INTERNATIONAL STANDARD

ISO 9694

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Dental phosphate-bonded casting investments

Revêtements pour coulées dentaires à liant-phosphate

Reference number
ISO 9694:1996(E)

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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Introduction

This is the first edition of a standard for dental phosphate-bonded casting investments. During its preparation consideration was given to including a requirement for setting expansion. No suitable test was available but work continues on the development of a requirement and a test for inclusion at the earliest possible date.

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Dental phosphate-bonded casting investments

1 Scope

This International Standard classifies dental phosphate-bonded casting investments into two types according to the intended use. It specifies requirements for the essential physical properties of the investment and the test methods to be used to determine these properties. It also includes a requirement for adequate instructions to accompany each package.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3696:1987, *Water for analytical use — Specification and test method.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 dental phosphate-bonded casting investment: Powder mixture of a refractory filler system and a binding system specially designed for casting dental alloys.

NOTE — The refractory filler system usually consists of refractory oxides such as silica. The binding system usually consists mainly of an acidic phosphate, such as ammonium dihydrogen phosphate, together with a basic oxide, such as magnesium oxide. When the powder is mixed with an appropriate liquid, it forms a paste that hardens to form an investment mould suitable for casting dental alloys. The appropriate liquid is either water, special liquid or special liquid mixed with water.

3.2 special liquid: Liquid made available by the manufacturer or supplier for mixing with the investment powder.

NOTE — The special liquid usually consists mainly of a suspension of colloidal silica particles in water.

4 Classification

Phosphate-bounded investments are classified into two types, according to their intended use with alloys having a solidus temperature above 1 080 °C, as follows:

Type 1: For inlays, crowns and other fixed restorations.

Type 2: For partial dentures and other cast, removable restorations.

NOTE — These investments may be used with alloys of lower melting temperature if so recommended by the manufacturer.

5 Requirements

5.1 Quality

The powder shall be of uniform quality and free from foreign matter and lumps when examined visually. If a special liquid (see 3.2) is required, it shall be free of abnormal sediment. If a mould liner is supplied, or if the use of a mould liner is recommended (see 8 d), it shall not contain asbestos fibre.

5.2 Fluidity

The diameter of the base of the set investment mass shall be at least 90 mm for Type 1 material and at least 70 mm for Type 2 material, when tested in accordance with 7.1.

5.3 Initial setting time

The initial setting time, tested in accordance with 7.2, shall not differ by more than 30 % from the time stated by the manufacturer. If the manufacturer gives a range of setting time, then the setting time shall not differ from the midpoint of this range by more than 30 % of this midpoint.

5.4 Compressive strength

The compressive strength of investment types 1 and 2 shall be not less than 2,5 MPa and 3 MPa respectively, when tested in accordance with 7.3.

5.5 Linear thermal expansion

The linear thermal expansion, when tested in accordance with 7.4 at 950 °C, shall not differ by more than 15 % from the value stated by the manufacturer. If manufacturer gives a range of linear thermal expansion, then the linear thermal expansion shall not differ from the midpoint of this range by more than 15 % of this midpoint.

6 Sampling, conditioning and mixing

6.1 Sampling

Material selected for testing shall not be beyond the stated expiry date [see 10.1 g)]. Sufficient retail packages of the material of one batch shall be obtained to provide at least 5 kg of material. Any packages that are not sealed shall be discarded.

If the powder is supplied in bulk, it shall be thoroughly blended and stored in a moisture-proof container.

If a special liquid is recommended by the manufacturer [see 8 b)], a supply shall be obtained.

6.2 Conditioning

Testing in accordance with 7.1 and 7.2 shall be carried out at (23 ± 1) °C and (50 ± 10) % relative humidity. All other testing of the investment shall be carried out at (23 ± 2) °C and (50 ± 10) % relative humidity. All testing shall be carried out in a room free from obvious drafts.

All test equipment shall be clean and dry. Before testing begins, material and test equipment shall be conditioned for not less than 16 h at the testing atmosphere.

