INTERNATIONAL STANDARD

ISO 28319

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Dentistry — Laser welding

Médecine bucco-dentaire — Soudage par laser

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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.

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 28319 was prepared by Technical Committee ISO/TC 106, *Dentistry*, Subcommittee SC 2, *Prosthodontic materials*.

Dentistry — Laser welding

1 Scope

This International Standard specifies requirements and test methods for laser welding, in the dental laboratory, of materials suitable for use in metallic restorations and appliances.

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 1942, *Dentistry — Vocabulary*

ISO 3585, *Borosilicate glass 3.3 — Properties*

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

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

ISO 10271, *Dental metallic materials — Corrosion test methods*

ISO 22674:2006, *Dentistry — Metallic materials for fixed and removable dental 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.

3.1
laser welding
method for joining similar or dissimilar metallic materials, using a laser beam as heat source, with or without a metallic filler material (welding rod), which produces coalescence by melting the metallic materials in order to join them by creating a fusion zone

3.2
brazing
method for joining similar or dissimilar metallic materials by applying heat and using a metallic brazing material as filler

NOTE 1 The brazing materials used have liquidus temperatures above 450 °C, but below the melting range of the metallic materials being joined. They flow by capillary action into the gap between the metallic base materials and join them by creating a metallurgical bond.

NOTE 2 Brazing differs from welding in that brazing does not melt the metallic base materials.

4 Requirements

4.1 Chemical composition

4.1.1 Metallic materials to be joined

The metallic materials to be joined shall comply with ISO 22674:2006, 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-based or noble-metal-based filler materials, the percentage of each of the constituents shall not deviate by more than 0,5 % (mass fraction) from the values stated in the manufacturer's instructions for use.

For base-metal-based filler materials, all elements present with more than 20 % (mass fraction) shall not deviate from the value stated in the manufacturer's 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 manufacturer's instructions for use by more than 1 % (mass fraction).

Testing shall be carried out in accordance with 7.2.

4.1.3 Hazardous elements in filler material

4.1.3.1 Recognised hazardous elements

For the purposes of this International Standard, 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 not contain 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.

Testing shall be carried out in accordance with 7.2.

4.2 Biocompatibility

Specific qualitative and quantitative requirements for freedom from biological hazard are not included in this International Standard, 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)

The tensile strength of laser-welded specimens shall exceed 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

The corrosion resistance of laser welded specimens shall be in the same range as that of the metallic materials to be joined. The ion release shall not exceed twice that of the metallic material. If two different metallic materials are joined, the ion release shall not exceed twice that of the metallic material with the lesser corrosion resistance. The metallic materials to be joined and the laser-welded specimens shall comply with ISO 22674:2006, 5.6.

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.

5 Sampling

The metallic filler material and the metallic material shall each be from one lot and 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 in accordance with ISO 22674, these data can be used. If not, perform the tests in accordance with ISO 22674 to determine the required proof strength values 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 manufacturer's instructions. Prepare casating alloy specimens by the "lost wax process" of investment casting. If the manufacturer recommends a forming method other than casting, use this method to assess the suitability of the metallic material for laser welding. Follow the manufacturer's instructions relating to the processing of the metallic material(s) and, if applicable, the filler material, including as regards 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 appropriate to their intended application.

If heat-treatment is recommended by the manufacturer, perform the tests in the heat-treated state in accordance with the manufacturer's instructions.

If laser welding is recommended following ceramic firing, the simulated ceramic firing of the specimens shall be in accordance with ISO 22674:2006, 7.2.3, and shall be applied before laser welding.

