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ILNAS-EN 1159-3:2003

Advanced technical ceramics - Ceramic composites, thermophysical properties - Part 3: Determination of specific heat capacity

Céramiques techniques avancées -
Composites céramiques, propriétés
thermophysiques - Partie 3:
Détermination de la capacité thermique

Hochleistungskeramik - Keramische
Verbundwerkstoffe, thermophysikalische
Eigenschaften - Teil 3: Bestimmung der
spezifischen Wärmekapazität

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National Foreword

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**Advanced technical ceramics - Ceramic composites,
thermophysical properties - Part 3: Determination of specific
heat capacity**

Céramiques techniques avancées - Composites
céramiques, propriétés thermophysiques - Partie 3:
Détermination de la capacité thermique spécifique

Hochleistungskeramik - Keramische Verbundwerkstoffe,
thermophysikalische Eigenschaften - Teil 3: Bestimmung
der spezifischen Wärmekapazität

This European Standard was approved by CEN on 2 January 2003.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and United Kingdom.



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Foreword

This document (EN 1159-3:2003) has been prepared by Technical Committee CEN/TC 184 "Advanced technical ceramics", the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2003, and conflicting national standards shall be withdrawn at the latest by October 2003.

This document supersedes ENV 1159-3:1995.

EN 1159 *Advanced technical ceramics – Ceramic composites, thermophysical properties* consists of three parts:

- *Part 1: Determination of thermal expansion*
- *Part 2: Determination of thermal diffusivity*
- *Part 3: Determination of specific heat capacity*

Annex A is normative. Annexes B and C are informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This part of EN 1159 describes two methods for the determination of the specific heat capacity of ceramic matrix composites with continuous reinforcements (1D, 2D, 3D).

Unidirectional (1D), bi-directional (2D) and tridirectional (XD, with $2 < x \leq 3$).

The two methods are:

- method A: drop calorimetry;
- method B: differential scanning calorimetry.

They are applicable from ambient temperature up to a maximum temperature depending on the method: method A may be used up to 2 250 K, while method B is limited to 1 900 K.

NOTE Method A is limited to the determination of an average value of the specific heat capacity over a given temperature range and can give a larger spread of results.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 60584-1, *Thermocouples - Part 1: Reference tables (IEC 60584-1:1995)*.

ENV 13233:1998, *Advanced technical ceramics – Ceramic composites – Notations and symbols*.

3 Terms and definitions

For the purposes of this European Standard, the following definitions and those given in ENV 13233:1998 apply.

3.1

specific heat capacity, C_p

amount of heat required to raise the temperature of a mass unit of material by 1 K at constant temperature and pressure

$$C_p = \frac{1}{m} \frac{dQ}{dT}$$

where

Q is the heat required for a test-piece of mass m

3.2

mean specific heat capacity, $\overline{C_p}$

amount of heat required to raise the temperature of a mass unit of a material from temperature T_1 to temperature T_2 at a constant pressure, divided by the temperature range $(T_2 - T_1)$ expressed in K

3.3

representative volume element (R.V.E.)

the minimum volume which is representative of the material considered

4 Method A - Drop calorimetry

4.1 Principle

A test piece is dropped from a conditioning chamber at a constant temperature T_1 to another chamber at a constant temperature T_2 .

The mean specific heat capacity is determined from the measured amount of heat required to maintain the temperature constant in the second chamber. Transfer of the test piece shall be done under conditions as close as possible to adiabatic conditions.

4.2 Apparatus

4.2.1 Drop calorimeter, there are several types of drop calorimeters. They include one (or more) conditioning chambers and measuring chambers which can be operated under controlled atmosphere and which are all equipped with a temperature control system which allows a temperature stability of less than 1 K.

The conditioning chamber shall have a homogeneous temperature zone size greater than the test specimen size. The measuring chamber shall have a homogeneous temperature zone of a sufficient length to accept several specimens and a sufficient thermal inertia to limit the temperature disturbance, due to the drop.

Heat transfer by radiation during the drop shall be avoided as far as possible.

4.2.2 Balance, with an accuracy of 0,1 mg for test pieces over 10 mg and an accuracy of 0,01 mg for test pieces below 10 mg.

4.2.3 Temperature detectors, thermocouples in accordance to EN 60584-1 shall be used for the measurement of temperature up to 1 920 K.

For higher temperature, infrared detectors or any other suitable device may be used.

4.2.4 Data acquisition system, the sampling period during the test shall be less than 0,5 s.

4.3 Standard reference materials

Standard reference materials which can be used for calibration purposes are listed in annex B.

4.4 Test specimens

The test specimens shall be representative of the material.

NOTE This criterion is generally met by test specimens containing the maximum number of representative volume elements, compatible with the volume of the crucible, if this number is less than five, several solutions are possible:

- a) the test specimens should have an exact number of representative volume elements;
- b) the material should be ground to powder and a specimen taken from this powder. However this solution will lead to results which may differ from results obtained on solid test pieces and should be used only if no other solution is possible;
- c) the material should be cut into specimens and a number of similar test specimens should be tested and an average value determined.

4.5 Calibration of calorimeter

4.5.1 General

Calibration of calorimeters, may be done according to two different methods. The first consists in dissipating a known amount of thermal power using a calibrated resistor introduced in the second chamber of the calorimeter. In