BS ISO 20507:2014

BSI Standards Publication

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

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National foreword

This British Standard is the UK implementation of ISO 20507:2014.

The UK participation in its preparation was entrusted to Technical Committee RPI/13, Advanced technical ceramics.

A list of organizations represented on this committee can be obtained on request to its secretary.

ISBN 978 0 580 76508 7

ICS 81.060.30

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 November 2014.

Amendments issued since publication

Date	Text affected

INTERNATIONAL STANDARD

ISO 20507

Second edition
2014-11-15

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

Céramiques techniques — Vocabulaire

Reference number
ISO 20507:2014(E)

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Published in Switzerland

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Foreword

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The committee responsible for this document is ISO/TC 206, *Fine ceramics*.

This second edition cancels and replaces the first edition (ISO 20507:2003), which has been technically revised.

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

1 Scope

This International Standard is a vocabulary, which provides a list of terms and associated definitions typically used for fine ceramic (advanced ceramic, advanced technical ceramic) materials, products, applications, properties, and processes. This International Standard contains, in separate lists, those abbreviations which have found general acceptance in the scientific and technical literature; they are given together with the corresponding terms and definitions or descriptions.

In this International Standard, the 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 International Standard 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] A list of some International Standards and draft International Standards of ISO/TC 206 “Fine ceramics” containing terms defined in this International Standard is given in the Bibliography.

2 Terms and definitions

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

2.1 General terms

2.1.1
advanced ceramic
advanced technical ceramic
fine ceramic
highly engineered, high performance, predominately 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.

2.1.2
antibacterial ceramic
fine ceramic 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

2.1.3
bio-sourced ceramic
fine ceramic produced from bio-sourced material

2.1.4
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; also, partially crystallized glass or glass-bonded ceramic is used.

2.1.5
carbon-carbon composite
fine ceramic composed of a carbon matrix containing carbon fibre reinforcement

Note 1 to entry: A carbon-carbon composite is mainly used for airplane breaks, and can also be used as furnace parts or heat resistant tiles for aerospace applications.

Note 2 to entry: The reinforcement is generally continuous.

2.1.6
ceramic
pertaining to the essential characteristics of a ceramic and to the material, product, manufacturing process, or technology

2.1.7
ceramic
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, carbon etc.

2.1.8
ceramic armor
armor uses by armor vehicle and personnel for its attenuative properties

2.1.9
ceramic capacitor
capacitor in which the dielectric material is a ceramic

EXAMPLE BL (boundary layer) capacitor, multilayer ceramic capacitor.

2.1.10
ceramic catalyst carrier
nonreactive ceramic substrate 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.

2.1.11
ceramic coating
layer of oxide ceramic and/or non-oxide ceramic 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 or chemical vapour deposition coating.

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

2.1.12
ceramic cutting tool
tool for machining operations, consisting of a fine ceramic having excellent wear, damage, and heat resistance

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

2.1.13
ceramic filter

2.1.13.1
electrical
filter using a piezoelectric ceramic as a resonator

2.1.13.2
porous
porous ceramic matter to be used in filtering a gas or a liquid

2.1.14
ceramic for electrical applications
DEPRECATED: electrical ceramics
ceramic for electronic applications
DEPRECATED: electronic ceramic
DEPRECATED: electroceramic
fine ceramic 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 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.

2.1.15
ceramic for nuclear applications
DEPRECATED: nuclear ceramic
fine ceramic having specific material properties required for use in nuclear environment

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

2.1.16
ceramic for optical applications
DEPRECATED: optical ceramic
fine ceramic used in optical applications because of its intrinsic properties

EXAMPLE Transparent alumina is used for high-pressure sodium lamp envelopes.

Note 1 to entry: Optical ceramics are tailored typically to exploit transmission, reflection, and absorption of visible and near-visible electromagnetic radiation.

2.1.17
ceramic heating resistor
heater making use of an electric conductive or a semi-conductive property of ceramics

2.1.18
ceramic honeycomb
fine ceramic body having multiple channels typically arranged in a honeycomb structure

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

2.1.19
ceramic ionic conductor
electroceramic in which ions are transported by an electric potential or chemical gradient

2.1.20
ceramic matrix composite
CMC
fine ceramic composed of a ceramic matrix containing reinforcement

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: C/C composites are included in CMC composites.

2.1.21
ceramic optical waveguide
optical waveguide formed on the surface of a ceramic substrate

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

2.1.22
ceramic sensor
sensor making use of semi-conductive, piezoelectric, magnetic, or dielectric properties of a fine ceramic

2.1.23
ceramic substrate
ceramic body, sheet, or layer of material on which some other active or useful material or component may be deposited or laid

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.

2.1.24
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.

2.1.25
cermet
composite material consisting of at least one distinct metallic 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, good corrosion resistance, and 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”.

2.1.26
continuous fibre ceramic composite
CFCC
ceramic matrix composite in which one or more reinforcing phases consists of continuous fibres

2.1.27
diamond-like carbon
DLC
form of carbon made by a CVD or PVD process, having hardness much higher than graphite but lower than diamond

Note 1 to entry: Diamond-like carbon is typically used as a hard coat material for engineering components or memory disks.

2.1.28
dielectric ceramic
ceramic dielectric
electroceramic having controlled dielectric properties

2.1.29
discontinuous fibre-reinforced ceramic composite
ceramic matrix composite material reinforced by chopped fibres

2.1.30
electro-optic ceramic
fine ceramic with a refractive index which changes in response to an applied electric field

Note 1 to entry: An electro-optic ceramic is a type of non-linear optical ceramic, used for optical shutters, optical modulating devices, optical memory devices, etc. 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”.

2.1.31
environmental barrier coating
EBC
ceramic coating possibly multilayered used to protect fine ceramics of environmental aggression

2.1.32
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.

2.1.33
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.

2.1.34
ferroelectric ceramic
non-linear polarizable electroceramic, 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.

2.1.35
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.

2.1.36
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.

2.1.37
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

2.1.38
geopolymer
inorganic polymeric ceramics formed from both aluminium and silicon sources

2.1.39
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.

2.1.40
hard ferrite
ferrite 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.

2.1.41
high-temperature superconductor
HTS
HTSC
superconducting ceramic having superconducting properties at temperatures above 77 K, the boiling point of liquid nitrogen

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

2.1.42
hybrid photocatalyst
photocatalyst (material) combined with other functional materials in order to complement and enhance the photocatalytic function

EXAMPLE 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.

2.1.43
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

2.1.44
in-plane reinforced (2D) ceramic matrix composite
ceramic matrix composite with continuous reinforcement, which is distributed principally in two directions

2.1.45
low emission ceramic
ceramic matrix composite with continuous reinforcement, which is distributed principally in two directions

2.1.46
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.

