TECHNICAL REPORT

ISO/TR 14569-1

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Dental materials — Guidance on testing of wear —

Part 1: Wear by toothbrushing

Produits dentaires — Recommandations relatives aux essais de résistance à l'usure —

Partie 1: Usure par brossage des dents

Reference number
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Foreword

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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 exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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.

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

This first edition cancels and replaces ISO/TS 14569-1:1999, which has been technically revised.

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

— *Part 1: Wear by toothbrushing*

— *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, these procedures are not really comparable because of the different wear mechanisms considered, and the lack of a generally accepted test method.

It therefore makes sense to utilize laboratory tests, investigating the various wear aspects arising separately under clinical conditions. They may determine 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 part of ISO/TR 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/TR 14569 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 —

Part 1:
Wear by toothbrushing

1 Scope

This part of ISO/TR 14569 provides 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 part of ISO/TR 14569 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 referenced documents are indispensable for the application 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 1183-1:2004, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pyknometer method and titration method*

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

ISO 3696:1987, *Water for analytical laboratory use — Specification and test methods*

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

3 Terms and definitions

For the purposes of this document, 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 should be tested at (23 ± 2) °C.

4.2 Apparatus and materials

4.2.1 Test machine, with at least two equivalent stations for specimens and provision for meeting the following requirements:

a) the load that presses the brush against the specimen is between 0,5 N and 2,5 N;

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

4.2.2 Analytical balance, with an accuracy of $\pm$ 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 reference [1], 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 3696:1987.

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 should 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 should be flat and wet-ground with grade 1 000 silicon carbide paper.

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

4.4 Determination of density

After the specimens have been conditioned in water at 37 °C for 7 d, determine the density, ρ, of the test material and ρ_{ref} of the reference material in accordance with ISO 1183-1:2004 (Method A) to 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 1 min after removal from the water and weigh to an accuracy of 0,1 mg (mass m_1).

Fix the specimens in the wear test machine (4.2.1), cover them with abrasive slurry (4.2.6) and use the toothbrushes (4.2.4) to effect wear 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 reference material. Each run may contain more than one type of material. If more than one material is to be tested, each run should 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, using the equations:

$$\Delta m = m_1 - m_2$$

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

where

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

$m_{2\text{ref}}$ 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}, using the equations:

$$\Delta V = \frac{\Delta m}{\rho}$$

$$\Delta V_{\text{ref}} = \frac{\Delta m_{\text{ref}}}{\rho_{\text{ref}}}$$

where

ρ is the density of the test material;

ρ_{ref} is the density of the reference material.

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.

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

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

6 Test report

The test report should contain at least the following information:

a) reference to this Technical Report i. e., ISO/TR 14569-1:2007;

b) the reference material (e.g. Plexiglas/Perspex/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) the responsible person and signature.