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Dentistry — Refractory investment and die material

Médecine bucco-dentaire — Revêtements et matériaux pour modèles réfractaires

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Foreword

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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).

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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 SC2, *Prosthodontic Materials.*

This second edition cancels and replaces the first edition (ISO 15912:2006), which has been technically revised. It also incorporates the Amendment ISO 15912-1:2006/Amd 1:2011.

In this edition, dental pressable-ceramic investment materials are included in the Scope for the first time. These products are intended for the production of ceramic crowns and inlays and, as such, the same requirements as those for an investment product intended for the production of metallic crowns and inlays by casting are relevant (Type 1, according to the classification in this standard).

The previous edition contained requirements and test methods that had been developed for discontinued composition specific standards. In recent years products have been introduced that have other chemistries (for the binder and the refractory phase), specifically to minimize chemical reaction between the mould and the molten casting metallic material. A number of technical changes have been made to enable all dental casting investment products, regardless of their composition, to seek compliance with this International Standard and maintains the agreed philosophy that this International Standard should be inclusive, application-driven and not be limited by composition considerations.

Where appropriate, aspects of the test procedures have been changed to follow the manufacturer's instructions for use. The requirement for thermal dimensional change now takes into account the cooling of some products (after burn-out) to a lower casting temperature. The specification for the dilatometer has been changed for it to be compatible with the heating — and where relevant, the cooling after burn-out — of the product to the casting temperature.

The procedure for determining the initial setting time has been revised to harmonize with that present in the latest edition of the standard for dental gypsum products, ISO 6873:2013.[1] Although substantially editorial, there are technical changes.

Information for use now requires a statement of the type of refractory phase(s) that is (are) present.

Labelling requirements for products that contain silica have been revised to comply with the current United Nations Globally Harmonized System for Classification and Labelling of Chemicals (UN GHS)[2] and recommendations for silica as a hazardous material.

Containers of liquid must be marked to indicate the use to which the liquid is put.

Dentistry — Refractory investment and die material

1 Scope

This International Standard gives requirements and test methods for determining the compliance of dental casting investment, dental brazing investment, dental pressable-ceramic investment and dental refractory die materials used in the dental laboratory, regardless of the composition of the refractory powder, the composition of the binder, or the particular application.

This International Standard classifies such products into types and classes, according to their intended use and the burn-out procedure recommended by the manufacturer.

It also gives requirements for marking, labelling and manufacturer's instructions.

It specifies requirements for the essential physical and mechanical properties of the products and the test methods to be used for determining them.

NOTE 1 Compliance with all of the requirements presented in Clause 5 may not be necessary for some products, and a requirement might not be applicable to a product with a particular binder chemistry or be intended for an application in which that requirement is irrelevant. When this is the case, a clear statement to this effect is given according to Clause 5.

NOTE 2 A specific quantitative requirement for setting expansion is not included in this International Standard. If the setting expansion of gypsum-bonded investment is measured, then the procedure given in ISO 6873[1] can be considered — a procedure not recommended, however, for investment materials with other binders.

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 286-2, *Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes — Part 2: Tables of standard tolerance classes and limit deviations for holes and shafts*

ISO 1942, *Dentistry — Vocabulary*

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

ISO 6344-1, *Coated abrasives — Grain size analysis — Part 1: Grain size distribution test*

ISO 6872, *Dentistry — Ceramic materials*

ISO 8601, *Data elements and interchange formats — Information interchange — Representation of dates and times*

ISO 15854, *Dentistry — Casting and baseplate waxes*

ISO 22674, *Dentistry — Metallic materials for fixed and removable restorations and appliances*

3 Terms and definitions

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

3.1
dental casting investment material
powdered particulate refractory and binder system that is mixed with a specified liquid to produce a pourable fluid that sets around a pattern to form the mould for casting a dental metallic prosthesis

Note 1 to entry: In some products, the binder may be dispersed in the refractory powder and the product is supplied as a mixed powder. Alternatively, the chemistry of the binder may lead to it being present in a solution (to be used with the powder that is supplied) with part or none of it being dispersed in the refractory powder, as received.

Note 2 to entry: The specified liquid may be pure water, an aqueous binder solution, or an aqueous solution to enhance expansion.

3.2
dental refractory die material
powdered particulate refractory and binder system that is mixed with a specified liquid to produce a fluid that sets (and is designed specifically) to form of a hard die, suitable for the production of a dental ceramic prosthesis using the sintering technique

3.3
dental brazing investment material
powdered particulate refractory and binder system that is mixed with a specified liquid to produce a fluid that sets (and is designed specifically) to form a cast upon which metallic components are held, or are partly embedded, accurately in place while they are joined by brazing

Note 1 to entry: The cast may be referred to as the model, though that is a deprecated term.

