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Fine ceramics (advanced ceramics, advanced technical ceramics) — Vocabulary

Céramiques techniques — Vocabulaire

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Foreword

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

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This fourth edition cancels and replaces the third edition (ISO 20507:2022), which has been technically revised.

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The main changes are as follows:

— abbreviations integrated into Clause 3;

— many composite-related terms added.

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Fine ceramics (advanced ceramics, advanced technical ceramics) — Vocabulary

1 Scope

This document specifies terms and associated definitions that are typically used for fine ceramics (advanced ceramic, advanced technical ceramic) materials, products, applications, properties and processes. This document also includes abbreviated terms that have found general acceptance in scientific and technical literature; each abbreviation is given with the corresponding full term and definition or description.

In this document, terms are defined using the term 'fine ceramic'. The definitions apply equally to 'advanced ceramics' and 'advanced technical ceramics', which are considered to be equivalent.

This document does not include terms which, though used in the field of fine ceramics, are of a more general nature and are also well known in other fields of technology.

NOTE Terms and definitions of a more general nature are available in ASTM C 1145 [1], EN 14232 [2] and JIS R 1600 [3].

2 Normative references

There are no normative references in this document.

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3 Terms and definitions

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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 General terms

3.1.1
advanced ceramic
advanced technical ceramic
fine ceramic
highly engineered, high performance, predominantly non-metallic, inorganic, ceramic material having specific functional attributes

Note 1 to entry: The use of fine ceramic, advanced ceramic and advanced technical ceramic is interchangeably accepted in business, trade, scientific literature and International Standards.

3.1.2
antibacterial ceramic
fine ceramic (3.1.1) that reveals surface antibacterial activity, usually associated with an antibacterial agent or photocatalytic behaviour, and is widely used for sanitary ware, tiles and various kinds of apparatus

3.1.3
bio-sourced ceramic
fine ceramic produced from bio-sourced material

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3.1.4
bioceramic
fine ceramic employed in or used as a medical device which is intended to interact with biological systems

Note 1 to entry: Bioceramics typically comprise products to repair or replace bone, teeth and hard tissue or to support soft tissue and/or control its function.

Note 2 to entry: Implants require a degree of biocompatibility.

Note 3 to entry: Bioceramics that are intended to interact actively with biological systems are often based on crystalline hydroxy(l)apatite; partially crystallized glass or glass-bonded ceramic is also used.

3.1.5
carbon-carbon composite
fine ceramic composed of a carbon matrix containing carbon fibre reinforcement

Note 1 to entry: A carbon-carbon (C/C) composite is mainly used for airplane brakes; it can also be used for furnace parts or heat-resistant tiles for aerospace applications.

Note 2 to entry: The reinforcement is generally continuous.

3.1.6
ceramic, adj
pertaining to the essential characteristics of a ceramic and to the material, product, manufacturing process or technology

3.1.7
ceramic, noun
essentially inorganic and non-metallic material

Note 1 to entry: The concept "ceramic" comprises products based on clay as raw material and also materials which are typically based on oxides, nitrides, carbides, silicides, borides and carbon.

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3.1.8
ceramic armour
armour used by armoured vehicle and personnel for its attenuative properties

3.1.9
ceramic capacitor
capacitor in which the dielectric material is a *ceramic* (3.1.7)

EXAMPLE Boundary layer (BL) capacitor; *multi-layer ceramic capacitor* (3.1.55) .

3.1.10
ceramic catalyst carrier
non-reactive *ceramic substrate* (3.1.24) to support a catalyst

Note 1 to entry: A ceramic catalyst carrier is typically made with a thin wall, has a large surface area and is used in contact with fluid matter.

3.1.11
ceramic coating
layer of *oxide ceramic* (3.1.61) and/or *non-oxide ceramic* (3.1.59) adhering to a substrate

Note 1 to entry: Ceramic coatings are produced by a variety of processes, e.g. dipping, plasma spraying, sol-gel coating, *physical vapour deposition* (3.2.51) and *chemical vapour deposition* (3.2.19) coating.

Note 2 to entry: Ceramic coatings are usually subdivided into thin coatings (<10 µm) and thick coatings (>10 µm).

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3.1.12
ceramic cutting tool
tool for machining operations, consisting of a *fine ceramic* (3.1.1) having excellent wear, damage and heat resistance

Note 1 to entry: Machining includes operations such as turning, drilling and milling.

