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ISO 15854

Third edition
2023-01

Dentistry — Casting and baseplate waxes

Médecine bucco-dentaire — Cires pour coulée et pour plaque de base

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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).

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).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 106, *Dentistry*, Subcommittee SC 2, *Prosthodontic materials,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 55, *Dentistry*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 15854:2021), which has been technically revised.

The main changes compared with the previous edition are as follows:

— the scope has been clarified;

— waxes supplied for use in CAD/CAM procedures have been included;

— the appearance after flaming has been extended to include casting waxes.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

For the purposes of this document, the term ‘casting’ includes ‘pressing’, as used for glass ceramics.

It is recommended that, in assessing possible biological or toxicological hazards, reference be made to ISO 7405 and ISO 10993-1.

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Dentistry — Casting and baseplate waxes

1 Scope

This document specifies the classification of and requirements for waxes used for dental casting (including products intended for CAD/CAM milling) using the lost-wax technique and dental baseplate preparation together with the test methods to be employed to determine compliance with these requirements.

Solid polymer products (such as acrylics) for CAD/CAM work, and thermoplastic or photo-curing resins used in additive processes, are not covered by this document.

This document does not include specific and quantitative requirements for freedom from biological hazards.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1942, *Dentistry — Vocabulary*

ISO 21920-2, *Geometrical product specifications (GPS) — Surface texture: Profile — Part 2: Terms, definitions and surface texture parameters*

ISO 6873, *Dentistry — Gypsum products*

ISO 8601-1, *Date and time — Representations for information interchange — Part 1: Basic rules*

ISO 22112, *Dentistry — Artificial teeth for dental prostheses*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
casting wax
mouldable material with minimal residue on ignition suitable primarily for shaping patterns in the production of cast restorations using the *lost-wax technique* (3.5)

3.2
baseplate wax
mouldable material primarily for forming occlusion rims, positioning and retaining artificial teeth therein, and shaping patterns that are duplicated in the denture base polymer

3.3
milling wax
casting wax (3.1) where patterns are formed by milling using CAD/CAM systems

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3.4
melting point
temperature above which no solid material exists at equilibrium

Note 1 to entry: For the practical purposes of this document, the melting point and the freezing point shall be considered as being the same.

3.5
lost-wax technique
method of casting using a wax pattern that is removed from the intact investment mould by melting or burning

4 Classification

Dental waxes covered by this document are classified according to the flow characteristics that represent their hardness, as follows:

a) Type 1 (casting wax, for lost-wax technique):
   1) Class 1: Soft;
   2) Class 2: Hard;
   3) Class 3: Milling.

b) Type 2 (baseplate wax):
   1) Class 1: Soft;
   2) Class 2: Hard;
   3) Class 3: Extra hard.

5 Requirements

5.1 Appearance

The wax shall be uniform in colour, supplied in pieces of uniform size, of smooth texture and free of foreign materials. Test in accordance with 8.1.

5.2 Flow

The wax when tested in accordance with 8.2 shall have flow values conforming with the appropriate requirements in Table 1.

Table 1 — Flow requirements percentages

Temperature °C	Type 1					Type 2					
	Class 1		Class 2		Class 3	Class 1		Class 2		Class 3	
	min.	max.	min.	max.	max.	min.	max.	min.	max.	min.	max.
23,0 ± 0,2	—	—	—	—	—	—	1,0	—	0,6	—	0,2
30,0 ± 0,2	—	1,0	—	—	—	—	—	—	—	—	—
37,0 ± 0,1	—	—	—	1,0	1,0	5,0	90,0	—	10,0	—	1,2
40,0 ± 0,1	50,0	—	—	20,0	20,0	—	—	—	—	—	—
45,0 ± 0,1	70,0	90,0	70,0	90,0	—	—	—	50,0	90,0	5,0	50,0
— not required											

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5.3 Behaviour on trimming

The wax shall be capable of being trimmed without chipping, flaking or other undesirable behaviour when tested in accordance with 8.3.

5.4 Behaviour on softening — Type 1

The wax shall soften without flaking or crumbling and shall cohere readily when tested in accordance with 8.4.

5.5 Appearance after flaming

The wax shall present a smooth glossy surface when tested in accordance with 8.5.

5.6 Behaviour on softening — Type 2

The wax shall soften without becoming sticky or crumbly and shall be mouldable without breaking or delaminating when tested in accordance with 8.6.

This requirement shall not apply to baseplate preforms where a suitable square test piece cannot be cut.

5.7 Residue on artificial teeth — Type 2

The wax shall not leave a visible residue on either ceramic or synthetic polymer teeth when tested in accordance with 8.7.

5.8 Behaviour of colouring material — Type 2

The colouring material shall neither separate from the wax nor impregnate the gypsum mould when tested in accordance with 8.7.

5.9 Adhesion on storage — Type 2

Adhesion due to storage of the wax shall be such that, when tested in accordance with 8.8, there shall be no evidence of damage to wax surfaces. Wax and separating paper surfaces shall separate cleanly and readily.

NOTE The separating paper can possibly not cover the whole area of the wax sheet.

5.10 Residue on ignition — Type 1

If the manufacturer does not state a value for the residue on ignition, the value as determined in accordance with 8.9 shall be no greater than 0,10 % by mass.

