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Dentistry — Laser welding and filler materials

Médecine bucco-dentaire — Soudage par laser et matériaux d'apport

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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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 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 106, *Dentistry*, Subcommittee SC 2, *Prosthodontic materials*.

This second edition cancels and replaces the first edition (ISO 28319:2010), which has been technically revised.

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

a) reference to the corrosion standard ISO 10271:2011, for corrosion test methods and measurements has been added;

b) a corrosion limit for the static corrosion test has been specified;

c) Annex A has been revised in order to describe the laser welding process.

Dentistry — Laser welding and filler materials

1 Scope

This document specifies requirements and test methods for laser welding and the filler materials thereto used in the dental laboratory for welding of metallic restorations and appliances.

For filler materials used in laser welding, this document also specifies the information given in the instructions for use, marking and labelling.

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

ISO 10271:2011, *Dentistry — Corrosion test methods for metallic materials*

ISO 15223-1:2016, *Medical devices — Symbols to be used with medical device labels, labelling and information to be supplied — Part 1: General requirements*

ISO 22674:2016, *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, ISO 22674 and the following apply.

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

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

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

3.1
laser welding
method for joining similar or dissimilar metallic materials, using a laser beam as the heat source, with or without a metallic filler material (welding rod), which produces coalescence by melting abutting zones of metallic material components thereby creating a common fusion zone

3.2
filler material
<laser welding> metallic filling material used for *laser welding* (3.1)

4 Requirements

4.1 Chemical composition

4.1.1 Metallic materials to be joined

The metallic materials to be joined shall conform to ISO 22674:2016, 5.1 and 5.2.

4.1.2 Filler material

4.1.2.1 Chemical composition

For all elements that are present in excess of 1,0 % (mass fraction), the percentage by mass of each of the constituent elements shall be declared by the manufacturer and shall be reported to a precision of 0,1 % (mass fraction).

Any element that is present in a concentration in excess of 0,1 % (mass fraction), but not in excess of 1,0 % (mass fraction), shall be identified either by name or symbol.

4.1.2.2 Permitted deviation from the reported composition

For silver or noble-metal elements in filler materials, the percentage shall not deviate by more than 0,5 % (mass fraction) from the values stated in the instructions for use.

For base-metal elements in filler materials, all elements, present with more than 20 % (mass fraction) shall not deviate from the value stated in the instructions for use by more than 2 % (mass fraction). Those present in excess of 1 % (mass fraction) but not in excess of 20 % (mass fraction) shall not deviate from the value stated in the instructions for use by more than 1 % (mass fraction).

4.1.3 Hazardous elements in filler material

4.1.3.1 Recognized hazardous elements

For the purposes of this document the elements nickel, cadmium, beryllium and lead are designated to be hazardous elements.

4.1.3.2 Permitted limits for hazardous elements

The filler material shall contain no more than 0,02 % (mass fraction) of cadmium or beryllium or lead. If the filler material contains more than 0,1 % (mass fraction) of nickel, the percentage shall not exceed the amount indicated on the package or label or insert.

4.2 Biocompatibility

Specific qualitative and quantitative requirements for freedom from biological hazard are not included in this document, but it is recommended that, in assessing possible biological hazards, reference should be made to ISO 10993-1 and ISO 7405.

4.3 Mechanical strength of laser welded joint (tensile strength)

If the 0,2 % proof strength of both of the metallic materials to be joined by laser welding is more than 350 MPa, the tensile strength of laser-welded specimens shall be at least 350 MPa.

If the 0,2 % proof strength of either one or both of the metallic materials to be joined by laser welding is below 350 MPa, the tensile strength shall exceed the lower 0,2 % proof strength of the two.

Testing shall be carried out in accordance with 7.3.

4.4 Corrosion resistance

4.4.1 Static immersion test

When pieces of a single metallic material are joined, the metal ion release shall not exceed 200 µg cm^{-2} in a time period of 7 d ± 1 h.

The metallic materials to be joined and the laser welded specimens shall conform to ISO 22674:2016, 5.7. Testing shall be carried out in accordance with 7.4.

4.4.2 Appearance after corrosion exposure

Magnified visual comparison prior to and after corrosion testing shall not reveal any visible selective corrosion in the vicinity of the laser weld.

Testing shall be carried out in accordance with 7.4.

4.5 Laser welding process

Specific information about the laser welding process is given in Annex A.

5 Sampling

The metallic filler material and the metallic material each shall be from one lot. It shall be sufficient to prepare the specimens as required in 6.1 and 6.2 including provision for a second set for tensile testing. Further samples and packaging materials shall be made available for inspection in accordance with 9.2.

If the proof strength values of 0,2 % non-proportional extension of the one or two metallic materials to be joined by laser welding are available from a test report according to ISO 22674, these data can be used. If not, perform the tests according to ISO 22674 to determine the required values of proof strength of 0,2 % non-proportional extension.

6 Preparation of specimens

6.1 General

The specimens consist of the metallic materials joined by laser welding either with or without using a filler material according to the instructions for use. For casting alloys to be tested prepare the test specimens by the “lost wax process” of investment casting. Methods other than casting may be recommended by the manufacturer for the metallic material to be tested for suitability for laser welding. Use such a method, if recommended by the manufacturer. Follow the instruction for use relating to the processing of the metallic material(s) and if applicable the filler material including the use of necessary aids and casting and welding equipment.

Specimens with visible defects shall be discarded and replaced. Specimens shall be separated from sprues, casting beads/runners, fins and other projections. Surface contaminations shall be removed.