2.1.47
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.

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).

2.1.48
monolithic ceramic
fine ceramic which has undergone consolidation through sintering 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.

2.1.49
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 are $TbMnO_3$, $BiFeO_3$, etc.

2.1.50
multidirectional ceramic matrix composite
ceramic matrix composite with continuous reinforcement which is spatially distributed in at least three directions

2.1.51
multilayered ceramic matrix composite
ceramic matrix composite where the matrix is composed of layers of different chemical compositions

2.1.52
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 (2.1.57).

2.1.53
nanostructured ceramic
ceramic material for which at least one of its structural or microstructural elements has one of its dimension is between 1 nm to 100 nm

2.1.54
non-oxide ceramic
fine ceramic produced primarily from substantially pure metallic carbides, nitrides, borides, or silicides or from mixtures and/or solid solutions thereof

2.1.55

optoelectronic ceramic

electroceramic, typically a ferroelectric ceramic in which the optical properties are controlled by electrical means

2.1.56

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.

2.1.57

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 (2.1.52).

2.1.58

piezoelectric ceramic

piezoceramic

electroceramic, typically a ferroelectric ceramic in which the elastic and dielectric properties are coupled, with practically linear dependence, between the magnitude and direction of mechanical force applied and the electric charge created, or conversely, between the strength and direction of an electric driving field and the elastic deformation obtained

Note 1 to entry: Typical piezoelectrics are barium titanate and lead zirconium titanate.

Note 2 to entry: Elastic deformation under the influence of an electric driving field is termed the inverse piezoelectric effect.

Note 3 to entry: Piezoelectric ceramics are capable of transforming mechanical energy into electrical energy or signals and vice versa.

2.1.59

photocatalyst

substance that performs one or more catalytic functions based on oxidation or reduction reactions under photoirradiation

Note 1 to entry: The functions include decomposition and removal of air and water contaminants, deodorization, antibacterial, self-cleaning, and antifogging actions. A photocatalyst can also be used for light energy conversion.

2.1.60

photocatalytic material

material in which or on which the photocatalyst is added by coating, impregnation, mixing, etc

Note 1 to entry: Materials include ceramic, metal, plastic, paper, cloth, etc. for general purposes.

2.1.61

relaxor dielectric

class of perovskite ferroelectric that shows significant changes in permittivity, ε, and loss tangent, tan δ, with frequency

2.1.62

semiconducting photocatalyst

substance that displays photocatalytic action based on its electronic band structure

Note 1 to entry: This applies to metal oxides like titanium dioxide, and sulfides. Photocatalysts which are not semiconducting includes metal complexes.

2.1.63
silicate ceramic
ceramic, made mainly from minerals and/or other siliceous raw materials, resulting in a microstructure with a substantial amount of silicate phases

Note 1 to entry: Electrical porcelain and steatite ceramics are typical silicate ceramics.

2.1.64
soft ferrite
ferrite having a weak magnetic anisotropy, resulting in high magnetic permeability and low magnetic loss

EXAMPLE Manganese-zinc-ferro-ferrite with spinel type crystal structure, used for coils, transformers for energy conversion; ferrite with garnet-type crystal structure, such as yttrium iron garnet, used for microwave applications.

2.1.65
structural ceramic
fine ceramic employed primarily in structural applications for its mechanical or thermomechanical performance

Note 1 to entry: The term “structural ceramic” is also applied to clay products for constructional purposes.

2.1.66
spintronic ceramic
ceramic that utilizes charge (electronic conductivity) and the spin (magnetization) of electrons

Note 1 to entry: Typical applications include the magnetic head on a hard disk utilizing the GMR (giant magneto resistivity) effect, as well as non-volatile MRAM (magneto-resistive random access memory), etc.

2.1.67
superconducting ceramic
electroceramic showing practically zero electrical resistance below a certain temperature

Note 1 to entry: Superconducting ceramics typically comprise certain combinations of oxides of copper, rare earths, barium, strontium, calcium, thallium and/or mercury and most of them are high-temperature superconductors.

2.1.68
surface-modified ceramic
fine ceramic in which the surface has been subjected to a deliberate physical or compositional modification

Note 1 to entry: Surface modification is normally intended to enhance properties or performance.

Note 2 to entry: Modification processes include ion diffusion, ion implantation, ion exchange, and chemical reactions such as oxidation.

2.1.69
thick ceramic coating
ceramic coating of a thickness typically equal to or greater than 10 µm

Note 1 to entry: Thick ceramic coatings are produced typically by thick film technology such as dipping (slurry), screen printing, or plasma spraying and so on.

2.1.70
thin ceramic coating
ceramic coating of a thickness typically less than 10 µm

Note 1 to entry: Thin ceramic coatings are produced typically by thin film technology such as sol-gel coating process (dipping, spin coating), chemical and physical vapour deposition process.

2.1.71
unidirectional (1D) ceramic matrix composite
ceramic matrix composite with continuous reinforcement which is distributed in one single direction

Note 1 to entry: The reinforcement typically comprises ceramic filaments.

2.2 Terms for form and processing

2.2.1
as-fired surface
external surface of a ceramic product after sintering

Note 1 to entry: The as-fired surface may be relatively rough compared with surfaces machined after sintering and may have e.g. pits and adherent debris.

2.2.2
binder
one or more mainly organic compounds which are added to the ceramic body in order to enhance compaction and/or to provide enough strength to the green body to permit handling, green machining, or other operations prior to sintering

2.2.3
binder phase
tough matrix phase embedding a rigid, hard, main, ceramic phase in a composite material

EXAMPLE Binder phase: cobalt, nickel; hard phase: tungsten carbide, tantalum carbide.

Note 1 to entry: A tough matrix phase reduces the brittleness and crack sensitivity and improves the strength and toughness of the composite material.

2.2.4
calcining
calcination
process for changing the chemical composition and/or phases of a powder or powder compact by the action of heat and atmosphere, prior to consolidation and processing

Note 1 to entry: This process is typically used for the removal of organic material, combined water and/or volatile material from a powder or powder compact.

2.2.5
casting
drain (hollow) casting
forming ceramic ware by introducing a body slip into an open, porous mould, and then draining off the remaining slip when the cast piece has reached the desired thickness

2.2.6
ceramic agglomerate
accretion of ceramic particles forming a coherent, but weakly bonded mass

Note 1 to entry: Ceramic agglomerates are unintentionally generated during manufacture and preparation of ceramic powders for ceramic production and may be difficult to break down.