If the residue on ignition is greater than 0,10 % by mass, this value shall be stated by the manufacturer and the value as determined in accordance with 8.9 shall be not more than 20 % greater than that stated value.

5.11 Biocompatibility

See ISO 7405 and ISO 10993-1 for guidance on compatibility in respect of waxes that are offered for use in the mouth or that are not specifically excluded from that application.

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6 Sampling

The amount of material procured for testing shall be at least 250 g for Type 1 or 500 g for Type 2 from one batch and one packet where possible. This material shall be obtained on the open market unannounced and thus taken randomly from stock.

7 Test methods — General

7.1 Ambient temperature

Unless otherwise specified in this document, all test piece preparation and testing shall be conducted at an ambient temperature of (23 ± 2) °C. Where necessary and appropriate, all material shall be allowed to equilibrate at this ambient temperature before testing for at least 24 h.

7.2 Apparatus function verification

All accessories, instruments and equipment shall be examined before use to ensure that they are in acceptable working order, appropriately calibrated, and complying with specifications stated for them in this document, as appropriate.

8 Test methods — Specific

8.1 Visual inspection

Carry out the inspection at an illuminance of at least 1 000 lux and at a distance not exceeding 250 mm. A person making the inspection shall have nominally normal visual acuity. Corrective (non-magnifying) untinted lenses may be worn.

8.2 Flow

8.2.1 Principle

The relative change in length of the test piece under a given load in a specified time is taken as a proxy for the inverse of viscosity.

8.2.2 Apparatus

8.2.2.1 Micrometer screw gauge

Micrometer screw gauge with a range of at least 10 mm, being readable and accurate to 0,005 mm or better, equipped with flat, parallel anvils at least 6,5 mm in diameter and a non-rotating spindle.

Avoidance of indentation of the wax test piece is essential.

8.2.2.2 Flow-testing instrument

Flow-testing instrument, such as shown in Figure 1, consisting of the following components:

— weight (see Figure 1, Key 1);

— shaft, which can move freely in its supports, lubricated as necessary (see Figure 1, Key 2);

— upper platen, metallic, minimum diameter 50 mm, lower surface flat and smooth, rigidly attached and normal to the axis of the shaft (see Figure 1, Key 3);

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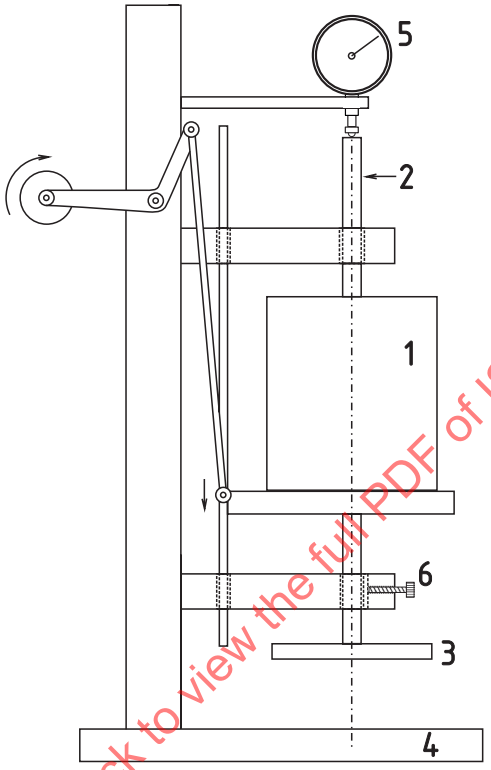
— base plate, metallic, flat smooth and parallel to the lower surface of the upper platen (see Figure 1, Key 4);

— measuring dial gauge or similarly functional instrument, with a range of at least 10 mm, readable and accurate to 0,005 mm or better, and rigidly supported (optional) (see Figure 1, Key 5);

— locking screw or equivalent device (required if the dial gauge is used) (see Figure 1, Key 6).



Key

1 weight
2 shaft
3 upper platen
4 base plate
5 dial gauge (optional)
6 locking screw

NOTE This figure is not to scale.

Figure 1 — Conceptual diagram of a suitable flow-testing instrument

The total mass of the components of items 1, 2 and 3 shall be such as to provide an axial compressive force of (19,6 ± 0,1) N. The weight (Figure 1, Key 1) shall be separated from the surface of the water in the bath by at least 20 mm. The upper platen (Figure 1, Key 3) shall be at least 5 mm thick for rigidity. The optional dial gauge (Figure 1, Key 5) and locking screw (Figure 1, Key 6) can replace the micrometer screw gauge for direct measurement of displacement (see 8.2.3).

The axial force calculation shall take into account the buoyancy of the immersed parts of the shaft and upper platen (using the value of 0,01 N/ml) and the force exerted by the dial gauge or other measuring device (Figure 1, Key 5), which force may be about 1 N and vary with its displacement if (as is usual) a spring is present. Appropriate control of the water level in the water bath (8.2.2.9) is required.

The locking screw or equivalent device shall not cause damage to the shaft (Figure 1, Key 2) and thereby impede its free movement.

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The base plate (Figure 1, Key 4) can conveniently be marked with a crosshair target, ⌖, avoiding affecting the surface of the central region, to enable the correct location of the test piece.

8.2.2.3 Pouring pan

For melting the wax, use a metal, glass or ceramic vessel, which may have a handle for convenience, similar in functionality to the example shown in Figure 2.

NOTE A volume of 10 ml to 20 ml can be adequate.