3.1.13
ceramic filter
⟨electrical⟩ filter using a *piezoelectric ceramic* (3.1.63) as a resonator

3.1.14
ceramic filter
⟨porous⟩ *porous ceramic* (3.1.66) matter to be used in filtering a gas or a liquid

3.1.15
ceramic for electrical applications
ceramic for electronic applications
DEPRECATED: electrical ceramic
DEPRECATED: electronic ceramic
DEPRECATED: electroceramic
fine ceramic (3.1.1) used in electrical and electronic engineering because of intrinsic, electrically related properties

Note 1 to entry: These intrinsic properties include electrical insulation, mechanical strength and corrosion resistance.

Note 2 to entry: This term includes ceramics for passive electrical applications, i.e. a *ceramic* (3.1.7) with no active electrical behaviour, having a high electrical resistivity, used for electrical insulation functions.

Note 3 to entry: This term may apply to silicate ceramics such as steatite and electrical porcelain.

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3.1.16
ceramic for nuclear applications
DEPRECATED: nuclear ceramic
fine ceramic (3.1.1) having specific material properties required for use in a nuclear environment

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Note 1 to entry: Ceramics for nuclear applications include materials for nuclear fuels, neutron absorbers, burnable neutron poisons, diffusion barrier coatings, inert container elements, fuel cladding and assembly duct.

3.1.17
ceramic for optical applications
DEPRECATED: optical ceramic
fine ceramic (3.1.1) used in optical applications because of its intrinsic properties

Note 1 to entry: For example, transparent alumina is used for high-pressure sodium lamp envelopes.

Note 2 to entry: Optical ceramics are typically tailored to exploit transmission, reflection and absorption of visible and near-visible electromagnetic radiation.

3.1.18
ceramic heating resistor
heater making use of an electric conductive or a semi-conductive property of ceramics

3.1.19
ceramic honeycomb
fine ceramic (3.1.1) body having multiple channels typically arranged in a honeycomb structure

Note 1 to entry: A *ceramic honeycomb* (3.1.19) is typically used as a *ceramic catalyst carrier* (3.1.10) , a filter or a heat exchanger regenerator, and is typically made of cordierite, mullite or aluminium titanate.

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3.1.20
ceramic ionic conductor
ceramic for electrical applications (3.1.15) in which ions are transported by an electric potential or chemical gradient

3.1.21
ceramic matrix composite
CMC
fine ceramic (3.1.1) composed of a ceramic matrix containing *reinforcement* (3.2.65)

Note 1 to entry: The reinforcement is often continuous, i.e. ceramic filaments, distributed in one or more spatial directions, but this term is also used for discontinuous reinforcement, e.g. short ceramic fibres, ceramic whiskers, ceramic platelets or ceramic particles.

Note 2 to entry: *carbon-carbon* (3.4.11) (C/C) composites are included.

Note 3 to entry: The acronym CFCC (*continuous fibre ceramic composite* (3.4.12)) is often used for a *ceramic matrix composite* (3.1.21) in which one or more reinforcing phases consist of continuous fibres.

3.1.22
ceramic optical waveguide
optical waveguide formed on the surface of a *ceramic substrate* (3.1.24)

Note 1 to entry: Optical single crystal of $LiNbO_3$ is typically used as a substrate for a *ceramic optical waveguide* (3.1.22).

3.1.23
ceramic sensor
sensor making use of semiconductive, piezoelectric, magnetic or dielectric properties of a *fine ceramic* (3.1.1)

3.1.24
ceramic substrate
ceramic body (3.2.9) , sheet or layer of material on which some other active or useful material or component may be deposited or laid

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EXAMPLE An electronic circuit laid on an alumina ceramic sheet. In catalysis, the formed, porous, high-surface-area carrier on which the catalytic agent is widely and thinly distributed for reasons of performance and economy.

3.1.25
ceramic varistor
ceramic material having high electrical resistivity at low voltage but high electrical conductivity at high voltage

Note 1 to entry: A zinc oxide varistor can be used as a protector in an electronic circuit.

3.1.26
cermet
composite material consisting of at least one distinct metallic phase and one distinct ceramic phase, the latter normally being present at a volume fraction greater than 50 %

Note 1 to entry: The ceramic phase, typically, has high hardness, high thermal strength, and good corrosion resistance; the metallic phase has good toughness and elastoplastic behaviour.

Note 2 to entry: The term “cermet” is a contracted form of ceramic metal.

Note 3 to entry: Materials containing typically less than 50 % by volume of ceramic phase are commonly called “metal matrix composites”.

