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Fine ceramics (advanced ceramics, advanced technical ceramics) — Ceramic composites — Notations and symbols

Céramiques techniques — Céramiques composites — Notations et symboles

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Foreword

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This document was prepared by Technical Committee ISO/TC 206, *Fine ceramics*.

Fine ceramics (advanced ceramics, advanced technical ceramics) — Ceramic composites — Notations and symbols

1 Scope

This document defines the symbols to be used to represent physical, mechanical and thermal characteristics, as determined by methods described in relevant ISO publications, for ceramic matrix composites. It is aimed at avoiding confusion in reporting measurements and characteristics of products.

Where possible, the definitions are in accordance with the relevant parts of ISO 80000. In addition, the symbols used in undertaking measurements of these characteristics are also defined.

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 80000-4, *Quantities and units — Part 4: Mechanics*

ISO 80000-5, *Quantities and units — Part 5: Thermodynamics*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 80000-4 and ISO 80000-5 and the following apply.

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

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

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

3.1
ceramic matrix composite
ceramic, carbon or glass matrix containing reinforcement distributed in one or more spatial directions

Note 1 to entry: Composites with continuous reinforcements constitute a specific class of these materials. Several subclasses of ceramic matrix composites with continuous reinforcements can be distinguished.

3.2
nomenclature
The symbol F/I/M applies usually to ceramic matrix composites:

— F indicates the chemical nature of fibrous reinforcement: C stands for carbon, SiC for silicon carbide, Al_2O_3 for alumina, etc.

— I indicates the chemical nature of fibre/matrix interphase: C stands for carbon, BN for boron nitride, $LaPO_4$ for monazite, etc.

— M indicates the chemical nature of matrix: C for carbon, SiC for silicon carbide, Al_2O_3 for alumina.

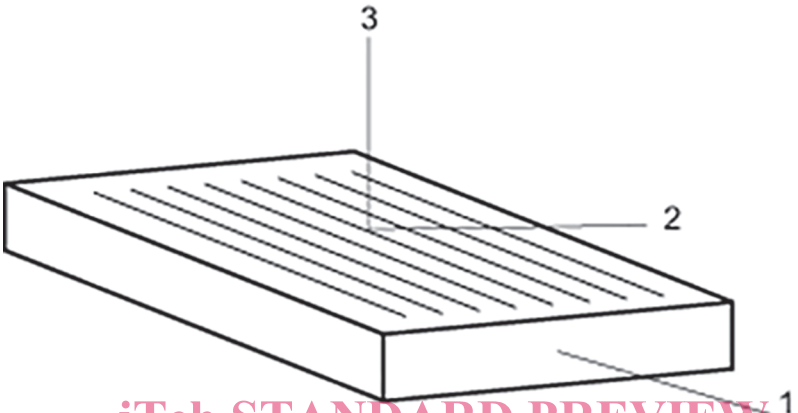
EXAMPLE 1 A ceramic matrix composite composed of a silicon carbide fibre, a carbon interphase and a silicon carbide matrix is denoted by SiC/C/SiC.

Note 1 to entry: More complex symbols can be used to describe the constituents with a greater degree of precision.

EXAMPLE 2 For a composite composed of a carbon fibre, a multi-layered interphase of four alternate layers of carbon and silicon carbide, and a silicon carbide matrix, the symbol is: $C_f/[C/SiC]_4/SiC_m$.

3.3
unidirectional ceramic matrix composite
1D material
ceramic matrix composite (3.1), the reinforcement of which is distributed in one single direction

Note 1 to entry: See Figure 1.