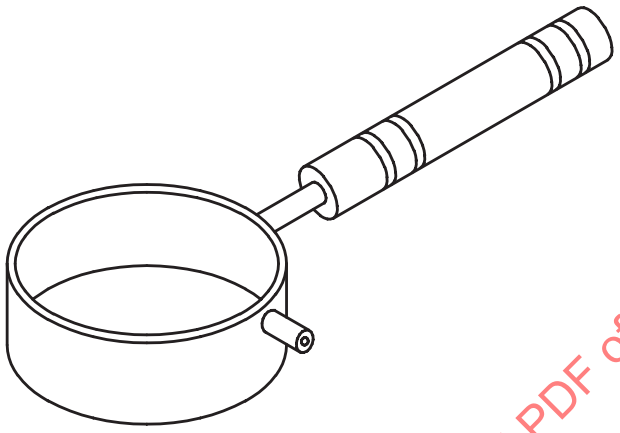

Figure 2 — Example of a suitable pouring pan

8.2.2.4 Heat source

For melting the wax, any convenient low-power or low-temperature system can be used. For example,

— an infrared lamp with nominal power of (250 ± 50) W using a bulb of type R40 or similar;

— a hotplate giving good thermal contact with the base of the pouring pan (8.2.2.3);

— a hot-air oven allowing the wax to be observed.

For preheating the mould (8.2.2.6), slab (8.2.2.7) and glass plate (8.2.2.8), an oven shall be used.

8.2.2.5 Thermometer

To measure the temperature of the molten wax, use an electronic thermometer with an accuracy of ±0,2 °C and a reading resolution of ±0,1 K or better over the temperature range 20 °C to 100 °C, and having a 95 % 10 K step change response time of less than 1 min.

8.2.2.6 Mould

For forming the flow test pieces, a metallic mould shall be used, for example made from stainless steel or brass. This shall consist of a flat plate, (6,00 ± 0,01) mm thick, with parallel top and bottom surfaces. The plate shall have one or more holes (10,00 ± 0,01) mm in diameter, with the axis of each hole perpendicular to the surface of the plate. The upper and lower faces of the plate shall be finished to roughness R_a ≤ 6,3 µm, and the hole wall shall be finished to roughness R_a ≤ 0,3 µm, according to ISO 21920-2.

NOTE It can be convenient to use a multiple mould such that several test pieces can be prepared at a time, for example as shown in Figure 3.

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Dimensions in millimetres

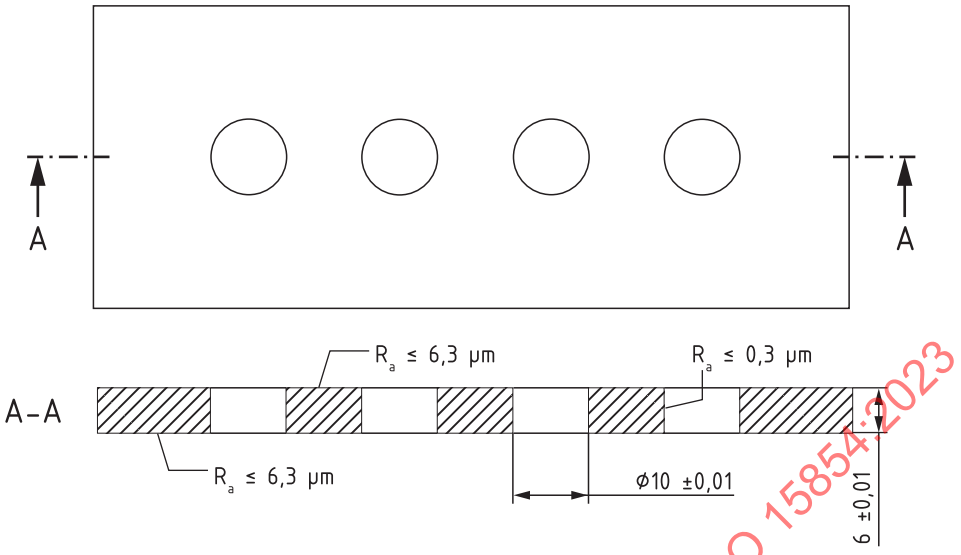

Figure 3 — Example of a suitable mould for preparing flow test pieces

8.2.2.7 Glass slab

As a base for the mould, use a flat, polished glass slab, large enough for the purpose (i.e. larger than the extent of the mould plate).

NOTE A dental mixing slab, approximately 150 mm long, 75 mm wide and 19 mm thick, is convenient.

8.2.2.8 Glass plate

For covering the mould (8.2.2.6), use a flat, polished glass plate, large enough for the purpose and covered with thin, flat aluminium foil. The assembly shall be weighed.

8.2.2.9 Water bath

Use a rigid, stable water bath of sufficiently large volume, equipped with a temperature control device and a stirring device that together ensure sufficient accuracy, stability and homogeneity of temperature, according to the tolerances shown in Table 1, over the test volume.

8.2.2.10 Anti-vibration table

If vibration is discernible, or there is an appreciable risk of flow results being affected by vibration, then an anti-vibration table, for example of the kind used to carry and isolate analytical balances, shall be used to carry the water bath (8.2.2.9).

NOTE Vibration, such as from traffic and footfall, and in particular the vertical component thereof ('hammering'), can cause flow values to be significantly increased, whether or not ordinarily apparent.

