INTERNATIONAL STANDARD

ISO 6872

Fourth edition
2015-06-01

Dentistry — Ceramic materials

Médecine bucco-dentaire — Matériaux céramiques

Reference number
ISO 6872:2015(E)

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

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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

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

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

The committee responsible for this document is ISO/TC 106, *Dentistry,* Subcommittee SC 2, *Prosthodontic materials.*

This fourth edition cancels and replaces the third edition (ISO 6872:2008), which has been technically revised with the following changes:

— new edition of ISO 23146:2012 for fracture toughness by SEVNB has been added as an alternative in Annex A. It has a rigorous procedure developed by ISO/TC 206, *Fine ceramics*;

— a restriction on the use of the SEVNB method for fracture toughness determination for 3Y-TZP has been added. In most cases, the notch cannot be made sharp enough with a razor blade;

— maximum chamfer size on bend bars has been reduced for the case of the thin specimens;

— recommendations to grind lengthwise were added to the bend bar preparation step in 7.3.1.2.2;

— the Y equations for SEVNB fracture toughness in 3–point have been refined and expanded to cover more configurations;

— modification to Table 1 changing "aesthetic" to "monolithic".

Introduction

Specific qualitative and quantitative requirements for freedom from biological hazard are not included in this International Standard, but it is recommended that in assessing possible biological or toxicological hazards, reference be made to ISO 10993-1 and ISO 7405.

Dentistry — Ceramic materials

1 Scope

This International Standard specifies the requirements and the corresponding test methods for dental ceramic materials for fixed all-ceramic and metal-ceramic restorations and prostheses.

2 Normative references

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

ISO 3696, *Water for analytical laboratory use — Specification and test methods*

ISO 1942, *Dentistry — Vocabulary*

ISO 13078, *Dentistry — Dental furnace — Test method for temperature measurement with separate thermocouple*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1942 and the following apply.

3.1 Material

3.1.1
addition ceramic
add-on ceramic
correction ceramic
dental ceramic material which is fired at a reduced temperature and is normally applied to restore contact areas on a dental restoration or prosthesis

3.1.2
aesthetic ceramic
dental porcelain (3.1.5) or *glass ceramic* (3.1.10) having appropriate translucency and colour used to mimic the optical properties of natural teeth

3.1.3
chromatic dentin ceramic
dentine ceramic having a high strength or saturation of the hue (color)

3.1.4
dental ceramic
inorganic, non-metallic material which is specifically formulated for use when processed according to the manufacturers' instructions to form the whole or part of a dental restoration or prosthesis

3.1.5
dental porcelain
predominantly, glassy *dental ceramic* (3.1.4) material used mainly for aesthetics in a dental restoration or prosthesis

3.1.6
dentine ceramic
dental ceramic (3.1.4) material used to form the overall shape and basic colour of a dental restoration or prosthesis simulating the natural tooth dentine

3.1.7
enamel ceramic
dental ceramic (3.1.4) material used to overlay, either partially or wholly, the *dentine ceramic* (3.1.6) and also, to form the more translucent incisal third of a dental restoration or prosthesis simulating the natural tooth enamel

3.1.8
flame-sprayed dental ceramic
dental ceramic core or substructure layer formed via the technique of flame-spraying

3.1.9
fluorescent ceramic
dental ceramic (3.1.4) material that absorbs radiant energy and emits it in the form of radiant energy of a different wavelength band all or most of whose wavelengths exceed that of the absorbed energy

EXAMPLE Absorption of ultraviolet light with emission of blue light.

3.1.10
glass ceramic (dental)
dental ceramic (3.1.4) material formed by the action of heat treatment on a glass in order to cause initiation and growth of a wholly or predominantly crystalline microstructure

3.1.11
glass-infiltrated dental ceramic
dental ceramic core or substructure layer which is porous and is subsequently densified by the infiltration of specialised glass at elevated temperature

3.1.12
glaze ceramic
dental ceramic (3.1.4) material which is overlayed and fired at a lower temperature compared to *dentine ceramic* (3.1.6) or *enamel ceramic* (3.1.7) to produce a thin coherent sealed surface, the level of gloss being determined by the firing conditions

3.1.13
liner
dental ceramic (3.1.4) material used on all ceramic substructure forming a layer that provides a background colour upon which dentine or opaceous dentine can be applied to achieve overall aesthetics

3.1.14
modelling fluid
liquid with which a dental ceramic powder is mixed in order to shape or model it into its required form prior to firing

3.1.15
modifying enamel ceramic
enamel ceramic (3.1.7) used to modify the surface contour of a restoration, for example, add a contact, often fired at a lower temperature than the enamel ceramic or dentine ceramic

3.1.16
monolithic ceramic
dental ceramic (3.1.4) that is substantially made of a single uniform material

Note 1 to entry: A thin layer of *glaze* (3.3.4) (staining technique) can be applied.

