TECHNICAL SPECIFICATION

ISO/TS 14569-1

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Dental materials — Guidance on testing of wear resistance —

Part 1: Wear by tooth brushing

Produits dentaires — Lignes directrices sur les essais de résistance à l'usure —

Partie 1: Usure par brossage

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. 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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed every three years with a view to deciding whether it can be transformed into an International Standard.

Attention is drawn to the possibility that some of the elements of this part of ISO/TS 14569-1 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 14569-1 was prepared by Technical Committee ISO/TC 106, *Dentistry*, Subcommittee SC 2, *Prosthodontic materials.*

ISO/TS 14569 consists of the following parts, under the general title *Dental materials — Guidance on testing of wear resistance*:

— *Part 1: Wear by tooth brushing*

— *Part 2: Wear by two- and/or three-body contact*

Introduction

It is well understood that the wear mechanisms in the mouth are very complex. In addition they may differ from one individual to another. Therefore it appears impossible to reproduce these varying conditions in a single wear test.

As a consequence, many wear tests have been proposed in dental science. Most of them consider mainly one specific aspect of the different mechanisms, and some of them even claim to be able to characterize the wear resistance of dental materials completely. However, mostly these procedures are not really comparable because of the different wear mechanisms considered, and the lack of a generally accepted test method.

Therefore, it makes sense to utilize laboratory tests, investigating the various wear aspects arising under clinical conditions separately. They may determine the wear only for the clinical situation in which the same wear mechanism dominates, but it might be possible to predict the complete clinical wear by a number of different test methods.

In this first part of ISO/TS 14569, wear by tooth brushing is considered. This is one aspect of the wear problem and may only be important for materials exposed to tooth brushing, such as materials used on labial surfaces.

The intention of this part of ISO/TS 4569 is to define conditions for the various existing laboratory tests so that they can deliver comparable results and can be used for at least a screening of different materials.

Dental materials — Guidance on testing of wear resistance —

Part 1:
Wear by tooth brushing

1 Scope

This Technical Specification gives guidelines for test methods for the assessment of resistance to wear by tooth brushing for the following materials: materials used for the preparation of artificial teeth, veneering of crowns and bridges.

This Technical Specification does not cover phenomena such as the marginal degradation and loss of substance by chemical processes, swelling, splintering of edges or wear from contact with the antagonist.

2 Normative references

The following normative documents contain provisions, which, through reference in this text, constitute provisions of this part of ISO/TS 14569. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO/TS 14569 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to apply. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 8627:1987, *Dentistry — Stiffness of the tufted area of toothbrushes.*

ISO 1942-2:1989, *Dental vocabulary — Part 2: Dental materials.*

ISO 3696:1987, *Water for analytical laboratory use.*

ISO 11609:1995, *Dentistry — Toothpastes — Requirements, test methods and marking.*

ISO 1183:1987, *Plastics — Methods for determining the density and relative density of non-cellular plastics.*

3 Terms and definitions

For the purposes of this Technical Specification, the terms and definitions given in ISO 1942-2 and the following apply.

3.1 wear
loss of substance by the action of the toothbrush in combination with toothpaste

NOTE Such wear is a type of three-body wear.

4 Test method

4.1 General test conditions

The specimens shall be tested at (23 ± 2) °C.

4.2 Apparatus and materials

4.2.1 Test machine, with at least two equivalent stations for specimens. The test machine shall provide for meeting the following requirements.

a) The load that presses the brush against the specimen shall be between 0,5 N and 2,5 N.

b) The temperature of the toothpaste slurry shall be kept at (23 ± 3) °C.

4.2.2 Analytical balance, with an accuracy of ± 0,1 mg.

4.2.3 Ultrasonic water bath, containing deionized water (4.2.5) and 1 % of a detergent such as sodium lauryl sulfate.

4.2.4 Toothbrushes, in accordance with ISO 8627, with a stiffness of 9 cN/mm^2 to 10 cN/mm^2 index 7.

4.2.5 Deionized water, of grade 3 in accordance with ISO 3696.

4.2.6 Toothpaste, in accordance with ISO 11609:1995, main text or A.3.6.

Prepare an abrasive slurry from a mixture of toothpaste and deionized water (4.2.5) in the ratio of 2 g of water to 1 g of toothpaste.