NOTE — Some components of the mixing and testing equipment are cleaned between tests. These items should be allowed to return to the specified test temperature before being reused.

6.3 Mixing

6.3.1 Apparatus

6.3.1.1 Clean apparatus for mechanical mixing in vacuum, as recommended by the manufacturer, and used exclusively for phosphate-bonded investments.

6.3.1.2 Timing device, such as a stopwatch.

6.3.2 Procedure

Measure, to an accuracy of ± 1 %, the required amount of powder and the required volume of liquid in the mixture ratio given by the manufacturer's instructions in accordance with 8 i). If the manufacturer specifies a range of concentration or volume for the liquid, use the midpoint concentration or volume. Pour the liquid into the mixing bowl and sift the investment powder into the liquid within 10 s, minimizing entrapment of air.

Begin timing from the moment the investment powder and the liquid first make contact. Hand-spatulate for 15 s and then mechanically mix for the time specified by the manufacturer [see 8 c)]. Then transfer the mixed investment to the test moulds or forms within 15 s.

7 Test methods

7.1 Fluidity

7.1.1 Apparatus

7.1.1.1 Clean, dry cylindrical ring mould, having a length of (50 ± 1) mm, an inside diameter of (35 ± 1) mm and constructed from a corrosion-resistant, nonabsorbent material.

7.1.1.2 Flat, square glass plate, measuring at least 150 mm × 150 mm.

7.1.1.3 Dental vibrator, operating on 50 Hz or 60 Hz power supply.

7.1.1.4 Scale, or rule, graduated in millimetres, to measure the major and minor diameters of the slumped mix.

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

7.1.2 Procedure

Coat the inside surface of the ring mould (7.1.1.1) with mould-release agent (7.1.1.5). Mix the investment as described in 6.3 using approximately 200 g of powder. Centre the mould base on the glass plate and place the plate on the dental vibrator platform. Vibrate the investment mix into the mould until it is slightly overfilled. Do not vibrate for more than 20 s. Level the mix flush with the top of the mould. At 135 s from the start of mixing (see 6.3.2), lift the mould vertically from the plate at a rate of approximately 10 mm/s, allowing the mix to slump on the plate. As

soon as the mixed investment has set, measure the largest and the smallest diameters of the set investment base, and record the average value.

Repeat this procedure, using freshly mixed investment.

7.1.3 Evaluation

If both tests carried out in 7.1.2 meet the requirement (5.2) of this International Standard, then the product meets this requirement of this International Standard. If neither meets the requirement, then the product fails to meet the requirements of this International Standard. If one test meets the requirement and one fails the requirement, then the test should be repeated three more times. If all three repeat tests meet the requirement (5.2), then the product meets the requirement of this International Standard. If any of the three repeat tests fails to meet the requirement, then the product fails to meet the requirements of this International Standard.

7.2 Initial setting time

7.2.1 Apparatus

7.2.1.1 Vicat needle apparatus, an example of which is shown in figure 1, meeting the following requirements:

a) Vicat needle (C), 50 mm long, of circular cross-section and with a diameter of (1 ± 0,05) mm.

b) Rod (B), of approximate dimensions 270 mm long and 10 mm in diameter.

c) Total mass of the rod and needle (A, B and C in figure 1) shall be (300 ± 1) g.

d) Scale (D), graduated in millimetres.

e) Baseplate (H) of plate glass, measuring about 100 mm × 100 mm.

7.2.1.2 Clean, dry conical ring mould, constructed from a corrosion-resistant, nonabsorbant material, having an inside diameter of 70 mm at the top and 60 mm at the base, and a height of 40 mm.

7.2.1.3 Mould-release agent, such as silicone spray or silicone grease, to facilitate repeat tests.

7.2.2 Procedure

Coat the inside surface of the ring mould (7.2.1.2) with mould-release agent (7.2.1.3) and place on the baseplate.