2.2.7
ceramic aggregate
accretion of ceramic particles forming a coherent mass with strong interfacial bonding

Note 1 to entry: Ceramic aggregates are intentionally generated during manufacture and preparation of ceramic powders and are difficult to break down.

2.2.8
ceramic body
totality of all inorganic and organic raw material constituents after preparation of ceramic powder but before the shaping and heat treatment to produce a ceramic

2.2.9
ceramic fibre
unit of ceramic matter characterized by a high length to diameter ratio

Note 1 to entry: Ceramic fibres are used as reinforcement in ceramic matrix composites in which case the diameter is usually smaller than 20 µm, the aspect ratio typically being greater than 100. This includes the short and long fibre.

2.2.10
ceramic filament
unit of ceramic matter of small diameter and very long length, considered to be continuous

Note 1 to entry: Ceramic filaments are typically used as reinforcement in continuous fibre ceramic matrix composites, as tow and as woven or non-woven fabrics.

2.2.11
ceramic grain
individual crystal within the polycrystalline microstructure of a ceramic

Note 1 to entry: This term is also used for individual, usually hard, particles of abrasive or refractory materials.

2.2.12
ceramic granulate
mass of granules produced from a ceramic body, usually in a free flowing form, used as a feedstock for producing a green body

Note 1 to entry: There are many granulation processes; the size of the granules is typically 40 µm or greater.

2.2.13
ceramic particle
small quantity of ceramic matter, monocrystalline, polycrystalline, or amorphous, in a discrete mass of size and shape controlled by its fabrication process

Note 1 to entry: Individual particles may accrete into unintentional ceramic agglomerates or intentional ceramic aggregates, or may be processed to form a ceramic granulate.

2.2.14
ceramic platelet
unit of ceramic matter, consisting typically of a single crystal in a plate-like shape

Note 1 to entry: Ceramic platelets may consist of oxide or non-oxide material.

Note 2 to entry: Ceramic platelets are used as reinforcement in ceramic matrix composites in which case the width of the platelets is usually smaller than 50 µm.

2.2.15
ceramic (powder) preparation
preparation of ceramic powder
process of converting powders and additives into a ceramic body, usually by comminution and/or mixing of the powder with binders and lubricants to provide the required chemical and physical characteristics

2.2.16
ceramic precursor
chemical or mixture of chemicals employed for the manufacture of a ceramic powder, ceramic granulate, thin ceramic coating, monolithic ceramic or a ceramic matrix composite, or ceramic fibres, ceramic whiskers or ceramic platelets, differing in composition from the fabricated ceramic product

EXAMPLE Gaseous silicon tetrachloride used for the formation of silicon nitride and silicon carbide; metal alkoxides used for the formation of metal oxide powders.

Note 1 to entry: This term is usually applied to gas or liquid mixtures which are decomposed to form ceramic materials.

2.2.17
ceramic whisker
unit of ceramic matter, consisting typically of a single crystal having a needle-like shape

Note 1 to entry: Ceramic whiskers may consist of oxide or non-oxide material.

Note 2 to entry: Ceramic whiskers may be used as reinforcement in ceramic matrix composites, in which case, the diameter of the crystals is usually smaller than 3 μm, the aspect ratio being less than 100.

2.2.18
chemical vapour deposition
CVD
process for producing a fine ceramic by reacting gaseous species and condensing the reaction product or by heterogeneous reaction at the surface of a substrate

Note 1 to entry: This process may be used for the preparation of a solid ceramic or a ceramic powder or a ceramic coating or for infiltration of a heated substrate.

2.2.19
chemical vapour deposition coating process
CVD coating process
chemical vapour deposition used for the formation of a fine ceramic coating on a substrate

2.2.20
chemical vapour infiltration
CVI
chemical vapour deposition used for producing a fine ceramic by heterogeneous reaction at the pore surface of a heated porous ceramic preform

Note 1 to entry: CVI is typically used to produce ceramic filament reinforced ceramic matrix composites.

2.2.21
cold isostatic pressing
CIP
process of preparing a green body from a ceramic powder or a ceramic granulate by the use of (pseudo-) isostatic pressure at or near room temperature

Note 1 to entry: This process is sometimes called “CIPing”.

2.2.22
consolidation
process of rigidizing a ceramic body

Note 1 to entry: Consolidation methods include mechanical densification, chemical bonding and sintering.

2.2.23
doctor blade process
process to form a ceramic sheet in which ceramic powder, binder, and solvent are mixed and spread by a knife edge (or a doctor blade) on to a carrier film

Note 1 to entry: The doctor blade process is used to form a ceramic sheet with good dimensional accuracy by adjusting the distance between a knife edge (or a doctor blade) and a carrier film.

Note 2 to entry: The doctor blade process is frequently called tape casting (2.2.65).

2.2.24
extrude
to shape a plastic body by forcing material through a die

2.2.25
filler
organic or inorganic additive to a fine ceramic, polymer or metallic body to control processing or properties

Note 1 to entry: Examples of the use of this term include: (a) organic (or rarely, inorganic) additives to a fine ceramic body which decompose or burn out during consolidation to create intentional porosity, e.g. discrete polymer particles, (b) predominantly inert, usually particular, fine ceramic substances introduced into a fine ceramic body to control processing or properties, e.g. silicon carbide particles used in a silicon-based polymer precursor for dimensional control during subsequent consolidation, (c) predominantly inert, usually particular fine ceramic materials introduced into a different matrix in order to modify properties, e.g. aluminium oxide or hydroxide introduced into a polymer to modify stiffness or wear resistance.

2.2.26
gel casting
process of shaping and forming a green body using the phenomenon of gelation of a suspension

2.2.27
gas pressure sintering
GPS
sintering by the combined application of heat and gas pressure

EXAMPLE Gas pressure sintered silicon nitride, GPSSN.

Note 1 to entry: The gas pressure is typically not greater than 10 MPa.

2.2.28
green body
green part
ceramic body that is compacted and/or shaped, but not yet heat-treated

2.2.29
green machining
machining of a green body to a predetermined shape

2.2.30
hot isostatic pressing
HIP
process of making a fine ceramic by application of an isostatic gas pressure at elevated temperatures

Note 1 to entry: The object may be an encapsulated powder or green body, or a pre-densified fine ceramic. Gas pressures are typically much greater than 10 MPa.

Note 2 to entry: This process is sometimes called “HIPing”.

2.2.31
(uniaxial) hot pressing
HP
process of making a fine ceramic, normally by application of a unidirectional (uniaxial) force at elevated temperature

Note 1 to entry: For uniaxial hot pressing, an inductively heated graphite die is usually employed.

