INTERNATIONAL STANDARD

ISO 18555

First edition
2016-02-01

Metallic and other inorganic coatings — Determination of thermal conductivity of thermal barrier coatings

Revêtements métalliques et autres revêtements inorganiques — Détermination de la conductivité thermique des revêtements barrières thermiques



Reference number
ISO 18555:2016(E)

© ISO 2016



COPYRIGHT PROTECTED DOCUMENT

© ISO 2016, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

Foreword ..... **iv**
Introduction ..... **v**
1 Scope **1**
2 Normative references **1**
3 Terms and definitions **1**
4 Principle **4**
5 Apparatus for measuring thermal diffusivity **4**
6 Specimen **5**
6.1 Shape and dimensions 5
6.2 Surface treatment 7
7 Measuring procedure **7**
7.1 Specimen thickness 7
7.2 Thermal diffusivity 7
7.2.1 Measurement of temperature-rise curve 7
7.2.2 Calculation of thermal diffusivity of substrate 7
7.2.3 Calculation of thermal diffusivities of BC and TC 7
7.3 Specific heat capacity 10
7.4 Bulk density 10
8 Thermal conductivities of BC and TC **11**
9 Report **11**
9.1 Items to be reported 11
9.2 Additional items to be selected for the report 12
Annex A (informative) **Areal heat diffusion time method** **13**
Annex B (informative) **Examples of theoretical temperature-rise curves** **16**
Bibliography **18**

© ISO 2016 – All rights reserved

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 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 107, *Metallic and other inorganic coatings*.

© ISO 2016 – All rights reserved

Introduction

Thermal barrier coatings are highly advanced material systems. They are generally applied to surfaces of hot-section components made of nickel or cobalt-based superalloys, such as combustors, blades, vanes of power-generation gas turbines in thermal power plants and aero-engines operated at elevated temperatures.

The function of these coatings is to protect metallic components for extended periods at elevated temperatures by employing thermally insulating materials which can sustain an appreciable temperature difference between load bearing alloys and coating surfaces. These coatings permit the high-temperature operation by shielding these components, thereby extending their lives.

Although thermal conductivity is one of the most important properties of thermal barrier coatings, the existing International Standard (ISO 18755:2005) includes only the method for determining the thermal diffusivity of monolithic ceramics, regarding the heat conduction in thermal barrier coating.

© ISO 2016 – All rights reserved

Metallic and other inorganic coatings — Determination of thermal conductivity of thermal barrier coatings

1 Scope

This International Standard specifies the method for determining the thermal conductivities of thermal barrier coatings consisting of metallic bond coats and ceramic top coats, in a direction normal to the coating surface, at room temperature.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1463, *Metallic and oxide coatings — Measurement of coating thickness — Microscopical method*

ISO 18755:2005, *Fine ceramics (advanced ceramics, advanced technical ceramics) — Determination of thermal diffusivity of monolithic ceramics by laser flash method*

EN 821-3, *Advanced technical ceramics — Monolithic ceramics. Thermophysical properties — Part 3: Determination of specific heat capacity*

ASTM E1269-11, *Standard Test Method for Determining Specific Heat Capacity by Differential Scanning Calorimetry*

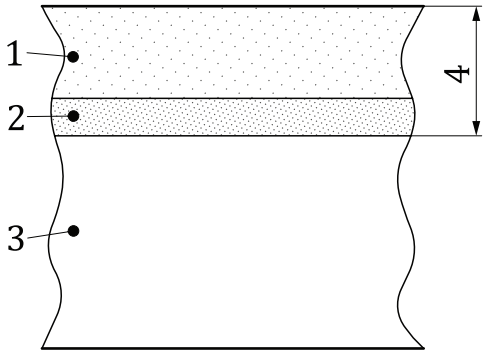
3 Terms and definitions

For the purpose of this standard, the terms and definitions given in ISO 18755:2005 and the following apply.

3.1
thermal barrier coating
TBC
two-layer coating consisting of a metallic bond coat (BC) and a ceramic top coat (TC), in order to reduce heat transfer from outside of the top coat through the coating to the substrate

Note 1 to entry: See Figure 1.