The water bath stirring device can, if attached to the water bath itself, be a source of significant vibration; it is preferable to suspend this component separately to avoid that vibration.

8.2.2.11 Silicone grease

Food-grade poly(dimethylsiloxane)-based, petroleum product-free grease of service temperature range at least −50 °C to 150 °C, of low to medium viscosity.

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8.2.2.12 Polyethylene film

Flat, smooth, crease and wrinkle-free, in approximately square sheets no less than 50 mm on a side.

8.2.2.13 Timing devices

Clocks or timers to permit intervals from 60 s to 25 h to be noted, accurate and reading to 1 s.

8.2.2.14 Deadweight

For loading the glass plate (8.2.2.8), according to the number of test pieces involved, such that the total load per test piece is (23 ± 1) N.

8.2.2.15 CAD/CAM machine

For Type 1 Class 3, any milling machine capable of producing the test pieces can be used. The machine setup, production and post-processing steps and conditions shall follow the requirements of the 'Instructions for Use' documentation of both the machine and the material manufacturers.

8.2.3 Preparation of test pieces

8.2.3.1 Type 1 Classes 1 and 2, Type 2

Lubricate the mould (8.2.2.6) internally with a very thin film of silicone grease as release agent and place it on a smooth glass slab (8.2.2.7). Preheat both to a temperature (10 ± 5) K above the melting point of the wax, which temperature shall be maintained until the liquid wax is ready to be poured.

NOTE 1 The melting point of the wax, if not known from the manufacturer's or supplier's information, can be determined by a procedure such as that indicated in Annex A.

Place a sufficient quantity of wax, breaking into pieces as necessary, in the pan.

NOTE 2 For guidance, the mould volume is about 0,5 ml per test piece.

If an infrared lamp is used for heating, place the pan on a thermally-insulating surface which is approximately 130 mm below the infrared lamp (i.e. such that the wax is irradiated from above), thereby heating the wax. Stir the wax constantly until it is completely melted and its temperature reaches (10 ± 5) K above the melting point of the wax.

If a hotplate is used for heating, place the pan on the hotplate, thereby heating the pan and thus the wax. Stir the wax constantly until it is completely melted and its temperature reaches (10 ± 5) K above the melting point of the wax.

If an oven is used for heating, place the pan in the oven, thereby heating the pan and the wax. Stir the wax from time to time until it is completely melted and its temperature reaches (10 ± 5) K above the melting point of the wax.

Once the wax has reached the required temperature, remove the mould (8.2.2.6) and glass slab (8.2.2.7) from the oven and pour the liquid, without splashing, into the mould. As the wax solidifies and shrinkage occurs, add more liquid wax, avoiding the trapping of any bubble of air in any 'pipe' that is forming. The mould shall be slightly overfilled to allow for cooling shrinkage and subsequent compression.

The loss of volatile components when the wax is molten can lead to changes in properties. It is recommended to minimize the time when molten, and preferably to less than 5 min.

When the wax has lost its surface gloss, place a smooth, flat aluminium foil-covered glass plate (8.2.2.8), preheated to (10 ± 5) K above the melting point of the wax and lubricated as above, on top of the mould (foil side in contact with the wax). Add the deadweight (8.2.2.14) to the top of the foil-covered glass plate such as to apply a force of (23 ± 1) N per test piece, and such as to load the test pieces uniformly, for (30 ± 1) min. Remove the deadweight and the glass plate, carefully peel off the aluminium foil, and

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remove excess wax progressively by drawing a straight-edged non-damaging (e.g. plastic) scraper, using a negative rake angle, across the mould, repeating as necessary to ensure that each test piece's top face is smooth, parallel and flush with the mould's top face.

Cool the mould containing the test piece(s), still resting on the glass slab (8.2.2.7), in water at (23 ± 2) °C (see 7.1) and then remove the mould from the glass slab. Check that the lower surface of each test piece is flat, smooth and flush with the mould's lower surface. Carefully remove each test piece from the mould. Check that the cylindrical surface is uniformly smooth and flaw-free. If either check shows any unsatisfactory test piece, replace such test pieces using fresh wax. If the checks are passed, store the test piece(s) at ambient temperature (see 7.1) for (24 ± 1) h before testing.

Test pieces that fail the check or that exceed 25 h after preparation shall be discarded; the wax shall not be re-used. Any excess wax from test piece preparation shall not be re-used.

NOTE 3 While the above preparation method is generally satisfactory, in the event that the liquid wax does not wet the wall of the mould, raising by a few degrees the melt temperature, or the mould preheat temperature, or both, within the stated tolerance of (10 ± 5) K above the melting point of the wax, can be beneficial in the case of some products.

8.2.3.2 Type 1 Class 3

Using any recommended or equivalent milling machine (8.2.2.15), prepare flow test pieces (6,00 ± 0,02) mm high, (10,00 ± 0,02) mm in diameter, with parallel top and bottom surfaces normal to the cylinder axis. The end faces and the cylinder wall shall be finished to roughness $R_a \leq 6{,}3$ µm, according to ISO 21920-2. The roughness can be determined by any suitable non-contact method, to avoid damage to the surface.

Milling wax not intended to be melted may show thermal history effects that compromise flow values. Where the wax is explicitly available for use by melting, for the purposes of this subclause, it shall be treated as Type 1 Class 2 and the flow test pieces shall be prepared as in 8.2.3.1.