Key

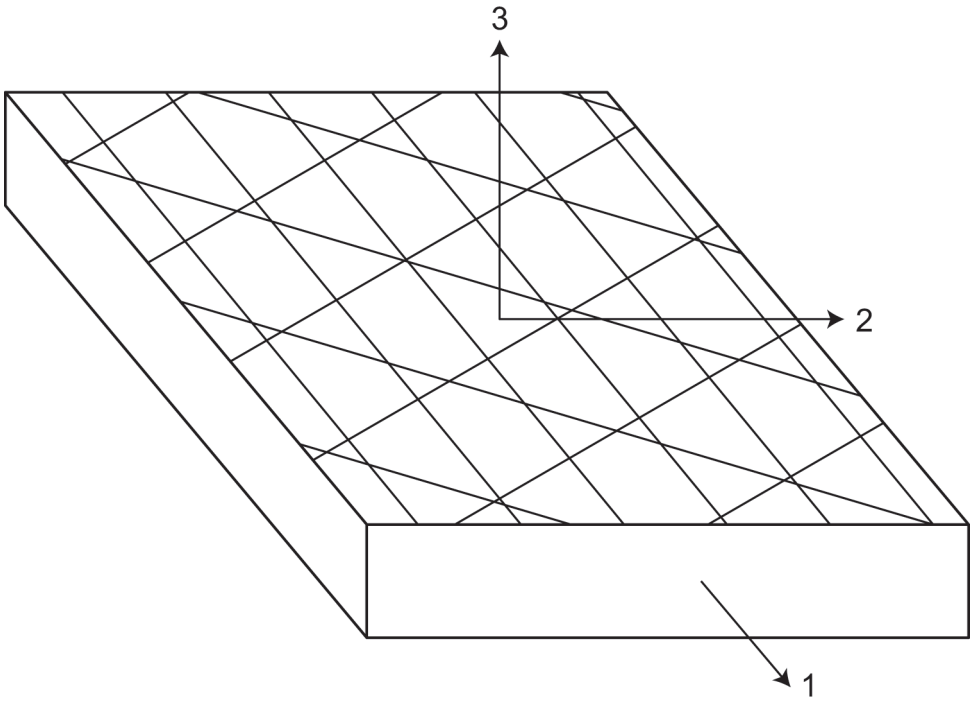
1	direction of reinforcement
2	direction of the greater transverse dimension (width), perpendicular to direction 1
3	direction of the smaller transverse dimension (thickness), perpendicular to direction 1

NOTE When the width and the thickness are equal, then directions 2 and 3 are equivalent and can be chosen freely.

Figure 1 — Schematic diagram of a 1D material

3.4
in-plane reinforced ceramic matrix composite
2D material
ceramic matrix composite (3.1), where the reinforcements are placed along at least two directions in a single plane

Note 1 to entry: See Figure 2.



Key

1 direction of the greater fraction of reinforcement

2 direction perpendicular to direction 1 in the plane of reinforcement (not necessarily a direction of reinforcement)

3 direction perpendicular to the plane of reinforcement

NOTE Strictly more than one direction of fibrous reinforcement, all contained within one plane [in the present case, three directions of reinforcement in plane (1,2)].

When several directions have an equal fraction of reinforcement, it shall be stated which direction is chosen as direction 1 in relation to the reinforcement structure (for example, orthogonal reinforced fabric: warp in direction 1, weft in direction 2).

Figure 2 — Schematic diagram of a 2D material

3.5
multidirectional ceramic matrix composite
xD (2 < × ≤3) material
ceramic matrix composite (3.1), where the reinforcement is spatially distributed in at least three directions not in a single plane

Note 1 to entry: See Figures 3 and 4.