6.2 Specimens for tensile testing

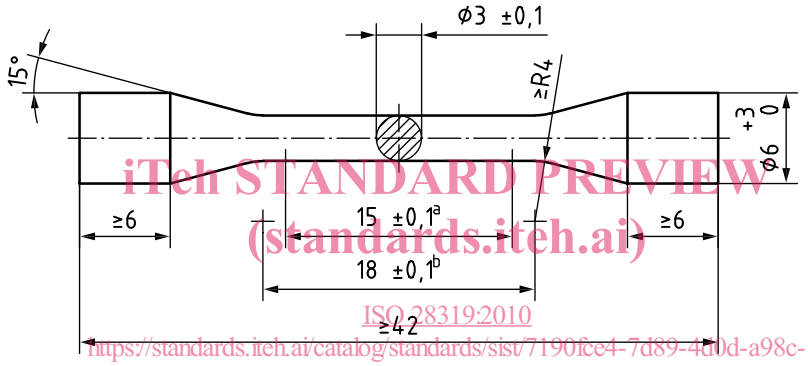
Prepare six specimens of the metallic material(s) to be laser-welded, which comply with either Figure 1 or Figure 2. Cut the specimens of the set at right angles to their long axis at the midpoint of the gauge length using a fine saw.

Replace specimens that have visible shrinkage, defects or porosities.

Prepare the ends of the specimens to the recommended seam geometry. See A.7 for guidance on seam geometry. 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. If a recommended filler material is used, follow the manufacturer's instructions (see Clause 8).

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.

Dimensions in millimetres

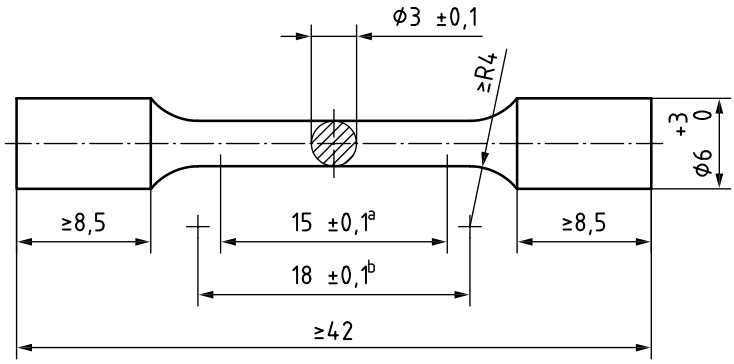


a Gauge length of (15 ± 0,1) mm.

b Parallel section of test specimen of (18 ± 0,1) mm.

Figure 1 — Test specimen with conical shoulders

Dimensions in millimetres



a Gauge length of (15 ± 0,1) mm.

b Parallel section of test specimen of (18 ± 0,1) mm.

Figure 2 — Test specimen with radial shoulders

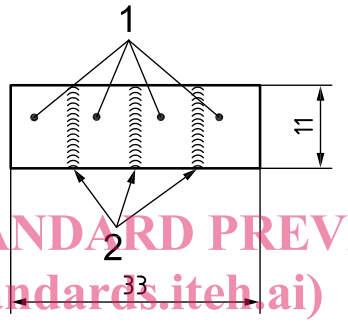
6.3 Specimens for corrosion testing

Platelets for the preparation of specimens are prepared in accordance with ISO 10271.

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 parts (of 11 mm × 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 metallic materials supplier [either AAAA or ABAB, where (in the latter specimen) A and B are parts from different plates]. 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 P 1200 in accordance with ISO 6344-1. Use a new grinding paper for the preparation of each specimen.

Dimensions in millimetres
All tolerances: ±2 mm



Key

1 metallic plate
2 laser-welded seam

Figure 3 — Specimen for corrosion testing, consisting of four laser-welded platelets

7 Testing

7.1 Visual inspection

Visually inspect to check that requirements specified in Clauses 8 and 9 have been met.

7.2 Chemical composition

Determine the composition of the filler material using analytical procedures with sensitivities appropriate to the concentration of each element and its permitted deviation from the stated value or permitted limit.

7.3 Tensile testing

7.3.1 General

Determine the tensile strength in accordance with ISO 22674 on six test specimens prepared in accordance with 6.2. Load the test specimens in tension in a mechanical testing instrument at a cross-head speed of $(1,5 \pm 0,5)\ \text{mm} \cdot \text{min}^{-1}$ until the specimens fracture.

Calculate the fracture stress on the basis of the original cross-sectional area, using the “force for elongation at fracture” derived from the force/elongation diagram.