NOTE The final attachment of a milled test piece to the source block can be dealt with in any appropriate and usual fashion but such that the design dimensions and surface quality are attained where that attachment is severed.

Check the dimensions of the test piece using the micrometer screw gauge (8.2.2.1), taking especial care in measuring the diameter that no damage is done. Check that the upper and lower surfaces of each test piece are flat, smooth and flaw-free, and that the cylindrical surface is uniformly smooth and flaw-free. If either check shows any unsatisfactory test piece, replace such test pieces using fresh wax. If the checks are passed, store the test piece(s) at ambient temperature (see 7.1) for (24 ± 1) h before testing.

Test pieces that fail the checks or that exceed 25 h after preparation shall be discarded.

Excess material or rejected test pieces for Type 1 Class 3, milling wax products that are not explicitly stated as capable of reuse by recasting shall be discarded and not reused. Milling waste shall not be reused.

8.2.4 Procedure

Place one test piece, cylinder axis vertical, between two sheets of polyethylene film (8.2.2.12), on the base plate under the upper platen of the flow-testing instrument, in air, at ambient temperature (7.1), ensuring that the test-piece axis is closely aligned with that of the shaft (by reference to the crosshair mark, if present; see 8.2.2.2). Carefully apply an axial compressive force of (19,6 ± 0,1) N to the test piece at ambient temperature for (60 ± 2) s, and then remove the test piece for measurement. Using the micrometer screw gauge, determine the length of the test piece (i.e. without the polyethylene films). Record this as the initial length (L_0), to the nearest 0,005 mm. Care shall be taken to avoid marking the end surfaces of the test piece or warming the test piece in the hands.

Stand the flow-testing instrument in the water bath such that the base plate upper surface is at least 70 mm below the water surface and allow it to equilibrate at the test temperature.

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Immerse the test piece in the water bath by using any suitable means to keep it immersed, in free-flowing water, and undamaged (e.g. inverted wire mesh basket) and allow it to equilibrate at the test temperature for (20 ± 1) min.

Keeping it immersed, replace the test piece, cylinder axis vertical, between two sheets of polyethylene film (8.2.2.12), centred under the upper platen of the flow-testing instrument (by reference to the crosshair mark, if present; see 8.2.2.2). Gently apply the axial force of (19,6 ± 0,1) N to the test piece for (10,0 ± 0,1) min. Then, raise the load and remove the test piece from the water bath and cool it in water at ambient temperature (see 7.1) for (30 ± 1) min. Carefully strip off the polyethylene films and note whether the end surface(s) are damaged. Using the micrometer screw gauge, determine the final length (L_1).

NOTE Given the caveat in 8.2.2.1 regarding buoyancy, a supplementary weight can be required to be added for the force specified to be obtained on immersion of the test equipment. This also applies to the alternative method, given below.

Alternatively, if the flow-testing instrument is equipped with a dial gauge and locking device, at ambient temperature in air record a fiducial reading on the dial gauge for just two sheets of polyethylene film in place (i.e. in air). Raise and lock the load system. Place the test piece on the base plate under the platen between the polyethylene films. Carefully release the locking device and gently apply the axial force to the test piece at ambient temperature for (60 ± 2) s. Apply the lock and record the dial gauge datum for the initial length (D_0). Remove the test piece from the flow-testing instrument, retaining the two sheets of polyethylene film.

Stand the flow-testing instrument in the water bath such that the base plate upper surface is at least 70 mm below the water surface and allow it to equilibrate at the test temperature.

Immerse the test piece in the water bath by using any suitable means to keep it immersed, in free-flowing water, and undamaged (e.g. inverted wire mesh basket) and allow it to equilibrate at the test temperature for (20 ± 1) min.

Keeping it immersed, replace the test piece, cylinder axis vertical, between the two sheets of polyethylene film (8.2.2.12), centred under the upper platen of the flow-testing instrument (by reference to the crosshair marks, if present; see Note 3 to 8.2.2.2) and allow the axial force to be applied to the test piece for (10 ± 1) min. Apply the lock again, then remove the flow-testing instrument from the water bath. Cool the entire system in water to ambient temperature (see 7.1) for (30 ± 1) min. Carefully release the locking device to reapply the load for (30 ± 1) s, then relock. Record the dial gauge reading (D_1).

Two such tests shall be performed at each of the temperatures specified in Table 1.

The wax of test pieces shall not be re-used.

8.2.5 Expression of results and evaluation

Report the flow (F), as determined by the change in test piece length, as a percentage of the initial length, using the formula

$$F = 100(L_1 - L_0)/L_1$$

or, alternatively,

$$F = 100(D_1 - D_0)/L$$

according to the method used, and rounded to one decimal place.

If both results meet the appropriate requirement listed in Table 1, the product complies with this requirement. If one result meets the requirement and one fails, two additional test pieces shall be tested. If both additional results meet the requirement, the product complies with this requirement. In any other case, it fails to comply.

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8.3 Behaviour on trimming test

8.3.1 Principle

The principle behind the behaviour on trimming test is to ascertain whether undesirable behaviour (e.g. chipping, flaking) occurs during a simulation of an aspect of normal handling appropriate to the wax type, by visual inspection (see 8.1).