3.1.17
opaceous dentine ceramic
dental ceramic (3.1.4) material having a higher opacity than a *dentine ceramic* (3.1.6) material, but which can still be used to contribute to the overall shape and basic colour of a dental restoration or prosthesis simulating the natural tooth dentine

3.1.18
opalescent enamel ceramic
enamel ceramic (3.1.7) material that scatters shorter wavelengths of light (e.g. blue) and transmits longer wavelengths of light (e.g. red)

3.1.19
opaque dental ceramic
dental ceramic (3.1.4) material which when applied to a metallic substructure, according to the manufacturer's instructions, acts to bond to the metal surface forming a layer that provides a background colour and interface upon which other dental ceramic materials can be applied to achieve overall aesthetics

3.1.20
shoulder ceramic
margin ceramic
dental ceramic (3.1.4) material used to form shape and colour at the marginal area of the dental restoration or prosthesis simulating natural tooth dentine in this area

3.1.21
stain ceramic
dental ceramic powder or paste which is normally intensely coloured and which is formulated to be used either internally or externally during the build-up of a dental restoration or prosthesis to simulate details within or on the surface as are found in natural teeth

3.1.22
substructure (core) dental ceramic
predominantly, polycrystalline dental ceramic material that forms a supporting substructure upon which one or more layers of *dental ceramic* (3.1.4) or dental polymer material are applied, either partially or totally, to form a dental restoration or prosthesis

3.2 Processing

3.2.1
air firing dental ceramic
firing of *dental ceramics* (3.1.4) under ambient atmospheric pressure

3.2.2
dental CAD/CAM
computer-aided design/computer-aided manufacture (CAD/CAM) procedures to manufacture a dental restoration or prosthesis normally including the following stages: a) a digital scanning procedure of the model, wax-up, or intra-orally to produce a 3D data set; b) software manipulation of the 3D data set to design the prosthesis; c) a computer-directed machine tool that performs the manufacturing process

3.2.3
condensation of dental ceramic
powder process whereby a slurry of dental ceramic powder is vibrated to compact the powder prior to sintering

3.2.4
injectable, castable, or pressable dental ceramic
dental ceramic (3.1.4) material, normally in the form of a pellet or ingot (often pre-sintered), designed for use in a specialised furnace which enables the ingot to be injected/cast/pressed into a mould prepared through the lost wax technique

3.2.5
sintering of a dental ceramic
process whereby heat and potentially other process parameters, for example, mechanical or gas pressure, are applied to a ceramic powder or powder compact in order to densify the ceramic into its required form

Note 1 to entry: "Firing" and "sintering" are used interchangeably in this International Standard ("firing" connoting the application of heat to drive sintering).

3.2.6
vacuum firing dental ceramic
firing of *dental ceramics* (3.1.4) at reduced pressure (i.e. under vacuum) to yield the required density and associated aesthetics especially the degree of translucency

Note 1 to entry: Dental ceramics for vacuum firing have a specific particle size distribution to reduce the entrapment of porosity.

3.3 Properties

3.3.1
class of dental ceramic
classification of a *dental ceramic* (3.1.4) material according to its intended function

3.3.2
fracture toughness
conventional fracture mechanics parameter indicating the resistance of a material to crack extension (propagation)

3.3.3
glass transition temperature
approximate midpoint of the temperature range over which a glass transforms between elastic and viscoelastic behaviour characterized by the onset of a rapid change in its coefficient of thermal expansion

3.3.4
glaze
surface appearance obtained when the gloss is clinically and aesthetically acceptable

4 Types, classes, and their identification

For the purposes of this International Standard, dental ceramics are designated into two types.

— Type I: Ceramic products that are provided as powders, pastes, or aerosols.