2.2.32
hydrothermal synthesis
process of preparing fine ceramics and other inorganic materials by chemical reaction in aqueous solution under high temperature and pressure in a pressure vessel such as an autoclave

Note 1 to entry: Fine ceramics in powder, film, or bulk forms may be prepared by hydrothermal synthesis.

2.2.33
injection moulding
IM
process of shaping a green body by injecting an appropriately formulated mass into a mould or die

2.2.34
liquid phase sintering
LPS
sintering achieved by the presence of a liquid phase

Note 1 to entry: The amount and properties of the liquid phase are determined by the composition of the green body, temperature and pressure. This process is enhanced by accelerated diffusion and dissolution-precipitation phenomena.

2.2.35
low-pressure chemical vapour deposition
LPCVD
chemical vapour deposition at low gas pressure

Note 1 to entry: The gas pressure is typically less than 0,01 MPa.

2.2.36
machined and refired
state of treatment of a fine ceramic component which has been machined and subsequently refired to modify the surface properties

2.2.37
manufacture of ceramic powders by flame pyrolysis
process of formation of ceramic particles by passing reactants through the combustion zone of a flame

2.2.38
manufacture of ceramic powders by gas-phase reaction
process of formation of ceramic particles from gaseous reactants using an external stimulus

EXAMPLE Silicon nitride powder produced by reaction between silicon tetrachloride gas and ammonia gas.

Note 1 to entry: External stimuli include heating, electrical discharge and laser irradiation.

2.2.39
manufacture of ceramic powders by sol-gel technique
process of formation of ceramic particles by using sol-gel processing in which the sol is dispersed into fine droplets before conversion into a gel, followed by further processing

Note 1 to entry: See sol-gel processing (2.2.59).

Note 2 to entry: The conversion of sol into gel can be by a reaction such as dehydration. The common route is a hydrolysis reaction followed by condensation to give direct precipitation of fine ceramic particles.

Note 3 to entry: Further processing includes drying and calcining of gel.

2.2.40
melt infiltration process
process used to fill CMC porosity by liquid infiltration of melt metal

2.2.41
metal-organic chemical vapour deposition
MOCVD
chemical vapour deposition using single or mixed metal-organic vapours

2.2.42
microwave sintering
use of high power, high frequency electromagnetic waves (microwaves) to heat a green body by internal dielectric loss to a sufficient temperature for sintering

Note 1 to entry: The action of the microwaves may in some cases accelerate the sintering process.

2.2.43
plasma-enhanced chemical vapour deposition
PECVD
chemical vapour deposition using a plasma assisted reaction

Note 1 to entry: The reaction in the gaseous phase can e.g. be stimulated by application of a plasma formed by coupled laser or other plasma generator.

Note 2 to entry: Also known as Plasma Activated Chemical Vapour Deposition (PACVD).

2.2.44
physical vapour deposition
PVD
process for producing, e.g. a ceramic film by transport of the required chemical species, some or all of which are generated from a source or sources by physical means such as thermal, electron beam, arc or laser evaporation or sputtering, and deposition onto a prepared substrate with or without the assistance of a reactive atmosphere, ionic bombardment or a gas plasma

2.2.45
polycrystalline diamond
PCD
polycrystalline form of carbon with cubic crystalline structure

Note 1 to entry: Polycrystalline diamond is normally prepared by high-pressure and high temperature processing to achieve direct bonding between diamond grains.

Note 2 to entry: Polycrystalline diamond film is normally prepared by low-pressure chemical vapour deposition.

2.2.46
plasma process
process for producing fine ceramics by using a high-temperature plasma, based on the vaporization of raw materials by the plasma and a subsequent condensation/deposition process

Note 1 to entry: Fine ceramics in powder, film, or bulk forms may be formed by plasma processes.

2.2.47
polymer derived ceramic
PDC
polymer used to obtain ceramics by pyrolysis

2.2.48
polymer impregnation pyrolysis
PIP
process of matricing for CMC by several cycles of polymer impregnation and pyrolysis

2.2.49
post-sintering
PS
sintering after a previous consolidation stage

EXAMPLE Post-sintered reaction-bonded silicon nitride, PSRBSN.

2.2.50
pressureless sintering
PLS
sintering in the absence of a raised mechanical or gas pressure

EXAMPLE Pressureless-sintered silicon nitride, PLSSN.

2.2.51
pyrolytic carbon
form of carbon produced through the thermal decomposition of carbon-containing precursors

Note 1 to entry: Precursors are, e.g. long-chain polymers or reacting gaseous mixtures.

Note 2 to entry: Pyrolytic carbon is used as interphase in ceramic matrix composite, which is the solid form of carbon deposited on a hot surface by cracking of gaseous or liquid hydrocarbons.

2.2.52
pyrolytic graphite
form of high-purity graphite produced from the vapour phase by thermal decomposition of carbon-containing gas and deposition on to a substrate

Note 1 to entry: Pyrolytic graphite usually has a highly oriented microstructure and strongly anisotropic properties.

2.2.53
reaction bonding
RB
process for producing a fine ceramic by consolidation of a green body by a chemical reaction between gaseous, liquid, or solid species at elevated temperature producing a bond between ceramic particles

EXAMPLE Silicon nitride objects can be produced by the reaction of silicon with nitrogen; reaction-bonded silicon nitride, RBSN.

Note 1 to entry: The use of this term for a process that falls under the definition of reaction sintering is deprecated.

2.2.54
reaction sintering
RS
process for producing a fine ceramic by consolidation of a green body by a solid state chemical reaction accompanied by solid state sintering at high temperatures to produce a bond between ceramic particles

EXAMPLE During the production of aluminium titanate ceramics, aluminium titanate can be formed by a solid state reaction between aluminium oxide and titanium oxide.

Note 1 to entry: The use of this term for liquid or gaseous reaction bonding process is deprecated.

2.2.55
reinforcement
ceramic particles, ceramic whiskers, ceramic platelets, ceramic fibres, or ceramic filaments incorporated in a fine ceramic, normally for the purpose of improving mechanical properties

Note 1 to entry: The reinforcement may alternatively be non-ceramic.

Note 2 to entry: The mechanical properties may be improved as regards their strength, toughness, wear resistance, hardness, creep resistance, or other characteristics.

Note 3 to entry: For ceramic matrix composites continuous reinforcement, i.e. ceramic filaments, is often used.

2.2.56
roll compaction
process of shaping a green body by feeding a granulated ceramic body between contra-rotating rollers which compact it into a strip or sheet

2.2.57
self-sustained high temperature synthesis
SHS
process for producing a solid fine ceramic in which primarily the heat of the exothermic reaction from reactant(s) is utilized

Note 1 to entry: Also known as self-propagating high temperature synthesis.