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3.1.27
diamond-like carbon
DLC
form of carbon made by a *CVD* (3.2.19) or *PVD* (3.2.51) process, having hardness much higher than graphite but lower than diamond

Note 1 to entry: *diamond-like carbon* (3.1.27) is typically used as a hard coat material for engineering components or memory disks.

3.1.28
dielectric ceramic
ceramic dielectric
ceramic for electrical applications (3.1.15) having controlled dielectric properties

3.1.29
discontinuous fibre-reinforced ceramic composite
ceramic matrix composite (3.1.21) material reinforced by chopped fibres

3.1.30
electro-optic ceramic
fine ceramic (3.1.1) with a refractive index which changes in response to an applied electric field

Note 1 to entry: An *electro-optic ceramic* (3.1.30) is a type of non-linear *optical ceramic* (3.1.17) used, for example, in optical shutters, optical modulating devices and optical memory devices. Transparent ferroelectrics are used as electro-optic ceramics, $LiNbO_3$ single crystals or PLZT polycrystals with low light scattering. The term "electro-optic" is often erroneously used as a synonym for "optoelectronic".

3.1.31
environmental barrier coating
EBC
ceramic coating (3.1.11) , possibly multi-layered, used to protect fine ceramics from environmental aggression

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3.1.32
far-infrared radiative ceramic
fine ceramic with specific property to radiate in the far-infrared

Note 1 to entry: Far-infrared radiative ceramics are typically used as heaters for industrial and domestic applications.

3.1.33
ferrite
fine ceramic with ferrimagnetic behaviour, having ferric oxide as a major constituent

Note 1 to entry: Magnetic ceramic is used as a synonym of ferrite but encompasses non-oxide-containing materials as well.

3.1.34
ferroelectric ceramic
non-linear polarizable *ceramic for electrical applications* (3.1.15), generally with a high level of permittivity, exhibiting hysteresis in the variation of the dielectric polarization as a function of the electric field strength and in the temperature dependence of the permittivity

Note 1 to entry: Polarization results in electrostrictive, piezoelectric, pyroelectric and/or electro-optic properties, which disappear above the transition or Curie temperature.

3.1.35
ferromagnetic ceramic
fine ceramic that exhibits a spontaneous magnetization without an applied external magnetic field, in which unpaired electrons with a small magnetic field of their own align with each other and show a large net magnetic moment

Note 1 to entry: Most ferrites that contain iron oxide as the main constituent show ferromagnetism.

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3.1.36
functional ceramic
fine ceramic, the intrinsic properties of which are employed to provide an active function

EXAMPLE Electronic or ionic conductor, component with magnetic, chemical or mechanical sensing function.

3.1.37
functionally graded ceramic
fine ceramic, the properties of which are deliberately varied from one region to another through spatial control of composition and/or microstructure

3.1.38
geopolymer
inorganic polymeric ceramics formed from both aluminium and silicon sources

3.1.39
glass-ceramic
fine ceramic derived from bulk glass or glass powder by controlled devitrification

Note 1 to entry: The glass is thermally treated to induce a substantial amount of crystallinity on a fine scale.

3.1.40
hard ferrite
ferrite (3.1.33) having strong magnetic anisotropy and high coercivity

EXAMPLE Barium hexaferrite, used as permanent magnets in loudspeakers; strontium hexaferrite, used as permanent magnet segments in electric motors.

3.1.41
high-temperature superconductor
HTS
HTSC
superconducting ceramic (3.1.75) having superconducting properties at temperatures above 77 K, the boiling point of liquid nitrogen

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Note 1 to entry: Superconducting ceramics typically comprise certain combinations of oxides of copper, rare earths, barium, strontium, calcium, thallium and/or mercury.

3.1.42
hybrid photocatalyst
photocatalyst (material) combined with other functional materials in order to complement and enhance the photocatalytic function

Note 1 to entry: Examples include photocatalytic air-purifying materials combined with an adsorbent and antibacterial material, in turn combined with an antibacterial agent, to continue to function in the absence of light.

3.1.43
indoor-light-active photocatalyst
substance that carries out many functions based on oxidization and reduction reactions produced by an artificial light source for general lighting service, including decomposition and removal of air and water contaminants, deodorization, and antibacterial, antifungal, self-cleaning and antifogging actions

3.1.44
in-plane reinforced ceramic matrix composite 2D material
ceramic matrix composite (3.1.21) where the reinforcements are placed along at least two directions in a single plane

3.1.45
low-emission ceramic
fine ceramic (3.1.1) with low emissivity in the infra red radiation range

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3.1.46
low temperature co-fired ceramic
LTCC
ceramic formed by co-firing with a metallic conductor at a lower temperature than conventional ceramics

Note 1 to entry: Low temperature co-fired ceramics are typically applied to ceramic multilayer substrates.