8.3.2 Apparatus

Wax knife of the pattern described as 'Fahen'.

8.3.3 Procedure

8.3.3.1 Type 1

Apply the blade of the wax knife, with a rake angle of (60 ± 15)° to the edge of a stick, sheet or block of the wax to carve off a section slowly and gently over at least 5 mm such as to leave a sharp margin of included angle (30 ± 15)°, using several passes as necessary. Inspect visually (see 8.1) the prepared edge for any signs of chipping, flaking, tearing or other undesirable behaviour.

The depth of cut and force required varies according to the hardness of the wax. The usual judgement of these should be used.

8.3.3.2 Type 2

Lay a strip of the wax, 10 mm wide, at least 20 mm long, on a flat glass surface. Apply the blade of the knife vertically across the width to cut the strip in two. Inspect visually the resulting cut edges for any signs of chipping, flaking, delamination, or other undesirable behaviour.

8.4 Behaviour on softening test — Type 1

8.4.1 Principle

The principle behind the behaviour on softening test is to ascertain whether undesirable behaviour (e.g. crumbling, flaking, failure to cohere) occurs during a simulation of an aspect of normal handling, by visual inspection (see 8.1).

8.4.2 Apparatus

8.4.2.1 Glass plate, of any convenient size, say, >50 mm long and 50 mm wide.

8.4.2.2 Wax knife of the pattern described as 'Fahen'.

8.4.3 Procedure

Using normal dental laboratory procedures, heat the wax knife and, with it, melt a small amount of wax and place it onto the glass plate. Visually observe (see 8.1) the state of the solid wax during this process for any signs of crumbling, flaking, or other undesirable behaviour.

Repeat the procedure with three further amounts of wax, adding each one immediately to the mass of wax on the glass plate. Allow to cool to ambient temperature and assess visually (see 8.1) whether the wax has developed into a cohesive mass without signs of separation, delamination, or other undesirable behaviour.

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8.5 Appearance after flaming test

8.5.1 Principle

The principle behind the appearance after flaming test is to ascertain whether undesirable behaviour (e.g. bubbling, segregation) occurs during a simulation of an aspect of normal handling, by visual inspection (see 8.1).

8.5.2 Procedure

8.5.2.1 Type 1

Use any convenient portion of wax as supplied, having one surface flat or otherwise, with an area of at least 1 cm^2. Using a normal dental laboratory procedure with a micro-burner or equivalent flame device, pass the flame over the surface quickly, repeating as necessary, until it has been superficially just melted. Allow to cool and inspect visually (see 8.1) the previously melted wax surface for smoothness and gloss.

8.5.2.2 Type 2

Cut a square from a sheet of wax of side equal to the supplied width and pass approximately half its area quickly over the lambent flame of a Bunsen burner or equivalent flame device, repeating until the surface has been superficially melted. Allow to cool and inspect visually (see 8.1) the previously melted wax surface for smoothness and gloss.

8.6 Behaviour on softening test — Type 2

8.6.1 Principle

The principle behind the behaviour on softening test (Type 2) is to ascertain whether undesirable behaviour (e.g. failure to cohere, delamination, inappropriate stickiness) occurs during a simulation of an aspect of normal handling, by visual inspection (see 8.1).

8.6.2 Apparatus

Mandrel: Use a smooth, polished circular cylinder of low thermal conductivity material, such as acrylic, of diameter (30 ± 1) mm and any convenient length (e.g. >75 mm).

8.6.3 Procedure

Take the test piece obtained in 8.5.2 and soften it evenly over the gas flame to the condition judged to be appropriate for forming a denture baseplate pattern. Manually, roll it into a tight cylinder and then promptly form it around the mandrel (8.6.2.1) into a U-shape (that is, with the arms approximately parallel, if the length permits). Visually check (see 8.1) for breakage, delamination, or other undesirable behaviour, and any wax sticking to the fingers during the test.

8.7 Residue on artificial teeth and behaviour of wax colouring material test — Type 2

8.7.1 Principle

The principle behind the residue on artificial teeth and behaviour of wax colouring material test (Type 2) is to ascertain whether any coloured component of the wax reacts with or adheres to denture teeth during a simulation of an aspect of normal processing, by visual inspection (see 8.1).

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8.7.2 Apparatus

8.7.2.1 Metal former

Use a metal former, similar in principle to that illustrated in Figure 4 a), and which incorporates a trough (6 ± 1) mm wide and (2,0 ± 0,5) mm deep for use in mounting artificial teeth.

NOTE It can be found convenient to taper the back and sides of the former to enable easier removal from the gypsum (see 8.7.2). Likewise, a separating agent can be applied to the major metal surfaces, but carefully avoiding contact with the wax and teeth, if convenient.