2.2.58
sintering
process of densification and consolidation of a green body by the application of heat with resulting joining of ceramic particles and increasing contact interfaces due to atom movement within and between the ceramic grains of the developing polycrystalline microstructure

Note 1 to entry: Sintering may take place either directly or through the agency of a secondary phase, e.g. in reaction sintering and liquid-phase sintering.

2.2.59
sol-gel processing
chemical synthesis of ceramic materials typically based on hydrolysis of ceramic precursors (alkoxides, acids, hydroxides) and subsequent condensation or aggregation to form sols followed by conversion to a gel and further processing

Note 1 to entry: A sol is a liquid dispersion of colloidal solid particles of up to several hundred nanometers in size, while a gel is a rigid interconnected network filled with either gas or liquid.

Note 2 to entry: Further processing includes, e.g. drying, calcining, and sintering.

Note 3 to entry: Organically-modified inorganic networks (ormocers) can be formed by sol-gel processing.

2.2.60
sol-gel coating process
process for producing a fine ceramic coating on a product by initially covering the surface with ceramic precursor followed by sol-gel processing

2.2.61
sol-gel consolidation technique
processing technique to produce a fine ceramic by using sol-gel processing in combination with casting, extrusion or impregnation with subsequent drying and sintering

Note 1 to entry: The size of articles produced by this technique is often limited by the large shrinkage arising from such processes.

2.2.62
solid casting
slip casting of a ceramic material without pour-off residue especially forming solid pieces or hollow ware if mold has a core

2.2.63
spark plasma sintering
SPS
sintering process in which a compact of powder is pressed using a die and is rapidly heated by pulsing direct current through the powder and/or the die

2.2.64
supercritical field synthesis
process for producing fine ceramics in a supercritical fluid of carbon dioxide or water

Note 1 to entry: Since a supercritical condition has the diffusivity characteristics of a gas phase and the solubility characteristics of a liquid phase, it is possible to prepare different chemical products compared with other liquid and gas phase processes.

Note 2 to entry: Supercritical field synthesis may be used to form fine ceramic powders, films, and bulk materials.

2.2.65
tape casting
process of shaping a green body in the form of a tape by casting a slurry of ceramic body (slip) as a film on a flat surface, followed by drying

Note 1 to entry: Organic additions to the slip give the tape flexibility and permit forms to be made from it by cutting, stamping, or punching, from which components such as substrates, packages, and capacitors can be manufactured.

Note 2 to entry: Most tape casting uses a doctor blade process (2.2.23).

2.2.66
vitreous carbon
form of carbon derived through solid phase carbonization from a preform comprising an appropriate highly cross-linked polymer

Note 1 to entry: Vitreous carbon is characterized by a pseudo-amorphous, isotropic structure with low density, and non-permeability for gases.

2.3 Terms for properties and testing

2.3.1
antibacterial
condition inhibiting the growth of bacteria on the surface of flat surface materials or cloths

2.3.2
antifungal activity
inhibition of germination or inactivation of fungal spores on the surface of materials

2.3.3
apatite-forming ability
capability to develop apatite on the surface

2.3.4
bulk density of ceramics
value obtained by dividing the mass of test specimen by the bulk volume of ceramic specimen

2.3.5
chip
piece of material broken off the edge or corner of a ceramic test-piece or component

Note 1 to entry: When pieces of material break off the edges or corners of a test-piece or component, they leave a “chipped area”.

2.3.6
competing failure modes
distinguishably different types of fracture initiation processes in ceramic test-pieces or components that result from concurrent critical flaw distributions

2.3.7
compound critical flaw distribution
flaw distribution in ceramic test-pieces or components which contain more than one type of strength-controlling flaw not occurring in a purely concurrent manner

Note 1 to entry: All test-pieces contain flaw type A and some additionally contain a second independent type B.

2.3.8
compressive strength
maximum value of uniaxial compressive stress at the instant of collapse of a ceramic test-piece, either by shearing or fragmentation

2.3.9
concurrent critical flaw distribution
competing critical flaw distribution
type of flaw distribution where every ceramic test-piece or component contains representative defects of each independent flaw type which compete with each other to cause failure

2.3.10
crack
plane of fracture in a ceramic test-piece or component without complete separation

2.3.11
critical flaw
flaw acting as the source of a failure in a ceramic test-piece or component

2.3.12
critical flaw distribution
distribution of type, shape, and size of critical flaws in a population of ceramic test-pieces or components

2.3.13
exclusive critical flaw distribution
type of flaw distribution where each test-piece or component contains defects from a single population, but more than one population is present in the batch

2.3.14
extraneous flaw
type of flaw which is not created during manufacturing

EXAMPLE Test-pieces with flaws from machining, which do not occur in the manufactured components.

2.3.15
flaw
inhomogeneity, discontinuity, or other structural irregularity in ceramic material

EXAMPLE Grain boundary, large grain, pore, impurity, crack.

Note 1 to entry: The term “flaw” should not be taken to mean that the material is functionally defective, but rather as an inevitable microstructural inhomogeneity.

Note 2 to entry: When the material is mechanically loaded, a flaw provides a stress concentration and enhances the risk of mechanical failure.

2.3.16
flaw distribution
spread of type, shape, and size of flaws within a single ceramic test-piece or component

2.3.17
flexural strength
maximum stress supported by a specified beam in bending at the instance of failure as determined at a given stress rate in a particular environment

2.3.18
four-point flexural strength
four-point bending strength
strength determined by bending a beam-shaped ceramic test-piece whereby the test-piece is supported on bearings near its ends, and is loaded equally at two positions symmetrically disposed about the centre of the supported span

Note 1 to entry: The term “quarter-point flexural strength” is sometimes used for the strength as measured by the four-point flexure geometry wherein the load positions are each one-quarter of the support span from the support bearings.

2.3.19
indoor lighting environment

indoor lighting environment with an artificial light source for general lighting service that does not include sunlight

2.3.20
photocatalyst antibacterial activity value

numerical difference between the logarithmic values of the total number of viable bacteria on the material with and without photocatalytic treatment after photoirradiation

Note 1 to entry: This value includes the decrease of the number of bacteria without UV irradiation.

Note 2 to entry: In ISO 27447, the film adhesion method and glass adhesion method are used for flat surface materials and textiles, respectively.

2.3.21
photocatalyst antifungal activity value

numerical difference between the logarithmic values of the total number of surviving fungal spores (colonies) on the material with and without photocatalytic treatment after UV irradiation

Note 1 to entry: This value includes the decrease of the number of fungal without UV irradiation.

2.3.22
photonic efficiency

percentage of the incident photon flux that induces a photochemical reaction in a photocatalyst

Note 1 to entry: It is assumed that one photon can induce the decolourization of one dye molecule in the case of methylene blue.