Note 2 to entry: A typical metallic conductor is silver, and a typical ceramic is alumina with glass added.

3.1.47
machinable ceramic
ceramic that, after the last consolidation heat treatment, can be machined to tight tolerances using conventional hardmetal or abrasive tools

EXAMPLE Boron nitride, glass-ceramics and porous aluminas.

Note 1 to entry: The natural mineral talc and pyrophyllite, machined and heat-treated, are sometimes also referred to as machinable ceramics.

3.1.48
matrix
ceramic phase(s) used to bind together the dispersed particles, platelets, fibres and filaments of a composite

Note 1 to entry: Ceramic phase(s) bind the constituent fibres of a fibrous reinforcement of a composite material.

3.1.49
MXene
class of two-dimensional inorganic compound consisting of a few-atomic-layer thick transition metal carbide, nitride or carbonitride

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3.1.50
MAX phase
layered, hexagonal carbide and nitride which have the general chemical formula given in Formula (1):

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$$M_{n+1}AX_{n/}(MAX) \quad (1)$$

where

n	= 1 to 4;
M	is an early transition metal;
A	is an A-group (mostly IIIA and IVA, or groups 13 and 14) element;
X	is carbon and/or nitrogen.

3.1.51
metallized ceramic
fine ceramic product with a coherent, predominantly metal layer applied to its surface

Note 1 to entry: Processes for metallization include painting, printing, electrolytic deposition and *physical vapour deposition* (3.2.51) .

Note 2 to entry: Metallization is carried out for specific modification of surface properties or to produce an interlayer for promoting the formation of a high-integrity bond with another material (often metallic).

3.1.52
monolithic ceramic
fine ceramic which has undergone *consolidation* (3.2.23) through *sintering* (3.2.70) to obtain a microstructure consisting predominantly of ceramic grains of one or more phases which are homogeneously distributed on a scale which is small compared to the dimensions of the part

Note 1 to entry: Ceramic parts with low or moderate porosity are included, whereas ceramic matrix composites with ceramic filaments are excluded.

Note 2 to entry: A secondary phase can also be non-ceramic.

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3.1.53
multiferroic ceramic
fine ceramic that exhibits more than one ferroic characteristic, i.e. ferromagnetism, ferroelectricity and ferroelasticity, simultaneously

Note 1 to entry: Multiferroic ceramics consist of two categories, i.e. single-phase multiferroics and composites or heterostructures exhibiting more than one ferroic characteristic. Typical single-phase multiferroics include $TbMnO_3$ and $BiFeO_3$.

3.1.54
multidirectional ceramic matrix composite xD (x > 2) material
ceramic matrix composite (3.1.21) where the continuous fibre *reinforcement* (3.2.65) is spatially distributed in at least three directions not in a single plane

3.1.55
multi-layer ceramic capacitor
MLCC
capacitor constructed by repeatedly stacking *dielectric ceramic* (3.1.28) layers and metal layers

3.1.56
multi-layered ceramic matrix composite
ceramic matrix composite (3.1.21) where the matrix is composed of layers of different chemical compositions

3.1.57
nanocomposite ceramic
composite with highly designed microstructure in which fine particles of nanometric size are dispersed in a ceramic matrix

Note 1 to entry: See *particulate-reinforced ceramic matrix composite* (3.1.62).

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3.1.58
nanostructured ceramic
ceramic material of which at least one structural or microstructural element has dimensions of 1 nm to 100 nm

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3.1.59
non-oxide ceramic
fine ceramic produced primarily from substantially pure metallic carbides, nitrides, borides or silicides, or from mixtures and/or solid solutions thereof

3.1.60
opto-electronic ceramic
ceramic for electrical applications, typically a ferroelectric ceramic in which the optical properties are controlled by electrical means

3.1.61
oxide ceramic
fine ceramic produced primarily from substantially pure metallic oxides or from mixtures and/or solid solutions thereof

Note 1 to entry: This term may also be applied to ceramics other than fine ceramics.

3.1.62
particulate-reinforced ceramic matrix composite
ceramic matrix composite in which the reinforcing components are particles of equiaxed or platelet geometry (in contrast to whiskers or short fibres)

Note 1 to entry: See *nanocomposite ceramic* (3.1.57).

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