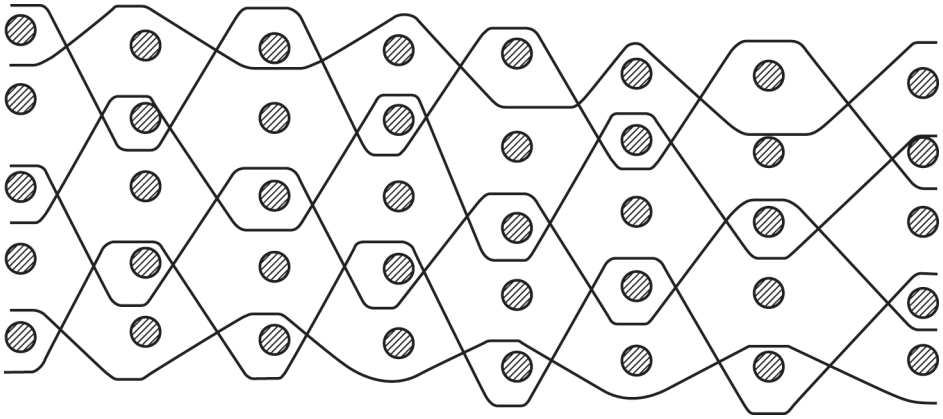
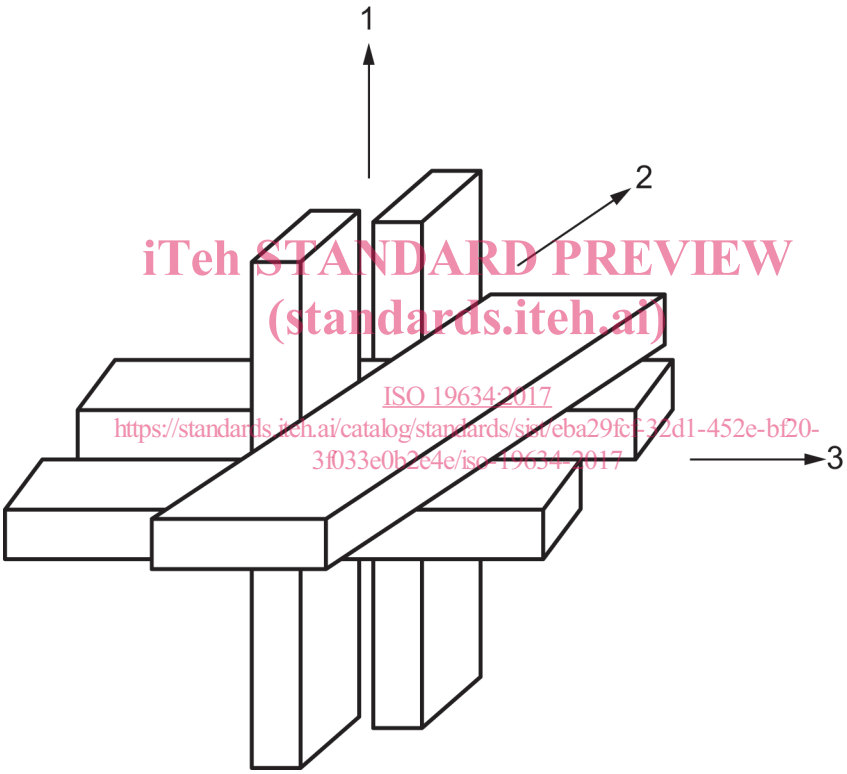


Figure 3 — Schematic diagram of a xD (2 < × ≤ 3) material



Key

1 direction of the greater fraction of reinforcement

2 direction perpendicular to direction 1

3 direction perpendicular to the plane containing directions 1 and 2

When several directions have equal fraction of reinforcement, it shall be stated which direction is chosen as direction 1, in relation to the reinforcement structure. When it is possible to define a plane of reinforcement, direction 2 will be chosen in this plane perpendicular to direction 1 (direction 2 is not necessarily a direction of reinforcement), and direction 3 will be perpendicular to the plane containing directions 1 and 2. When it is not possible to define a plane of reinforcement, direction 2 is chosen arbitrarily, but perpendicular to direction 1 and shall be clearly identified.

Figure 4 — Schematic diagram of a 3D material

4 Symbols

The symbols used for the various mechanical and thermal quantities are given in Tables 1 to 4.

Table 1 — Symbols related to physical quantities

Quantity	Symbol	Definition	Unit	Remark
Density	ρ	Ratio of the mass of a body to its volume	kg/m^3	
Apparent density	ρ_a	Ratio of the mass of the body to its total volume	kg/m^3	
Bulk density	ρ_b	Ratio of the mass of the dry material of a porous body to its volume	kg/m^3	Bulk volume = sum of volumes of solid material, open pores and closed pores
Linear density	t	Ratio of the mass of a multifilament tow to its length	tex	Tex is the mass in grams per 1 000 m
Porosity	P	Ratio of the total volume of pores in a porous body to its total volume	—	
Apparent porosity	P_a	Ratio of the volume of open pores to total volume	—	
Mass	m	Quantity of matter in a body	g	
Phase volume fraction	$V_{f,j}$	Fractional volume of phase of type j determined from micrographs of polished cross-sections	—	