3.4
dental pressable ceramic investment
powdered particulate refractory and binder system that is mixed with a specified liquid to produce a pourable fluid that sets around a pattern to form a mould into which a dental pressable-ceramic, softened by heating, can be forced under pressure

3.5
special liquid
liquid, other than water, supplied by the manufacturer for mixing with the dental casting investment powder for the purpose of increasing the expansion of the mould

3.6
slow- or step-heating method
heating method in which (at a time after setting that is recommended by the manufacturer) the dental casting investment mould, or dental pressable-ceramic mould, or dental brazing investment cast or dental refractory die is placed in a burn-out furnace set at room temperature, after which the temperature of the furnace is increased to the end temperature in a series of stages and at a programmed rate recommended by the manufacturer

3.7
quick-heating method
heating method in which (at a time after setting that is recommended by the manufacturer) the dental casting investment mould, or dental pressable-ceramic mould, or dental brazing investment cast, or dental refractory die is placed directly into the hot burn-out furnace that is set and held at the burn-out temperature recommended by the manufacturer

3.8
burn-out temperature
<Types 1 and 2 materials> temperature to which the mould is heated to burn off the pattern material and expand the mould

3.9
burn-out temperature
<Type 3 material> temperature to which the cast is heated to burn off any material used for shielding and accurately locating the components to be brazed, and to expand the cast

3.10
burn-out temperature
<Type 4 material> temperature to which the die is heated initially to burn off the pattern material

3.11
casting temperature
<Types 1 and 2 materials intended for casting a dental metallic material> temperature of the mould at which the molten metallic material is forced into the mould

3.12
ceramic pressing temperature
<Type 1 investment materials intended for use with dental pressable-ceramics> temperature at which the mould and ceramic ingot are taken and at which the ceramic is pressed into the mould

Note 1 to entry: The mould is placed in a burn-out furnace at a lower temperature and held at this temperature before the pressable-ceramic ingot is placed in the crucible of the mould, after which both are transferred to the pressing furnace, that is at, or is raised to, a higher temperature to soften the ceramic ingot

3.13
green state
condition of the material immediately after setting before structural changes are brought about by aging or burn-out, changes that produce increased strength or further dimensional changes

4 Classification

For the purposes of this International Standard, dental casting investment, dental brazing investment, dental pressable-ceramic investment and dental refractory die materials are classified into the following types, according to the intended application:

— Type 1, for the construction of inlays, crowns and other fixed prostheses;

— Type 2, for the construction of complete or partial dentures or other removable appliances;

— Type 3, for the construction of casts used in brazing procedures;

— Type 4, for the construction of refractory dies.

In addition, the materials are divided into two classes: Class 1 is recommended for burn-out by a slow- or step-heating method; Class 2 is recommended for burn-out by a quick-heating method.

5 Requirements

5.1 General

If a manufacturer claims suitability for both classes, then the material shall satisfy the requirements when it is subjected to both heating techniques. This applies to requirements 5.5 and 5.6 and, if appropriate, requirement 5.7.

5.2 Material consistency and freedom from contamination

When examined in accordance with 7.1, the powder shall be uniform and free of lumps and foreign matter. If a special liquid is supplied, it shall be free of sediment.

5.3 Fluidity

When measured in accordance with 7.2, the fluidity shall not vary by more than 30 % from the value stated by the manufacturer [according to 8.3 a)].

This requirement does not apply to silica bonded investments (i.e. products in which an alcoholic solution of ethyl silicate is used in the binding system).

5.4 Initial setting time

When measured in accordance with 7.3, the initial setting time shall not vary by more than 30 % from the value stated by the manufacturer [according to 8.3 b)]. If the manufacturer gives a range for the initial setting time, then the measured initial setting time shall not vary by more than 30 % from the mid-point of this range.

5.5 Compressive strength

When measured in accordance with 7.4, the compressive strength of a test-piece shall not be less than 70 % of the value stated by the manufacturer [according to 8.3 c)] and in no case shall be lower than 2 MPa.

5.6 Linear thermal dimensional change

When measured in accordance with 7.5, the linear thermal expansion, for all four Types, shall not vary by more than 20 % from the value stated by the manufacturer [according to 8.3 d)]. If the manufacturer gives a range for the linear thermal expansion, then the measured linear thermal expansion shall not vary by more than 20 % from the mid-point of this range.

When measured in accordance with 7.5, the linear firing shrinkage for a Type 4 material shall not vary by more than 15 % from the value stated by the manufacturer [according to 8.3 e)]. If the manufacturer gives a range for the linear firing shrinkage, then the measured linear firing shrinkage shall not vary by more than 15 % from the mid-point of this range.