The specimens shall be in the metallurgical state(s) appropriate to their intended application(s).

If a heat-treatment is recommended by the manufacturer, perform the tests in the heat-treated state in accordance with the instruction for use.

If laser welding is recommended following ceramic firing, the simulated ceramic firing of the specimens shall be in accordance with ISO 22674:2016, 7.2.3, and shall be applied before laser welding.

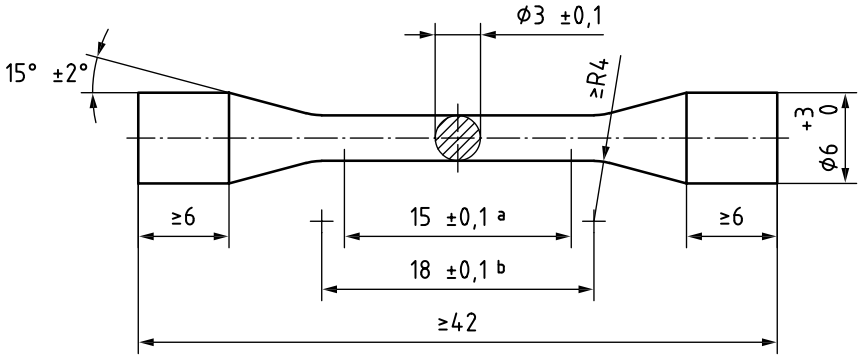
6.2 Specimens for tensile testing

6.2.1 General

Prepare six specimens of the metallic material(s) to be laser welded which conform to either Figure 1 or Figure 2. Cut the specimens of the set at right angles to its long axis at the midpoint of the gauge length using a fine saw.

Replace specimens that have visible shrinkages, defects or porosities.

Dimensions in millimetres

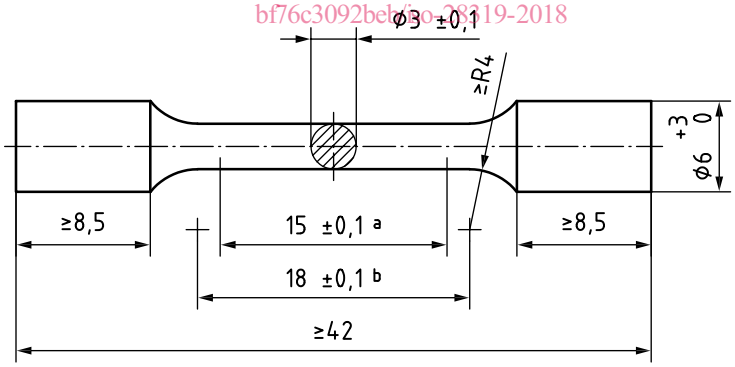


a Gauge length.

b Rotation symmetrical section of test specimen.

Figure 1 — Test specimen with conical shoulders

Dimensions in millimetres



a Gauge length.

b Parallel section of test specimen.

Figure 2 — Test specimen with radial shoulders

6.2.2 Procedure

Support the two halves of the specimens and align them in an investment or a rigid jig. If two different metallic materials are to be laser welded, use one of each for the two halves. In case the recommended filler material is used, follow the instruction for use (see Clause 8).

Weld the specimens with a laser welding unit in accordance with the instructions for use.

After laser welding, ensure that the diameter of each tensile specimen is within the tolerances given in Figure 1 or Figure 2, and does not show visual evidence of radial run-out when rotated.

6.3 Specimens for corrosion testing

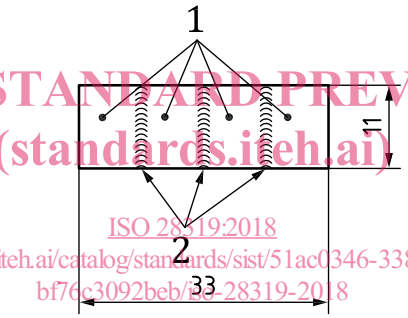
6.3.1 General

Platelets for preparation of specimens are prepared according to ISO 10271:2011, 4.1.6.

For corrosion testing of a laser-welded joint, two test specimens measuring 33 mm × 11 mm × 1 mm shall be prepared (see Figure 3).

Platelets of each metallic material to be joined are cut, to create four narrow parts (of 11 × 8,25 mm each). Once the platelets have been cut, the parts shall be laser-welded in the combination to be tested following the specifications of the manufacturer of the metallic materials (either AAAA or ABAB; A = material 1; B = material 2). Following laser welding, remove at least 0,1 mm from all surfaces of the samples using standard metallographic procedures ending with wet silicon carbide paper of grade P1200 in accordance with ISO 6344-1. Use the same piece of grinding paper solely for the preparation of specimens of the same combination.

Dimensions in millimetres
All tolerances: ± 2 mm



Key

1 metallic plate
2 laser welded seam

Figure 3 — Specimen for corrosion testing, consisting of four platelets fused by laser welding

6.3.2 Seam geometry

There are four possible and permitted seam geometries: V-seam, I-seam, X-seam and Y-seam, as shown in Figures 4 to Figure 7. The initial letters V, I, X and Y before "–seam" in the names describe these geometries.

Prepare the ends of the specimens to the recommended seam geometry.

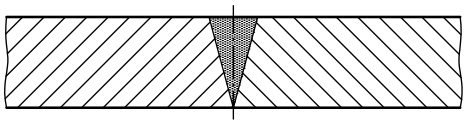


Figure 4 — V-seam