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Fine ceramics (advanced ceramics, advanced technical ceramics) — Determination of thermal diffusivity of monolithic ceramics by flash method

Céramiques techniques — Détermination de la diffusivité thermique des céramiques monolithiques par la méthode flash

Reference number
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Foreword

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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 206, *Fine ceramics*.

This second edition cancels and replaces the first edition (ISO 18755:2005), which has been technically revised.

The main changes are as follows:

— a change of title and scope to enable the use of flash lamps to generate the energy pulse;

— the addition of three new informative annexes: one dealing with the determination of the intrinsic thermal diffusivity; the second with the determination of specific heat and thermal conductivity of the samples tested; and the third providing precision data for the method on the basis of an inter-laboratory study carried out by seven European laboratories in 2020-2021 in the framework of the project Hi-TRACE;

— an additional normative reference to provide clear instructions on the determination of the density of the materials to be analysed;

— relevant specifications added concerning the size and the density of the specimen;

— improvement of Annex F, with an updated list of potential reference material and incorporation of a validation method.

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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Fine ceramics (advanced ceramics, advanced technical ceramics) — Determination of thermal diffusivity of monolithic ceramics by flash method

1 Scope

This document specifies the test method for the determination of thermal diffusivity from room temperature to at least 1 700 K by the flash method for homogeneous monolithic ceramics with porosity less than 10 %.

Flash methods, like laser flash, are applicable to homogeneous isotropic materials with thermal diffusivity values ranging from 0,1 to 1 000 $mm^2 s^{-1}$ within the temperature range from approximately 100 K to 2 300 K.

The method described in Annex G describes how to estimate, on the basis of the thermal diffusivity test, the specific heat capacity and the thermal conductivity of homogeneous monolithic ceramics with porosity less than 10 %.

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 3611, *Geometrical product specifications (GPS) — Dimensional measuring equipment: Micrometers for external measurements — Design and metrological characteristics*

ISO 18754, *Fine ceramics (advanced ceramics, advanced technical ceramics) — Determination of density and apparent porosity*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology 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
thermal diffusivity
thermal conductivity divided by the product of specific heat capacity and density

3.2
thermal conductivity
density of heat flow rate divided by temperature gradient under steady state condition

3.3
specific heat capacity
heat capacity per unit mass

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3.4
pulse width
τ_p
full width at half maximum (FWHM), which is the time duration when the laser or light pulse intensity is larger than half of its maximum value on time basis

3.5
centroid of laser pulse
chronological centroid of laser light energy

3.6
centroid of light pulse
chronological centroid of light energy

3.7
spatial energy distribution of pulse laser beam
energy density of the laser beam or light flash incident at each point on the front face of the specimen

3.8
transient temperature curve
transient temperature change of the rear face of the specimen after the light pulse heating

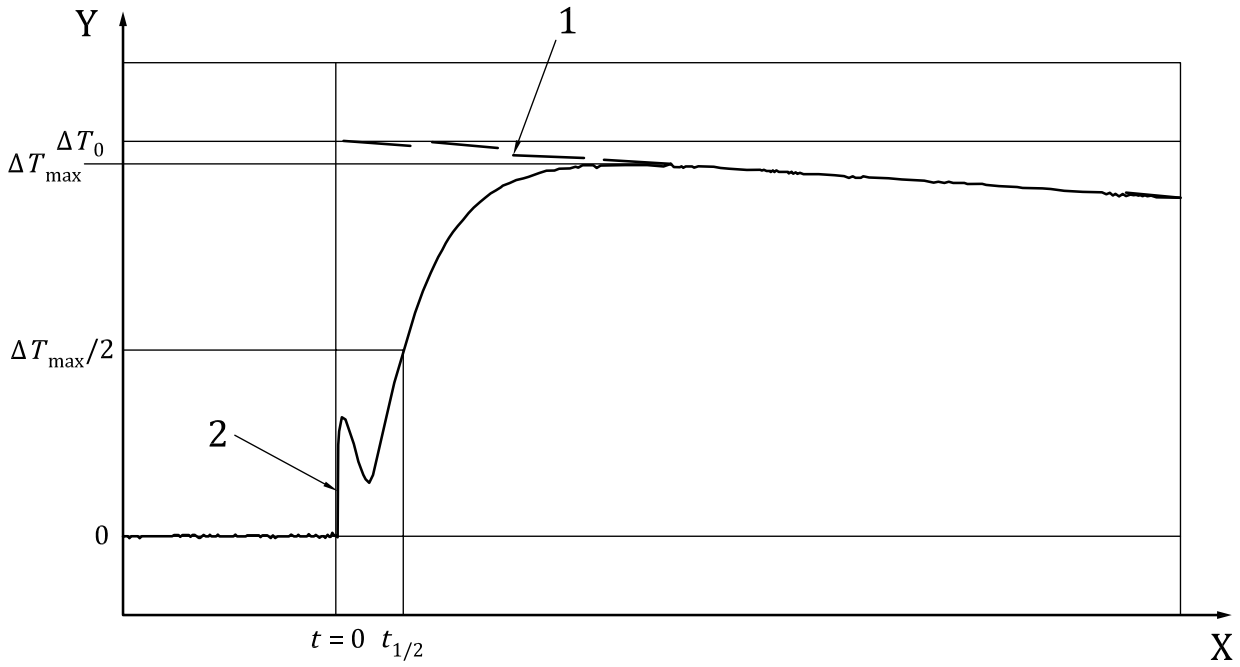
3.9
transient radiance curve
transient change of the spectral radiance from the rear face of the specimen after the light pulse heating

Note 1 to entry: It should be noted that the observed transient curve is proportional to the change of the spectral radiance rather than the change of temperature when a radiation thermometer or a radiation detector is used to observe the transient temperature rise of the specimen after the light pulse heating.

3.10
maximum temperature rise
ΔT_{max}
difference between the steady temperature before the pulse heating and the maximum temperature of the rear face of the specimen after the pulse heating

Note 1 to entry: See Figure 1.

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Key

X time

Y temperature rise

1 exponential function $[\Delta T_0 \ exp(-t/\tau_c)]$

2 initial noise

Figure 1 — Transient temperature curve of the rear face of the specimen after a light pulse heating onto the front face of the specimen

3.11
half rise-time
$t_{1/2}$
time until $\Delta T_{max}/2$ is attained from the pulse heating

3.12
characteristic time of heat loss
τ_c
time of heat loss determined when the cooling region is fitted with an exponential function, $[\Delta T_0 \ exp(-t/\tau_c)]$

Note 1 to entry: See Figure 1.

3.13
extrapolated temperature rise
ΔT_0
temperature rise determined when the cooling region is fitted with an exponential function, $[\Delta T_0 \ exp(-t/\tau_c)]$

4 Apparatus

4.1 General

The apparatus shall be designed for obtaining the thermal diffusivity from the transient temperature curve of the rear face of a specimen after the light pulse is irradiated onto the front face of the specimen. It shall consist of the principal components as shown in Figure 2.

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