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Plastics — Determination of thermal conductivity and thermal diffusivity ~~—~~ —

Part 4: Light flash method

Plastiques — Détermination de la conductivité thermique et de la diffusivité thermique — ~~Partie 4: Méthode par flash lumineux~~

Partie 4: Méthode par flash lumineux

PROOF

Style Definition

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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 document 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.htmlwww.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 5, *Physical-chemical properties*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 249, *Plastics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 22007--4:2017), which has been technically revised.

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

— —the term laser flash has been replaced by the more general term light flash.

A list of all parts in the ISO 22007 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 — Determination of thermal conductivity and thermal diffusivity —

Part 4: Laser Light flash method

1 Scope

This document specifies a method for the determination of the thermal diffusivity of a thin solid disc of plastics in the thickness direction by the light flash method. This method is based upon the measurement of the temperature rise at the rear face of the thin-disc specimen produced by a short energy pulse on the front face.

The method is applicable to homogeneous solid plastics as well as composites having an isotropic or orthotropic structure. In general, it covers materials having a thermal diffusivity, α, in the range 1×10^{-7} $m^2 \cdot s^{-1} < \alpha < 1 \times 10^{-4}$ $m^2 \cdot s^{-1}$. Measurements can be carried out in gaseous and vacuum environments over a temperature range from −100 °C to +400 °C.

NOTE For inhomogeneous specimens, the measured values can be specimen thickness dependent.

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/IEC Guide 98--3, Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)

ISO 291, Plastics — Standard atmospheres for conditioning and testing

ISO 527--1, Plastics — Determination of tensile properties — Part 1: General principles

ISO 2818, *Plastics — Preparation of test specimens by machining*

ISO 22007--1, Plastics — Determination of thermal conductivity and thermal diffusivity — Part 1: General principles

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 22007-1 and the following apply.

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

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

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

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3.1
pulse width
t_p
duration for which the light pulse intensity is larger than half of its maximum value

Note 1 to entry: It is expressed in seconds (s).

3.2
time origin
t_0
start of the light pulse

Note 1 to entry: It is expressed in seconds (s).

3.3
maximum temperature rise
ΔT_{max}
difference between the maximum temperature reached by the rear face of the specimen after the light pulse has passed and its steady temperature before the pulse

Note 1 to entry: It is expressed in kelvins (K).

3.4
half-rise time
$t_{1/2}$
time from the *time origin* (3.2)(3.2) until the rear-face temperature increases by one-half of ΔT_{max}

Note 1 to entry: It is expressed in seconds (s).

3.5
thermogram
temperature versus time curve for the rear face of the specimen

3.6
thickness
d
dimension of the test specimen in the direction of heat transfer measurement

Note 1 to entry: It is expressed in metres (m).

4 Principle

One side of a flat-sheet test specimen is subjected to an energy pulse which has a very short duration compared with the half-rise time (see 6.1)6.1) and a uniform spatial energy distribution. The transient temperature rise on the opposite face (rear face) is recorded as a function of time (see Figure 1).Figure 1). The thermal diffusivity is obtained by comparing the experimental thermogram with a theoretical model (see Clause 9 and Annex B).Clause 9 and Annex B).

5 Apparatus

5.1 General

The apparatus shall be designed to obtain the thermal diffusivity as described in Clause 4Clause 4 and shall consist of the following main components as shown in Figure 2.Figure 2. These are the furnace or climatic chamber with a specimen holder and temperature measurement device (e.g. thermocouple), the flash source (e.g. laser), the pulse detector, the transient detector (IR detector) and the control, data acquisition and analysis unit.

5.2 Furnace or climatic chamber

The furnace or climatic chamber shall meet the following requirements.

a) a) The temperature range shall be appropriate to the range of materials to be studied. Depending on the range of temperature, the specimen is maintained at a constant temperature by a cryostat or by a furnace.

b) b) It shall be capable of maintaining the test temperature constant to within ±0,5 K or less for at least 30 min.

c) c) The temperature measurement device shall be capable of measuring the furnace or climatic chamber temperature with a resolution of ±0,1 K and an accuracy of ±0,5 K or better.

d) d) The furnace or climatic chamber shall be fitted with two windows, one transparent to the pulse radiation and the other transparent to the working wavelength range of the IR detector.

e) e) If required, the test environment shall be vacuum or inert-gas atmosphere to avoid oxidative degradation during heating and testing of the specimen. For cryoscopic measurements, care shall be taken to avoid water condensation on the windows.

NOTE Measurement under vacuum will eliminate convection effects.

The specimen holder shall be designed to minimize thermal contact with the specimen and to suppress stray light transmitted from the light beam to the IR detector.

The test temperature shall be measured using a calibrated temperature measurement device that is preferably in contact with the specimen or the specimen holder but at least within 1 mm of the specimen holder.

The temperature measurement device shall be designed so as not to significantly disturb the temperature field generated in the specimen by the light pulse.

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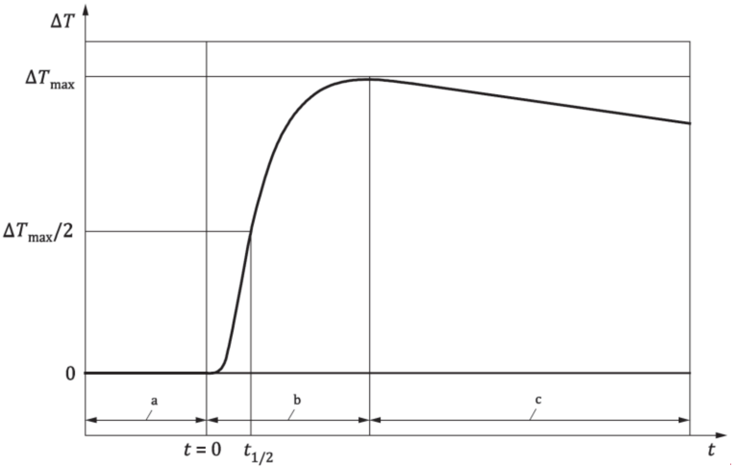

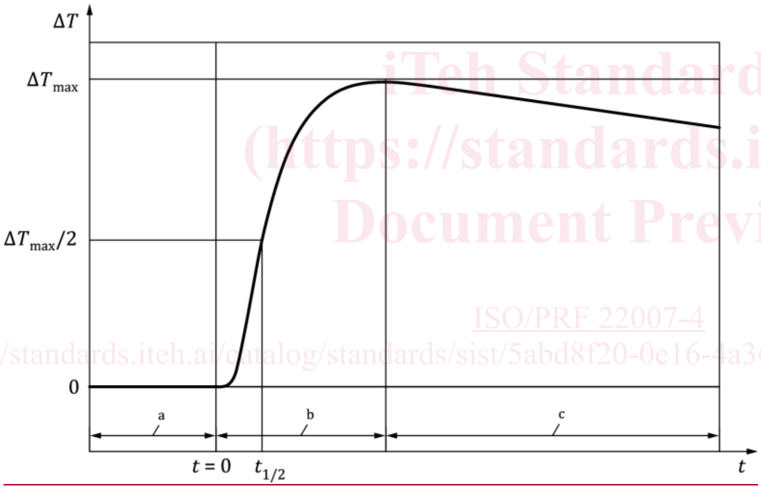

Key

t time

ΔT temperature rise

[a] Baseline.

[b] Transient-rise period.

[c] Cooling period.

Figure 1 — Example of thermogram

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