— Type II: All other forms of ceramic products.

Ceramics are divided into five classes according to their intended clinical use and according to the descriptions in Table 1. If colour is added to a ceramic powder for identification purposes, the colour coding given in Table 2 is recommended.

Table 1 — Classification of ceramics for fixed prostheses by intended clinical use with required mechanical and chemical properties

Class	Recommended clinical indications	Mechanical and chemical properties	
		Flexural strength [MPa] minimum value for mean (see 7.3.1.4)	Chemical solubility [μg/cm²]
1	a) Monolithic ceramic for single-unit anterior prostheses, veneers, inlays, or onlays adhesively cemented.	50	<100
	b) Ceramic for coverage of a metal framework or a ceramic substructure.	50	<100
2	a) Monolithic ceramic for single-unit anterior or posterior prostheses adhesively cemented.	100	<100
	b) Partially or fully covered substructure ceramic for single-unit anterior or posterior prostheses adhesively cemented.	100	<2 000
3	a) Monolithic ceramic for single-unit anterior or posterior prostheses and for three-unit prostheses not involving molar restoration adhesively or non-adhesively cemented.	300	<100
	b) Partially or fully covered substructure for single-unit anterior or posterior prostheses and for three-unit prostheses not involving molar restoration adhesively or non-adhesively cemented.	300	<2 000
4	a) Monolithic ceramic for three-unit prostheses involving molar restoration.	500	<100
	b) Partially or fully covered substructure for three-unit prostheses involving molar restoration.	500	<2 000
5	Monolithic ceramic for prostheses involving partially or fully covered substructure for four or more units or fully covered substructure for prostheses involving four or more units.	800	<100

Table 2 — Recommended colour coding for the identification of type I dental ceramic powders

Material	Colour coding
Dentine ceramic	Pink
Enamel ceramic	Blue
Fluorescent ceramic	Yellow
Highly chromatic dentine ceramic	Orange
Opalescent enamel ceramic	Blue-green
Modifying enamel ceramic (e.g. translucent, clear)	Purple

5 Requirements

5.1 Uniformity

The inorganic pigment(s) used to produce the colour of a fired dental ceramic and any organic colorants (for colour coding) shall be uniformly dispersed throughout the dental ceramic material and in powdered ceramic products, no segregation of the pigment(s) shall take place when the powder is mixed as in 7.1.3. Check by visual inspection.

5.2 Freedom from extraneous materials

5.2.1 Dental ceramic materials shall be free from extraneous materials when assessed by visual inspection.

5.2.2 Dental ceramic materials shall not have an activity concentration of more than 1,0 $Bq \cdot g^{-1}$ of ^{238}U. Test in accordance with 7.2.2.

5.2.3 Any colorants used to colour code the ceramic powder, as per Table 2, are recommended to be food-quality organic materials.

5.3 Mixing and condensation properties of type I ceramics

When mixed as in 7.1.3 with water or the modelling fluid recommended by the manufacturer, a dental ceramic powder shall neither form lumps, nor granules, when assessed by visual inspection.

The paste formed shall be suitable for making the indicated restorations and prostheses by condensation of successive layers. When the paste is condensed as in 7.1.4, it shall neither crack, nor crumble, when assessed by visual inspection during drying.

5.4 Physical and chemical properties

The physical and chemical properties of ceramic test specimens tested in accordance with the relevant methods detailed for type I and type II ceramics in Clause 7 shall comply with the requirements specified in Table 1. The coefficient of thermal expansion of the ceramics shall not deviate by more than $0,5 \times 10^{-6}\ K^{-1}$ from the value stated by the manufacturer (see 8.2.2). The glass transition temperature of the ceramics shall not deviate by more than 20 °C from the value stated by the manufacturer (see 8.2.2).

5.5 Biocompatibility

See the introduction for guidance on biocompatibility.

5.6 Shrinkage factor

The absolute accuracy of the shrinkage factor by which the dimensions of the partially sintered material is to be divided as provided under 9.2.2 c) shall be ±0,002.

6 Sampling

6.1 Type I ceramics

Use retail packages from the same batch containing enough material to carry out the specified tests plus an allowance for repeated tests, if necessary. Where there is more than one shade in a class of dental ceramic, perform test with a colour/shade most commonly used. All of the materials tested shall be of the same lot.