# International Standard 4739

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# Wrought copper and copper alloy products — Selection and preparation of specimens and test pieces for mechanical testing

*Produits corroyés en cuivre et en alliages de cuivre — Prélèvement et préparation des spécimens et des éprouvettes pour essais mécaniques*

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**Descriptors** : copper, copper alloys, wrought products, tests, test specimens, specimen preparation.

## 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

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# Wrought copper and copper alloy products — Selection and preparation of specimens and test pieces for mechanical testing



## 1 Scope and field of application

This International Standard defines the operations by which specimens and test pieces for mechanical testing are to be obtained to represent wrought copper and copper alloy products.

The selection and preparation of samples for chemical analysis are defined in ISO 1811/2.

## 2 References

ISO 196, *Wrought copper and copper alloys — Detection of residual stress — Mercury(I) nitrate test.*

ISO 1811/2, *Copper and copper alloys — Selection and preparation of samples for chemical analysis — Part 2 : Sampling of wrought products and castings.*[1)]

ISO 2624, *Copper and copper alloys — Estimation of average grain size.*

ISO 2626, *Copper — Hydrogen embrittlement test.*

ISO 2712, *Copper and copper alloys — Rockwell superficial hardness test (N and T scales).*

ISO 4746, *Oxygen-free copper — Scale adhesion test.*

ISO 6506, *Metallic materials — Hardness test — Brinell test.*

ISO 6507, *Metallic materials — Hardness test — Vickers test — Part 1 :* HV 5 *to* HV 100.
*Part 2 :* HV 0,2 *to less than* HV 5.

ISO 6508, *Metallic materials — Hardness test — Rockwell test — Scales A, B, C, E, F, G, H.*[2)]

ISO 6892, *Metallic materials — Tensile testing.*

ISO 7438, *Metallic materials — Bend test.*

ISO 7800, *Metallic materials — Wire — Simple torsion test.*

ISO 7801, *Metallic materials — Wire — Reverse bend test.*

ISO 7802, *Metallic materials — Wire — Wrapping test.*

ISO 8492, *Metallic materials — Tube — Flattening test.*[2)]

ISO 8493, *Metallic materials — Tube — Drift expanding test.*[2)]

IEC Publication 468, *Method of measurement of resistivity of metallic materials.*

## 3 Definitions

For the purpose of this International Standard, the following definitions apply :

**3.1 inspection lot** : A consignment or a part thereof comprising products of the same grade or alloy, form, temper and thickness or cross-section, processed in the same manner. The size of lot and the sampling rate to be used may be included in the product specification.

**3.2 sample** : One or more pieces taken from an inspection lot.

**3.3 specimen** : A piece taken from the sample, for the purpose of producing a test piece.

1) Under revision.

2) At present at the stage of draft.

**3.4 test piece** : A piece taken from a specimen and suitably prepared for the test.

**3.5 test** : The operation to which the test piece is subjected in order to measure or ascertain a property.

## 4 Selection and preparation of specimens for mechanical testing

### 4.1 Location and size of specimens

The specimens shall be taken from the samples so as to preserve orientation in relation to the product corresponding to the requirements in clause 5.

Specimens shall be taken from the sample subsequent to the completion of the process and treatments that the product undergoes to establish its size, shape, temper, physical properties and finished condition.

In cases where this is not possible or desirable, the sample or specimens may be taken at a stage of the manufacturing process where the subsequent operations do not change the properties or characteristics to be measured.

The specimens shall be large enough to allow manufacture of the test pieces which are necessary for the required tests, and may include sufficient material to allow manufacture of the test pieces for any retests required.

### 4.2 Identification of specimens

Each specimen shall be marked, tagged or labelled in such a manner that it is possible to identify the sample from which it was taken and, if required, its location and orientation in the product.

Marking shall be done in such a manner that it does not change the characteristics of the part of the specimen from which the test pieces are to be made.

### 4.3 Preparation of specimens

Cutting shall be done in such a manner that it does not change the characteristics of the part of the specimen from which the test pieces are to be made.

Thus, the dimensions of the specimens shall provide an adequate machining allowance to permit removal of the zone affected by this cutting.

Specimens may not be machined or treated in such a way that their mechanical properties are altered. Any straightening required shall be done with great care, preferably by hand.

### 4.4 Number of specimens

The sampling rate shall be specified in the material specification. Unless otherwise specified, the supplier shall sample the inspection lot at such a rate that he can establish that the material conforms to the product specification. If a sampling plan is to be used, the use and the contents of the plan shall be agreed upon between supplier and purchaser.

## 5 Selection and preparation of test pieces

### 5.1 Identification of test pieces

#### 5.1.1 Marking

Each test piece shall be marked in such a manner that it is possible to identify the sample from which it was taken and, if required, its location and orientation in the product.

Marking shall be done in such a manner that it does not change the characteristics of the test piece.

If a test piece is marked by stamping, this shall not be in a place or manner which interferes with subsequent testing. Test pieces required for stress corrosion tests shall not be stamped.

Where it is not convenient to mark on a test piece, an identification tag or label may be attached.

#### 5.1.2 Machining

Any necessary machining shall be done in such a manner that it does not change the characteristics of the material in the test piece.

### 5.2 Test pieces for the tensile test

The shape and recommended dimensions of test pieces are specified in ISO 6892.

In addition, unless otherwise specified in the material standard, the following conditions apply.