5.7 Adequacy of expansion of Type 1 and Type 2 materials

When cast in accordance with 7.6, the diameter of the cast metallic disc, or when pressed in accordance with 7.6, the diameter of the pressed ceramic disc (as is appropriate) with respect to the diameter of the pattern from which it was made, shall be

a) no smaller than 99,5 % in case of a Type 1 material;

b) no smaller than 99,0 % in case of a Type 2 material.

This does not apply to either dental brazing investment material, Type 3, or dental refractory die material, Type 4.

6 Sampling, test conditions and mixing

6.1 Sampling

Use material from a single lot in packages that have been produced for retail. Use only sealed, undamaged packages (i.e. packets and containers) that have not exceeded the “use before” date.

6.2 Test conditions

Carry out all testing in a controlled atmosphere: (23 ± 2) °C, (50 ± 10) % relative humidity and free from obvious draughts.

Holding the material and all test equipment under these controlled conditions for a minimum period of 15 h prior to testing is recommended.

6.3 Mixing

Mix according to the manufacturer's instructions. When a special liquid is supplied, use it at the manufacturer's recommended dilution according to 8.2 d). If water is required, use water that complies with Grade 3 according to ISO 3696.

If a range is given in 8.2 e) for the powder to liquid ratio, or in 8.2 d) for the dilution of the special liquid, use the midpoint of this range to produce a mix for determining compliance with requirements 5.3, 5.4, 5.5 and 5.6.

6.3.1 Apparatus

The following items may be needed, depending on the manufacturer's instructions:

a) **mixing bowl**, clean, dry, flexible, for hand mixing;

b) **spatula,** rigid for hand mixing;

c) **vacuum mixer** with an appropriate clean and dry mixing bowl;

d) **timer,** capable of measuring time to an accuracy of 1 s.

6.3.2 Procedure

Measure the required mass of powder and the recommended volume of liquid, each to an accuracy of 1 %.

Pour the liquid into the mixing bowl and add the powder. Commence timing when liquid and powder make first contact.

Hand spatulate and/or mix mechanically (with a vacuum, if specified) for the appropriate period, according to manufacturer's instructions. If the manufacturer recommends a range of mixing times, use the mid-point of the range.

7 Test methods

7.1 Material consistency and freedom from contamination

7.1.1 Test procedure

Examine the material, as received, visually without the aid of magnification. Use eyesight that has nominally normal visual acuity. Corrective (non-magnifying) lenses may be worn.

7.1.2 Test report

Report whether the product meets, or does not meet, the requirement for material consistency and freedom from contamination (5.2). If it does not meet this requirement, state the reason.

7.2 Fluidity

7.2.1 Apparatus

7.2.1.1 Clean and dry **cylindrical ring mould**, having a length (50 ± 1) mm, an inside diameter of (35 ± 1) mm that is made from a corrosion-resistant, non-absorbent material.

7.2.1.2 Flat square **glass plate**, with a glazed surface and measuring at least 150 mm × 150 mm.

7.2.1.3 Dental vibrator.

7.2.1.4 Scale or ruler, graduated in millimetres and at least 150 mm in length.

7.2.1.5 Mould-release agent, such as silicone spray or silicone grease.

7.2.2 Number of test-pieces

Make two test-pieces from two mixes of the material.

Three more test-pieces (from three mixes of the material) are required if the result from one test-piece meets the requirement specified in 5.3 and the other does not.

7.2.3 Test procedure

Coat the inside of the ring mould with a thin layer of mould release agent.

Mix according to 6.3, using a mass of powder with the appropriate volume of liquid to produce a mix that is sufficient to fill the mould. Centre the mould on the glass plate and place the plate on the dental vibrator platform. Vibrate the mix into the mould until it is slightly overfilled. Vibrate for a further (20 ± 2) s. After this time, do not vibrate. Level the mix flush with the top of the mould and remove the excess from the plate. 30 s after the end of mixing, lift the mould vertically from the plate using a smooth action over a period of 5 s to allow the column of mix to slump onto the plate. As soon as the material has set, measure the largest and smallest diameters on the base of the set test-piece to an accuracy of 1 mm, and record the average value as the first result.

Repeat the test and record the second result, being the average of the two measurements made on the second test-piece.

7.2.4 Evaluation of results

If both results meet the requirement (5.3), the product complies.

If neither result meets this requirement, then the product fails to comply.

If the result of one test meets this requirement and one fails to do so, repeat the test three more times.

If the results of all three of these additional tests meet the requirement (5.3) then the product complies. Otherwise, it fails to comply.

7.2.5 Test report

Report

a) the result for every test conducted in accordance with 7.2.3, including those for additional test-pieces (if these were required) and the average value (to 1 mm) for the results of those test-pieces that comply with the requirement (5.3);

b) the value for the fluidity given by the manufacturer according to 8.3 a);

c) a statement that the product meets or does not meet the requirement for fluidity (5.3).