2.3.23
pore

cavity in a ceramic

Note 1 to entry: Pores may be located in the interior or at the surface. Pores at the surface are usually called pits.

2.3.24
porous region

inhomogeneity comprising a concentration of pores in a ceramic

Note 1 to entry: If interconnected to the surface of a ceramic test-piece or component, such a region will retain dye when dye-tested.

2.3.25
precrack

crack that is intentionally induced into the test specimen prior to testing the specimen to fracture

2.3.26
proof testing

application of a predetermined stress to a ceramic test-piece or component over a defined period of time to ascertain whether it contains a serious strength-limiting defect

Note 1 to entry: Removal of the failed test-pieces or components from a batch modifies the failure statistics of the survivors, such that the two-parameter Weibull distribution is typically no longer valid.

2.3.27
ring-on-ring strength

maximum value of equibiaxial flexural stress, at fracture, generated in a symmetrical plate-shaped ceramic test-piece by applying forces to opposing sides through dissimilar sized concentric ring contacts

2.3.28
R-curve behaviour
increase in apparent toughness with crack growth in ceramic test-pieces or components

Note 1 to entry: This effect may arise as a consequence of changes to microcrack distributions ahead of the crack or of local internal stressing, e.g. through phase transformations, or through uncracked or wedged ligaments behind the crack tip.

2.3.29
self-loaded deformation
deformation that results when a ceramic test-piece or component distorts under its own weight at elevated temperatures

Note 1 to entry: Self-loaded flexural deformation is sometimes referred to as “sagging”.

2.3.30
self-cleaning effect
maintenance of surface cleanliness of a material by employing a photocatalyst loaded onto the surface

EXAMPLE Glass, tiling and other facings for buildings, and plastics and coatings for general purposes.

Note 1 to entry: Self cleaning using photocatalysis is achieved through decomposition of surface contaminants by redox reactions, and/or hydrophilicity that allows stains or dirt to be easily removed by the flow of (rain) water over the surface.

2.3.31
specific photocatalytic activity
measure of capacity of a material to promote a specific photochemical reaction under defined conditions

Note 1 to entry: Specific photocatalytic activity is expressed in mole per square metre and hour [$mol/(m^2h)$].

2.3.32
static fatigue
degradation of strength under a constant load smaller than the failure load

Note 1 to entry: Weakening typically occurs by subcritical crack growth (or slow crack growth).

2.3.33
subcritical crack growth
slow crack growth
extension of existing cracks or flaws in the microstructure of a ceramic test-piece or component under a stress which does not produce instantaneous failure

Note 1 to entry: Subcritical crack growth can be caused by stress corrosion, creep crack growth, or active corrosion.

2.3.34
subcritical crack growth parameters
slow crack growth parameters
parameters describing the relationship between crack growth velocity and stress intensity factor at the crack tip in a ceramic test-piece or component

2.3.35
strength by sphere indentation
maximum force to the fracture of a test-piece when a compressive force is applied to the test-piece through the spherical indenter

2.3.36
thermal shock resistance
ability of a ceramic test-piece or component to withstand stress induced by rapid changes of temperature

Note 1 to entry: Thermal shock resistance is determined by the material properties, the shape and size of the test-piece or component and the thermal environment.

Note 2 to entry: This term may be used in a more specific sense for a specified type of test, e.g. quenching into water from a high initial temperature.

2.3.37
three-point flexural strength
three-point bending strength
strength determined by bending a beam-shaped ceramic test-piece whereby the test-piece is supported on bearings near its ends and a central load is applied

2.4 Abbreviations for ceramic materials

2.4.1
ALN
aluminium nitride
fine ceramic based principally on aluminium nitride

Note 1 to entry: Aluminium nitride typically contains a small amount of oxygen.

2.4.2
ALON
aluminium oxynitride
fine ceramic, based principally on aluminium oxynitride

Note 1 to entry: Aluminium oxynitride is generally in a cubic crystalline phase form.

2.4.3
Ap
apatite
group of calcium-phosphates including bone mineral and the main inorganic constituent of bones and teeth similar to hydroxy(l)apatite, which has the composition $Ca_{10}(PO_4)_6(OH)_2$

Note 1 to entry: Bone mineral may also contain ions such as CO_3^{2-}, F^-, Na^+ and Mg^{2+}.

Note 2 to entry: In the mineralogical field, the term “apatite” is used as a group name for apatite minerals including fluorapatite, chlorapatite, etc.

2.4.4
AT
aluminium titanate
fine ceramic, based principally on aluminium titanate

Note 1 to entry: Aluminium titanate as a crystalline phase is sometimes referred to as tialite.

2.4.5
ATZ
alumina toughened zirconia
zirconium oxide-based fine ceramic, normally of the TZP type, with aluminium oxide added

Note 1 to entry: The aluminium oxide addition increases hardness, stiffness and strength.

2.4.6
BN
boron nitride
fine ceramic, based principally on boron nitride

Note 1 to entry: The chemical formula of the compound boron nitride and the abbreviation are identical.

Note 2 to entry: The abbreviation “BN” is normally applied to material having the hexagonal crystalline structure.

2.4.7
BTO
barium titanium oxide

fine ceramic, based principally on barium titanium oxide

Note 1 to entry: Barium titanium oxide typically comprises a crystalline perovskite structure phase.

Note 2 to entry: BT is also used instead of BTO.

2.4.8
CAS
calcium aluminosilicate

fine ceramic, glass, or glass-ceramic material based principally on oxides of calcium, aluminium, and silicon

Note 1 to entry: Calcium aluminosilicate typically contains the crystalline phases anorthite, gehlenite, or other calcium silicate- based phases.

Note 2 to entry: Cement phase literature may incorporate numbers into this abbreviation.

2.4.9
CBN
cubic boron nitride

fine ceramic, based principally on boron nitride having a cubic crystalline structure

Note 1 to entry: Boron nitride in the cubic crystalline form is analogous in structure to diamond.

2.4.10
CMC
ceramic matrix composite

fine ceramic, composed of a ceramic matrix containing reinforcement

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: C/C composites are included in CMC composites.

2.4.11
CSZ
cubic stabilized zirconia

fine ceramic, based principally on zirconium oxide, which contains sufficient additional oxide species to retain the cubic crystal modification on cooling from the processing temperature to room temperature

Note 1 to entry: Theoretically CSZ should contain only the cubic crystal modification, but depending on the composition and the thermal history small amount of other crystal modifications can be present.

Note 2 to entry: Typically stabilizers include magnesia, calcia, yttria, or other rare-earth species.