© ISO 2016 – All rights reserved



Key

1 top coat (TC)
2 bond coat (BC)
3 substrate
4 thermal barrier coating (TBC)

Figure 1 — Diagrammatic view of a section of TBC

[SOURCE: ISO 14188:2012, definition 3.1, modified]

3.2
apparent thermal diffusivity
thermal diffusivity of the specimens [substrate with bond coat (BC) and substrate with thermal barrier coating (TBC)] in a direction normal to the coating surface

3.3
normalized temperature rise
T*(*t*)/Δ*T
value which is determined by dividing the difference between the temperature of the specimen rear surface after the pulse heating and the temperature of the specimen rear surface before the pulse heating by the difference between the maximum temperature of the specimen rear surface and the temperature of the specimen rear surface before the pulse heating

$$\frac{T(t)}{\Delta T}=\frac{T_1(t)-T_0}{T_{\max}-T_0}$$

where

$T_1(t)$ is temperature of specimen rear surface after pulse heating by a flash method;

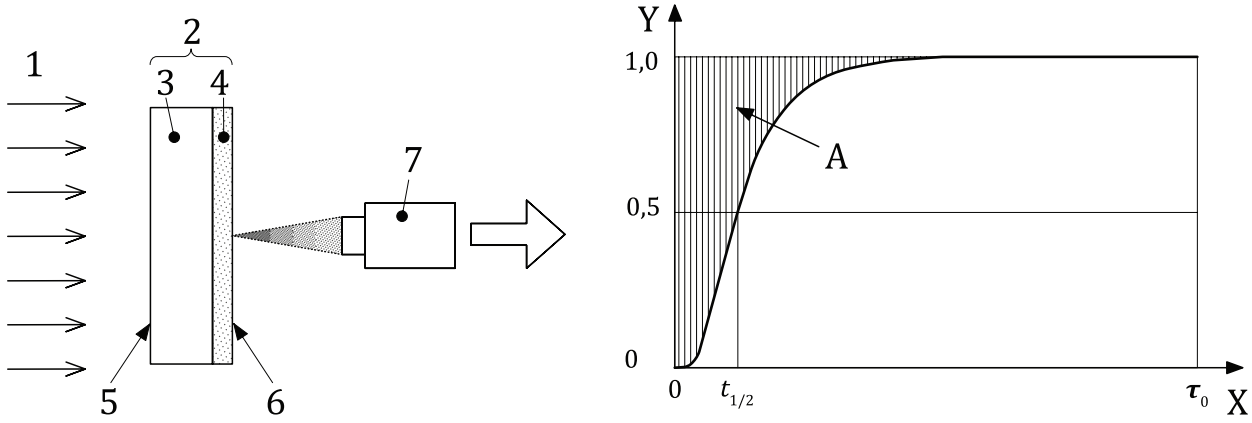
t is time;

T_0 is temperature of the specimen rear surface before pulse heating;

$T_{\max}$ is maximum temperature of specimen rear surface.

Note 1 to entry: See Figure 2.

© ISO 2016 – All rights reserved



a) Flash method **b) Temperature-rise curve under ideal conditions**

Key

1	pulse heating	X	time (s)
2	specimen	Y	normalized temperature rise $T(t)$ / ΔT
3	substrate	A	areal heat diffusion time (s)
4	TBC		
5	front surface		
6	rear surface		
7	infrared radiometer		

Figure 2 — Flash method and temperature-rise curve under ideal conditions

3.4
temperature-rise curve
curve which shows the variation in the normalized temperature rise of the specimen rear surface with time

Note 1 to entry: See the thick solid line in Figure 2b.

3.5
half rise-time
$t_{1/2}$
time required for the normalized temperature rise to reach 0,5 in the temperature-rise curve

Note 1 to entry: See Figure 2b.

3.6
areal heat diffusion time
A
area with time-dimension which is bordered by the horizontal line at the height of the maximum temperature-rise and by the temperature-rise curve

Note 1 to entry: See Figure 2b.

3.7
heat diffusion time
τ_0
time period beginning with pulse heating of the specimen front surface until time at which the specimen temperature becomes uniform

$$\tau_0 = \frac{d^2}{\alpha}$$

© ISO 2016 – All rights reserved