#### 5.2.1 Rolled flat products

Flat test pieces shall be used for thicknesses up to and including 10 mm.

The test piece shall be made so that both rolled surfaces are included undisturbed.

For thicknesses over 10 mm up to and including 25 mm round test pieces shall be used, the longitudinal axis of which shall be located at a distance from the surface equal to half the thickness.

For thicknesses over 25 mm, the test pieces shall be taken with their axes 13 mm from one face.

#### 5.2.2 Solid products with round cross-section

Products up to and including 40 mm diameter shall be tested in full section or by means of a round test piece taken from the centre of the product. For products over 40 mm diameter, round test pieces shall be used. The longitudinal axis of the test piece shall be located at half the distance between the surface and the centre.

#### 5.2.3 Solid products with square or polygonal cross-section

The stipulations for the location of test pieces given in 5.2.2 shall be applied.

The circle inscribed within the cross-section shall determine the location of the test piece.

#### 5.2.4 Solid products with rectangular cross-section

Flat test pieces shall be used for thicknesses up to and including 10 mm.

The test pieces shall be made so that both the two wider surfaces are included undisturbed.

For thicknesses over 10 mm up to and including 25 mm round test pieces shall be used, the longitudinal axis of which shall be located at a distance from the surface equal to half the thickness.

For thicknesses over 25 mm the test pieces shall be taken with their axes 13 mm from one face.

#### 5.2.5 Tubes

Test pieces shall be obtained by one of the following means :

a) Wherever possible, tubes shall be tested in full section.

b) Where testing of tubes in full section is impracticable, test pieces shall be taken from strips cut longitudinally from the tubes. The central portion of the test piece shall not be flattened, but the ends may be flattened, without heating, for gripping in the testing machine.

c) For tubes having wall thickness over 10 mm, test pieces shall be turned from strips cut longitudinally from the tubes. The longitudinal axis of the test piece shall be located at a distance from the surface equal to half the thickness of the tube.

#### 5.2.6 Wire

Test pieces shall be free from kinking and undue deformation caused by tight coiling of the inspection lot.

#### 5.2.7 Forgings

Test pieces shall be obtained by one of the following means as agreed between the supplier and the purchaser.

a) from the forging itself in such a way that its longitudinal axis coincides as nearly as possible with the principle direction of metal flow;

b) from a specimen attached to the forging;

c) from a separate specimen, forged from the same stock and treated in the same way as the forging itself.

### 5.3 Test pieces for the bend test according to ISO 7438

#### 5.3.1 Flat rolled products

Unless otherwise agreed or specified, the test pieces shall be made in such a way that after bending, the axis of the bend is at right angles to the direction of the final rolling. If necessary, the thickness of the test piece may be reduced by machining on one side only; the original surface shall then be on the outside of the bend.

#### 5.3.2 Other products

Unless otherwise agreed or specified, the test piece should be made with the longitudinal axis parallel to the direction of final drawing or rolling.

### 5.4 Test pieces for the resistivity test according to IEC Publication 468

If of suitable size for testing, wrought products may be tested as manufactured on full section. Otherwise, products should be rolled or drawn to 2 mm diameter or other suitable size. Copper shall be annealed at 500 °C for 1/2 h in an inert atmosphere before testing. For heat-treatable alloys, diameter and heat treatment shall be agreed between supplier and purchaser.

### 5.5 Test pieces for the hardness test

Test pieces shall be of adequate size and shape to permit testing by the required method. For wrought products, specimens may be taken to permit testing in a plane parallel or perpendicular to the direction of deformation given to the product.

The surface of the test piece shall be sufficiently smooth and even to permit the accurate determination of the required properties. It shall be free from scale and foreign matter. In preparing the test piece, care shall be taken to avoid any change in condition, e.g. due to heating or cold working.

The tests shall be carried out according to ISO 2712, ISO 6506, ISO 6507 and ISO 6508 as appropriate.

### 5.6 Test pieces for testing of tubes

Test pieces shall be prepared according to ISO 8492 and ISO 8493.

### 5.7 Test pieces for testing of wire

Test pieces shall be prepared according to ISO 7800, ISO 7801 and ISO 7802.

### 5.8 Test pieces for the estimation of grain size

Test pieces shall be representative of the product. Distortion shall be avoided.

Unless otherwise stipulated, metallographic test pieces shall be mounted so that the face to be examined is parallel to the direc-

tion of working and perpendicular to the drawn or rolled surfaces.

The test shall be carried out according to ISO 2624.

### 5.9 Test pieces for the stress corrosion tests

The pieces shall be representative of the product. Distortion or work hardening shall be avoided. Swarf adhering to the cut test pieces shall be carefully removed.

Test pieces shall be cut to the dimensions stated in ISO 196.

### 5.10 Test pieces for the hydrogen embrittlement test

Test pieces shall be representative of the product.

Test pieces shall be prepared according to ISO 2626.

### 5.11 Test pieces for the scale adhesion test

Test pieces shall be representative of the product. The specimens may be cold or hot-rolled or forged to an intermediate size and then cleaned of scale and oxide inclusions before final rolling or machining to a maximum 2 mm thickness of drawing to wire not less than 1 mm diameter.

Test pieces shall be prepared as according to ISO 4746.

### 5.12 Test pieces for microscopic examination of copper(I) oxide

Test pieces shall be representative of the product excluding the surface.