4.2.7 Five reference specimens, made from a linear uncrosslinked and unplasticized poly(methyl methacrylate) (PMMA) reference material with a molecular weight over 1 000 000.

4.3 Preparation of test specimens

Prepare specimens of the dental material under test in accordance with the manufacturer's instructions. Use a mould designed according to the requirements of the test machine. Prepare at least six specimens. Prepare reference specimens of PMMA (4.2.7) in the same manner.

The dimensions of the reference specimens shall not differ by more than 0,2 mm from the corresponding dimensions of the test specimens.

The surfaces of the specimens which are exposed to the tooth brushing shall be flat and wet-ground with grade 1000 silicon carbide paper.

Condition all test specimens and reference specimens (4.2.7) in water at (37 ± 1) °C for 7 days prior to the test.

4.4 Determination of density

After the specimens have been conditioned in water at 37 °C for 7 days, determine the density ρ of the test material and ρ_{ref} of the reference material in accordance with ISO 1183:1987 (Method A) with an accuracy of two decimal places. In this test, the density of the plastic objects is determined by Archimedes' principle.

4.5 Test procedure

Remove the specimens from the water bath and rinse them with tap water. Clean them afterwards for 1 min in an ultrasonic bath (4.2.3). Remove the specimens individually from the ultrasonic bath and dab them with blotting paper or a drying cloth until free from visible moisture. Then wave each specimen in the air for 15 s and weigh to an accuracy of 0,1 mg 1 min after removal from the water (mass m_1).

Fix the specimens in the wear test machine (4.2.1), cover them with enough abrasive slurry (4.2.6) and wear with the toothbrushes (4.2.4) for a given time, long enough that the change in mass of the reference material specimen is at least 2 mg.

Test at least five specimens of each test material and of the reference material. Each run may contain more than one type of material. If more than one material is to be tested, each run shall contain the test material(s) and the reference material.

After the wear test, remove all specimens from the machine and subject them to the same cleaning and drying as above. Again weigh the specimens 1 min after removal from the water to an accuracy of 0,1 mg (mass m_2).

5 Calculation and expression of results

5.1 Calculate the loss in mass (worn mass) for each test specimen (Δm) and the reference specimen (Δm_{ref}), in milligrams, to the nearest 0,1 mg, from the equations:

$$\Delta m = m_1 - m_2$$

$$\Delta m_{ref} = m_{1ref} - m_{2ref}$$

where

m_{1ref} is the mass of the reference material specimen before the test;

m_{2ref} is the mass of the reference material specimen after the test.

5.2 Calculate the loss in volume (worn volume) from each test specimen (ΔV) and reference specimen (ΔV_{ref}) from the equations:

$$\Delta V = \frac{\Delta m}{\rho}; \qquad \Delta V_{ref} = \frac{\Delta m_{ref}}{\rho_{ref}}$$

where

ρ is the density of the test material (4.4);

ρ_{ref} is the density of the reference material (4.4).

5.3 Calculate the relative worn volume (V_{relw}) from the following equation, using the mean values for ΔV and ΔV_{ref} for each individual run.

$$V_{relw}\ (\%) = \frac{\overline{\Delta V} \times 100}{\overline{\Delta V}_{ref}}$$

If there are large differences in the Δm values from one test run to the next, the V_{relw} values shall be calculated for each individual run.

6 Test report

The test report shall contain at least the following information:

a) reference to this Technical Specification ISO/TS 14569-1;

b) the reference material (e.g. Plexiglas, Perspex or Acrylite) and any specification to characterize the material if available;

c) the mean value of the worn volume ΔV and number of samples of the test material;

d) the mean value of the worn volume ΔV_{ref} and number of samples of the reference material;

e) the mean value and the range of values of the relative worn volume V_{relw};

f) the density ρ of the test material;

g) the density ρ_{ref} of the reference material;

h) the toothpaste used in the test;

i) the toothbrush used in the test and how often it was changed during the test;

j) any change made in the test procedure as described in clause 4;

k) the date of test;

l) responsible person and signature.