater than or equal to 0.02 mm, the value and algebraic sign shall be recorded; this shall be added algebraically to the penetration measurement reading. This correction term is used in each test.

Note: Quartz and borosilicate glass are suitable materials for blank specimens.

5.2 Indenter

The indenter shall be a hardened steel cylinder, which as a length of not less than 2 mm, a cross-sectional area of $(1.000 \pm 0.015) \text{ mm}^2$, a diameter of $(1.128 \pm 0.008) \text{ mm}$, fixed to the bottom of the load rod. The lower surface of the indenter in contact with the specimen shall be flat, perpendicular to the axis of the load bar, free of burrs.

5.3 Heating equipment

The heating equipment shall be a liquid bath, fluidization bed, or direct contact heating device, as shown in Figure 2. For heat transfer media other than gas (air), the specimen immersion depth shall be at least 35 mm.

A high-efficiency stirrer or device for flowing the solid heat transfer medium shall be provided. If a liquid is used for heat transfer, it shall be ensured that the selected liquid is stable at the operating temperature and has no effect on the specimen, such as expansion or cracking.

If different heating equipment selections lead to differences in test results, a liquid bath shall be used.

The heating equipment shall be equipped with a temperature controller capable of uniformly increasing the temperature at a rate of $(50 \pm 5) ^\circ\text{C/h}$ or $(120 \pm 10) ^\circ\text{C/h}$. The heating rate shall be periodically verified, by automatically checking the temperature readings or manually checking the temperature.

The heating rate shall be verified periodically, by checking the automatic temperature readings or manually checking the temperature. If the temperature change is $(5.0 \pm 0.5) ^\circ\text{C}$ or $(12.0 \pm 1.0) ^\circ\text{C}$ every 6 minutes during the test, the heating rate requirement shall be considered met.

Since most instruments use a proportional-integral-derivative (PID) controller to control heating, temperature changes exceeding the specified tolerance are permissible in the first 10 minutes of heating or before reaching $40 ^\circ\text{C}$. Under normal circumstances, the controller will adjust itself to the correct power and interval requirements to achieve the desired heating rate.

Note: Accelerated cooling is preferable for heating equipment.

Liquid paraffin, transformer oil, glycerin, silicone oil can be used as liquid heat transfer media, or other liquids. For fluidization beds, alumina powder may be used.