Adjust the scale of the needle apparatus (7.2.1.1) to read zero when the needle is in contact with the baseplate. Make an investment mix according to 6.3 using 400 g of investment powder. Overfill the ring mould with the mix and then level the surface. When the glossy surface of the mix has completely disappeared, lower the needle until it touches the surface and then release it gently, allowing it to sink into the mix under its own mass. Repeat this procedure at 15-s intervals, wiping the needle clean after each penetration and moving the sample at least 5 mm so that the needle does not enter the same place twice. Avoid making any penetration of the needle closer than 5 mm to the mould walls. Record the initial setting time as the time from the start of mixing (see 6.3.2) until the needle first fails to penetrate the investment to within 5 mm of the mould bottom.

Repeat this procedure, using freshly mixed investment.

7.2.3 Evaluation

If both tests carried out in 7.2.2 meet the requirement (5.3) of this International Standard, then the product meets this requirement of this International Standard. If neither meets the requirement, then the product fails to meet the requirement of this International Standard. If one test meets the requirement and one fails the requirement, then the test should be repeated three more times. If all three repeat tests meet the requirement (5.3), then the product meets this requirement of this International Standard. If any of the three repeat tests fails to meet the requirement, then the product fails to meet the requirements of this International Standard.

7.3 Compressive strength

7.3.1 Apparatus

7.3.1.1 One or more sectional or split moulds, sufficient to produce cylindrical specimens with a diameter of (20 ± 0,2) mm and a length of (40 ± 0,4) mm, constructed from a corrosion-resistant material. Ends of the mould shall be parallel within 0,05 mm.

7.3.1.2 Flat glass plates, sufficient in size and quantity to cover the ends of all moulds.

7.3.1.3 Dental vibrator.

7.3.1.4 Compression-testing machine, adjusted to a rate of loading of (5 ± 2) kN/min.

NOTE — When using a testing machine with a constant cross-head rate, this rate should be adjusted so that the average rate of loading between the initial application of the load and the failure of the specimen is (5 ± 2) kN/min. Trial specimens should be run to determine the appropriate cross-head speed.

7.3.1.5 Mould-release agent, such as silicone grease.

7.3.2 Procedure

Lubricate the inside surface of the mould (7.3.1.1) with the mould-release agent (7.3.15). Place the mould on the glass plate (7.3.1.2). Make an investment mix according to 6.3, using 300 grams of powder. Slightly overfill the mould with the investment mix, applying slight vibration (7.3.1.3). Before the glossy surface has completely disappeared from the mix, put a second glass plate on the mould and press it down until the glass contacts the mould. Remove the specimen from the mould 30 min after the start of mixing (see 6.3.2) and store it at (23 ± 2) °C and (50 ± 10) % relative humidity.

Prepare five specimens from at least two mixes of investment. Prior to testing, measure the diameter of each specimen. The commencement of compression testing of each specimen shall be (120 ± 5) min from the start of mixing.

Position each specimen between the loading platens of the compression-testing machine (7.3.1.4) so that the specimen is loaded in an axial direction. Do not use packing between specimen and platen. Using the machine, apply the compressive force until fracture occurs and record the compressive force (F), in newtons, at which fracture occurs.

7.3.3 Evaluation

For each specimen tested, calculate the maximum stress (S), in megapascals, using the recorded maximum force (F), in newtons, as follows:

$$S = F/314$$

The compressive strength of at least four of the five specimens must meet the requirement given in 5.4 for the product to meet the requirement of this International Standard. If only three of these specimens meet this requirement, then all of a further set of five specimens must meet the requirement, so that eight out of ten meet the requirement, in order for the product to meet the requirement of this International Standard.

7.4 Linear thermal expansion

7.4.1 Apparatus

7.4.1.1 Vitreous silica dilatometer, including a linear inductive transducer instrument or other measuring instrument which exerts a measuring force which is not greater than 0,5 N. The equipment shall be capable of measuring the change in length, to the nearest 0,01 mm, on heating at a rate of (5 ± 1) °C over the range from 23 °C to 950 °C and on maintaining the specimen at (950 ± 10) °C.