8.7.2.2 Processing equipment

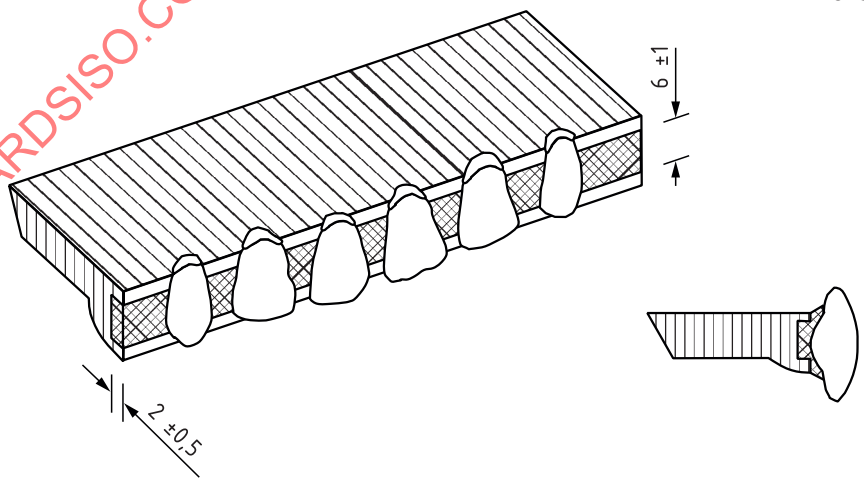
Use normal dental laboratory apparatus for denture flasking and processing.

8.7.3 Procedure

Place a strip of the test wax in the trough of the metal former (see 8.7.2.1), pressing it into place, softening by gentle heating as necessary, in order to fill it, levelling the surface flush with the trough walls, as necessary. Mount three anterior synthetic polymer teeth and three anterior ceramic teeth that conform to ISO 22112 in the wax, as shown in Figure 4 a), by pressing firmly into place until in contact with the metal of the former above and below. If the teeth are supplied mounted on a carrier secured by wax, the teeth shall be cleaned of all traces of wax using boiling water, detergent or steam as appropriate. If there is any residual colour on the teeth (see 8.1), those teeth shall be discarded and replacements that meet the condition used.

Using ordinary dental laboratory techniques as used for acrylic denture bases, invest the metal former with the mounted teeth in a denture flask using dental plaster or stone, or both, which conform to ISO 6873 [see Figure 4 b)], and using a release agent if appropriate. Let the flask remain undisturbed for (2,5 ± 0,5) h after pouring the plaster or stone in contact with the wax and teeth. Then immerse the flask in a water bath at (50 ± 2) °C for (10,0 ± 0,5) min, then remove it from the water and open it immediately. Remove the metal former and the bulk of the wax, then flush the flask with a continuous stream of boiling water for (60 ± 5) s. Examine visually (see 5.7 and 8.1) all tooth and gypsum surfaces that were in contact with the wax.

Dimensions in millimetres



a) Example of a suitable metal former with teeth attached

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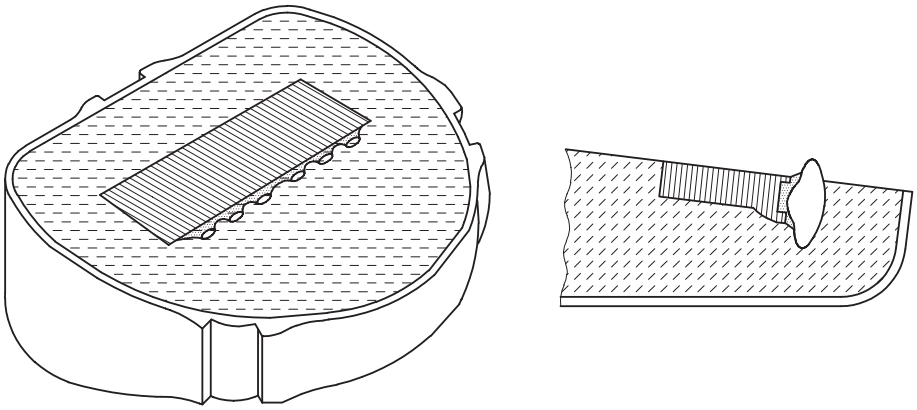

b) Lower portion of denture flask containing invested metal former with teeth attached

Figure 4 — Illustrative example of suitable apparatus for the test for residue on artificial teeth and behaviour of wax colouring material

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8.8 Adhesion on storage test — Type 2

8.8.1 Principle

The principle behind the adhesion on storage test (Type 2) is to ascertain whether undesirable behaviour (adhesion of wax to separating paper, as supplied) occurs during an accelerated simulation of long-term storage, by visual inspection (see 8.1).

8.8.2 Apparatus

8.8.2.1 Platens, two, (50 ± 1) mm wide, (60 ± 1) mm long and at least 5 mm thick of any convenient rigid thermally-conductive material (e.g. brass or stainless steel).

8.8.2.2 Oven, capable of maintaining a temperature of (30 ± 1) °C (for Class 1) or (40 ± 1) °C (for Class 2 or 3), as necessary.

8.8.2.3 Deadweight, of mass such as to bring the total force exerted on the wax by it and the upper platen to (15,0 ± 0,1) N.

8.8.3 Procedure

Take a set of three neighbouring wax sheets from the contents of a package as a unit, leaving the separating paper in place, including a sheet on both top and bottom. Cut this stack, if necessary, without separating it, to a size of 50 mm × 75 mm and place it between the two platens (8.8.2.1) in such a manner that 15 mm of the stack projects from one end of the platens (which are themselves aligned vertically). Then place this test assembly horizontally on a flat rigid surface in the oven (8.8.2.2) maintained at a temperature of (30 ± 1) °C for Class 1 wax or (40 ± 1) °C for Class 2 and Class 3 waxes. Place the deadweight (8.8.2.3) centrally on the upper platen. After (24,00 ± 0,25) h remove the assembly from the oven and allow to cool in air to ambient temperature (see 7.1) with the deadweight in place for (120 ± 5) min. Remove the deadweight and upper platen, and separate the assembly by opening from the projecting ends, peeling off each wax sheet and separating paper in turn, and examine visually (see 5.9 and 8.1) the wax and separating paper surfaces in contact with each other for any evidence of adhesion or damage, ignoring the margin immediately adjacent to any cut edge.