2.4.12
EBC
environmental barrier coating

ceramic coating possibly multilayered used to protect fine ceramics of environmental aggression

2.4.13
FSZ
fully stabilized zirconia

fine ceramic, based principally on zirconium oxide, which contains sufficient stabilizing oxide species to retain only the high-temperature cubic crystal modification on cooling from the processing temperature to room temperature

Note 1 to entry: The stabilizer is typically one or more of magnesia, calcia, yttria, and other rare earth species.

2.4.14
GPSSN
gas pressure sintered silicon nitride
fine ceramic, based principally on silicon nitride, densified by gas pressure sintering

Note 1 to entry: When sintering silicon nitride, the gas atmosphere elected should normally contain nitrogen in order to inhibit the dissociation of the nitride at elevated temperatures.

2.4.15
HA
hydroxy(l)apatite
fine ceramic, based principally on oxides of calcium and phosphorus with hydroxyl ions typically forming the crystalline phase hydroxy(l)apatite

Note 1 to entry: In the bio-medical field including the biomaterial field, HAp is also acceptable as an abbreviation of hydroxyapatite to avoid confusion with abbreviation of hyaluronan (hyaluronic acid), HA.

2.4.16
HPSC
hot-pressed silicon carbide
fine ceramic, based principally on silicon carbide, densified by the action of an applied force (normally unidirectional) at elevated temperature

2.4.17
HPSN
hot-pressed silicon nitride
fine ceramic, based principally on silicon nitride, densified by the action of an applied force (normally unidirectional) at elevated temperature

2.4.18
HTS
HTSC
high-temperature superconductor
superconducting ceramic having superconducting properties at temperatures above 77 K, the boiling point of liquid nitrogen

2.4.19
ITO
indium tin oxide
fine ceramic, based principally on oxides of indium and tin

Note 1 to entry: Indium tin oxide typically comprises a crystalline bixbyite structure phase.

2.4.20
LAS
lithium aluminosilicate
fine ceramic, typically a glass or glass-ceramic, based principally on oxides of lithium, aluminium, and silicon

Note 1 to entry: Lithium aluminium silicate typically contains crystalline phases such as petalite, beta-eucryptite, or their solid solutions.

2.4.21
LPSSC
liquid-phase sintered silicon carbide
fine ceramic, based principally on silicon carbide, densified by liquid-phase sintering at high temperatures

2.4.22
MAS
magnesium aluminosilicate
fine ceramic, typically a glass or glass-ceramic, based principally on oxides of magnesium, aluminium and silicon

Note 1 to entry: Magnesium aluminium silicate typically contains the crystalline phase cordierite.

2.4.23
MAT
magnesium aluminium titanate
fine ceramic, based principally on oxides of magnesium, aluminium and titanium

Note 1 to entry: Magnesium aluminium titanate typically contains the crystalline phase pseudo-brookite.

2.4.24
PCD
polycrystalline diamond
polycrystalline form of carbon with cubic crystalline structure

Note 1 to entry: Polycrystalline diamond is normally prepared by high-pressure and high-temperature processing to achieve direct bonding between diamond grains.

Note 2 to entry: Polycrystalline diamond film is normally prepared by low-pressure chemical vapour deposition.

2.4.25
PLZT
lead lanthanum zirconium titanate
fine ceramic, based principally on oxides of lead, lanthanum, zirconium and titanium

Note 1 to entry: Lead lanthanum zirconium titanate typically comprises crystalline perovskite structure phase.

2.4.26
PMN
lead magnesium niobate
fine ceramic, based principally on oxides of lead, magnesium, and niobium

Note 1 to entry: Lead magnesium niobate typically comprises crystalline perovskite structure phase.

2.4.27
PMNT
lead magnesium niobium titanate
PMN-PT
lead magnesium niobate-lead titanate
fine ceramic, based principally on oxides of lead, magnesium, niobium, and titanium

2.4.28
PSRBSN
post-sintered reaction-bonded silicon nitride
fine ceramic, based principally on silicon nitride, which as a green body, comprising elemental silicon and liquid-phase forming sintering aids, is first reaction-bonded in a nitrogen atmosphere, followed by sintering at higher temperatures

Note 1 to entry: When sintering silicon nitride, the gas atmosphere selected should normally contain nitrogen in order to inhibit the dissociation of the nitride at elevated temperatures.

2.4.29

PSZ

partially stabilized zirconia

fine ceramic, based principally on zirconium oxide, which contains insufficient stabilizing oxide species to retain only the high-temperature cubic crystal modification on cooling from the processing temperature to room temperature

Note 1 to entry: The stabilizer is typically magnesia, calcia, yttria, or ceria. Normally the material partially destabilizes on cooling to comprise two or more different modifications.

2.4.30

PZT

lead zirconium titanate

fine ceramic, based principally on oxides of lead, zirconium, and titanium

Note 1 to entry: Lead zirconium titanate typically comprises crystalline perovskite structure phases.

2.4.31

RBAO

reaction-bonded aluminium oxide

fine ceramic, based principally on aluminium oxide, typically densified by the in-situ reaction between oxygen and elemental aluminium inside a green body containing aluminium oxide and aluminium powders

2.4.32

RBSC

reaction-bonded silicon carbide

fine ceramic, based principally on silicon carbide, typically densified by the in-situ reaction between carbon and elemental silicon inside a green body containing silicon carbide, silicon, and carbon powders

Note 1 to entry: The object may be porous if the reaction is with particulate silicon, or dense if the reaction is with liquid silicon by infiltration. In the latter case an elemental silicon phase is normally present.

Note 2 to entry: The term “reaction-sintered silicon carbide” and the abbreviation “RSSC” are sometimes used, but both are deprecated, because reaction sintering is not involved.

2.4.33

RBSN

reaction-bonded silicon nitride

fine ceramic, based principally on silicon nitride, produced principally by the in-situ reaction of nitrogen with a green body comprising primarily elemental silicon

Note 1 to entry: Reaction-bonded silicon nitride usually exhibits an open porosity.

Note 2 to entry: The term “reaction-sintered silicon nitride” and the abbreviation “RSSN” are sometimes used, but both are deprecated, because reaction sintering is not involved.

2.4.34

RSC

recrystallized silicon carbide

fine ceramic, based principally on silicon carbide, prepared in coarse-grained porous form by sintering at very high temperature

2.4.35

SBF

simulated body fluid

in the evaluation of fine ceramics for biomedical use, an inorganic solution having a similar composition to human blood plasma without organic components

Note 1 to entry: In the bio-medical field, a substitute for body fluid and cell culture medium, e.g. Ringer’s solution, Hank’s solution and Eagle’s minimum essential medium, are sometimes called “simulated body fluid” or “pseudo-body fluid”.