NOTE If the wax is supplied in preformed shapes that do not permit the above sizes and loads, an equivalent test at the same stress, i.e. (5,00 ± 0,02) kPa, can be performed.

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8.9 Residue on ignition test— Type 1

8.9.1 Principle

The principle behind the residue on ignition test (Type 1) is to ascertain whether an excessive amount of non-volatile, non-oxidizable material is present in the wax, by weighing.

8.9.2 Apparatus

8.9.2.1 Crucible, glazed ceramic or platinum, volume at least 50 ml, with lid.

8.9.2.2 Balance, capable of weighing approximately 50 g, or the mass of the crucible and lid (8.9.2.1) plus 15 g, whichever is the greater, reading and accurate to ±0,000 1 g.

8.9.2.3 Furnace, capable of maintaining a temperature of (700 ± 20) °C.

Flammable vapours are produced during the heating of the wax. All appropriate measures shall be taken to avoid explosion and fire. Adequate ventilation is essential, for example, by using an extraction hood.

8.9.2.4 Desiccator, with a heat-proof ceramic plate and containing dried silica gel as desiccant.

8.9.3 Procedure

Condition the crucible and lid to a constant mass (±0,000 1 g) by sufficient repeated heating to (700 ± 20) °C and cooling to ambient temperature in the desiccator (8.9.2.4).

For all such weighings, the crucible and lid have to be at ambient temperature to avoid weighing errors due to air convection, to which errors the weighing is very sensitive. Such convection can be indicated by apparent weight instability but this is not guaranteed.

Two successive weighings within tolerance shall be considered satisfactory.

Allowing the crucible and lid to cool to, say, 150 °C to 200 °C before placing in the desiccator can be found convenient.

Tare the conditioned crucible and lid and add to the crucible no less than 10 g of wax, and weigh to an accuracy of 0,000 1 g. Place the crucible with the lid in place into the cold furnace (temperature less than 100 °C) and increase the temperature to (700 ± 20) °C at a rate not exceeding 20 K/min. Once that temperature is reached, remove the lid and place it alongside the crucible. Reclose the furnace and maintain that temperature for (60 ± 2) min. Immediately thereafter, replace the lid, then remove the crucible and place it in the desiccator. Allow to cool to ambient temperature (see 7.1) for at least 30 min and reweigh.

The use of the lid can be essential to avoid loss due to splatter on boiling the wax during the initial heating.

NOTE 1 The reducing conditions arising from carbonization of wax components can cause reduction of the residue, but if that carbon is not burnt off, the residue will be excessive. Taking the lid off during the hold at high temperature avoids both problems.

NOTE 2 For Type 1 Class 3, if the manufacturer states that the production burnout conditions for the product differ from those ordinarily used [see 9.1 g)] the conditions of peak temperature and duration required for this test can be required to be adjusted upwards to suit.

Allowing the crucible to cool to, say, 150 °C to 200 °C before placing in the desiccator is recommended.

Carry out two determinations using separate pieces as supplied.

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If preforms are being tested, each determination shall be from separate sprues where this is the mode of presentation.

Express the residue on ignition as a percentage of the original mass of the sample. If both results meet the requirement according to 5.10, the product complies. If both do not meet the requirement, the product fails. If one result only meets the requirement, repeat the test a further three times. To comply, all three additional results shall meet the requirement.

9 Marking and packaging

9.1 Marking

Each container shall be marked clearly with at least the following information:

a) trade or brand name of the product, including any article number or other specific identifier;

b) name and address of the manufacturer or authorized representative agent;

c) lot number (batch number);

d) type, class and description of wax according to Clause 4;

e) for Type 1, minimum net mass, or number of pieces for prefabricated patterns; for Type 2, minimum net mass and sheet dimensions, if rectangular;

f) for Type 1, if the manufacturer makes a claim for the value of the residue on ignition (8.9), or if the value is greater than 0,1 % by mass, this shall be stated;

g) for Type 1 Class 3, required burnout conditions (temperature, time) if these are other than ordinarily used for Type 1 Classes 1 and 2.

h) recommended storage conditions.

If production or expiry dates are given, they shall be in accordance with the ISO 8601-1.

9.2 Packaging

The packaging shall not alter the wax and shall protect it against damage and contamination.

Type 2 wax sheets shall be interleaved with separating paper, to prevent self-adhesion.

10 Test report

The test report shall include at least the following items:

a) identification of the tested wax, including lot or batch number (see 9.1);

b) for each test requirement, see 5.1 to 5.10, as appropriate, a statement as to whether the outcome is pass or fail, and if fail the observations or reason(s) for this conclusion;

c) for 5.2, each flow value obtained shall be included, in order;

d) for 5.10, each percentage residue value obtained shall be stated, in order;

e) any circumstances or conditions thought likely to have affected the results or their validity;

f) reference to this document and its year of publication, i.e. ISO 15854:2023;

g) any deviation from any of the test methods specified, whether deliberate or accidental; if deliberate the reason shall be stated.

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