2.4.36
SC
SiC
silicon carbide
fine ceramic, based principally on silicon carbide

2.4.37
SIALON
sialon
silicon aluminium oxynitride
fine ceramic, based principally on compounds or solid solutions in the four-component silicon-aluminium-oxygen-nitrogen system

Note 1 to entry: The prefixes α-, β-, or O- may be used in combination with the abbreviation SIALON to indicate the type of crystal structure.

Note 2 to entry: "Sialon" written in lower case letters has the same meaning as "SIALON" written in upper case letters.

Note 3 to entry: Compounds and solid solutions with the component close to AlN are often referred to as AlN polytypoids.

2.4.38
SISC
silicon-infiltrated silicon carbide
fine ceramic, based principally on silicon carbide rendered non-porous by infiltration with liquid silicon

Note 1 to entry: The infiltration process may involve reaction bonding.

2.4.39
SN
silicon nitride
fine ceramic, based principally on silicon nitride

Note 1 to entry: The abbreviation "SN" is used only in combination with a processing prefix; when no processing prefix is required, the quasi-chemical formula "SiN" is often used, but this is deprecated.

2.4.40
SNO
silicon oxynitride
fine ceramic, based principally on silicon oxynitride

2.4.41
SOFC
solid oxide fuel cell
electrochemical conversion device including oxide ceramic of oxygen ion conductor, which produces electricity directly from oxidizing a fuel

2.4.42
SSC
sintered silicon carbide
fine ceramic, based principally on silicon carbide, densified by sintering processes at high temperature in the absence of a raised mechanical or gas pressure

Note 1 to entry: Usually small amounts of sintering aids are added and a non-oxidizing atmosphere is provided.

2.4.43
SSN
PLSSN
(pressureless) sintered silicon nitride
fine ceramic, based principally on silicon nitride, densified by pressureless sintering

Note 1 to entry: When sintering silicon nitride, the gas atmosphere selected should normally contain nitrogen in order to inhibit the dissociation of the nitride at elevated temperatures.

2.4.44
TCP
tricalcium phosphate
fine ceramic, based principally on oxide of calcium and phosphate without hydroxyl ions nor hydrogen ions typically forming principally the crystalline phase tricalcium phosphate

Note 1 to entry: The crystal phase type is changed with temperature: Low temperature phase, beta (β), and high temperature phase, alpha (α). In English technical literature, the abbreviations β-TCP and α-TCP are used for low and high temperature phases, respectively.

2.4.45
TTPSZ
transformation-toughened partially stabilized zirconia
fine ceramic, based principally on partially stabilized zirconia in which the destabilization on cooling is controlled so as to precipitate zirconia of the tetragonal modification within grains of the cubic modification

Note 1 to entry: The stabilizer is typically magnesia or yttria and less frequently calcia or mixtures of other oxides.

Note 2 to entry: The use of the abbreviation “Mg-PSZ” (magnesia partially stabilized zirconia) is deprecated for this specific type of zirconia, as opposed to its use for bulk refractories.

2.4.46
TZP
tetragonal zirconia polycrystals
fine ceramic, based principally on zirconium oxide, having a fine-grained structure in which the amount of stabilizing species is controlled such that the principal crystalline phase retained at room temperature is the high-temperature tetragonal modification

Note 1 to entry: The stabilizer is normally yttria.

Note 2 to entry: The use of the abbreviation “TPZ” and the term “tetragonal-PSZ” is deprecated.

2.4.47
YAG
yttrium aluminium garnet
fine ceramic, based principally on oxides of yttrium and aluminium

2.4.48
YBCO
yttrium barium copper oxide
superconducting ceramic, based principally on oxides of yttrium, barium, and copper

2.4.49
YIG
yttrium iron garnet
fine ceramic, based principally on oxides of yttrium and iron, typically comprising a crystalline phase of the garnet structure

2.4.50
YSZ
yttria stabilized zirconia
cubic stabilized zirconia where yttrium oxide is the stabilizing agent

2.4.51
ZTA
zirconia toughened alumina
fine ceramic, based principally on aluminium oxide with additions of zirconium oxide in various forms to provide modification of mechanical properties

2.4.52
ZTC
zirconia toughened ceramic
fine ceramic, containing zirconia particles in a matrix phase to provide modification of mechanical properties

2.4.53
ZTS
zirconium titanium stannate
zirconium tin titanate
fine ceramic, based principally on oxides of zirconium, titanium, and tin

Note 1 to entry: Zirconium titanium stannate typically comprises crystalline perovskite structure phases.

2.5 Abbreviations for processes

NOTE The following abbreviations are derived from terms that define processes used to achieve a ceramic product. These abbreviations may be added as a prefix to the abbreviations of ceramic materials as appropriate. In such cases they are used as adjectives, the form of which can be derived from the noun given; for example RBSN means reaction bonded silicon nitride. In some cases the abbreviation alone also stands for the equipment used for the process, e.g. "CIP" for cold isostatic press.

2.5.1
CIP
cold isostatic pressing
see cold isostatic pressing (2.2.21)

2.5.2
CVD
chemical vapour deposition
see chemical vapour deposition (2.2.18)

2.5.3
CVI
chemical vapour infiltration
see chemical vapour infiltration (2.2.20)

2.5.4
GPS
gas pressure sintering
see gas pressure sintering (2.2.27)

2.5.5
HIP
hot isostatic pressing
SEE hot isostatic pressing (2.2.30)

2.5.6
HP
(uniaxial) hot pressing
see (uniaxial) hot pressing (2.2.31)

2.5.7
IM
injection moulding
see injection moulding (2.2.33)

2.5.8
LPCVD
low-pressure chemical vapour deposition
see low-pressure chemical vapour deposition (2.2.35)

2.5.9
LPS
liquid-phase sintering
see liquid-phase sintering (2.2.34)

2.5.10
MOCVD
metal-organic chemical vapour deposition
see metal-organic chemical vapour deposition (2.2.41)

2.5.11
PECVD
plasma-enhanced chemical vapour deposition
see plasma-enhanced chemical vapour deposition (2.2.43)

2.5.12
PLS
pressureless sintering
see pressureless sintering (2.2.50)

2.5.13
PS
post-sintering
see post-sintering (2.2.49)

2.5.14
PVD
physical vapour deposition
see physical vapour deposition (2.2.44)

2.5.15
RB
reaction bonding
see reaction bonding (2.2.53)

2.5.16
RS
reaction sintering
see reaction sintering (2.2.54)

2.5.17
SHS
self-sustained high temperature synthesis
see self-sustained high temperature synthesis (2.2.57)

2.5.18
SPS
spark plasma sintering
see spark plasma sintering (2.2.63)

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