

BS EN 16090:2011



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Copper and copper alloys — Estimation of average grain size by ultrasound

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National foreword

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English Version

Copper and copper alloys - Estimation of average grain size by ultrasound

Cuivre et alliages de cuivre - Estimation de la taille moyenne de grain par ultrasons

Kupfer und Kupferlegierungen - Bestimmung der mittleren Korngröße durch Ultraschall

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Foreword

This document (EN 16090:2011) has been prepared by Technical Committee CEN/TC 133 “Copper and copper alloys”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2012, and conflicting national standards shall be withdrawn at the latest by June 2012.

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Introduction

The test by ultrasound described in this standard has the objective of estimating the dimension of average grain size in copper and copper alloy products.

When using this test by ultrasound technique it is important to recognise that the estimation of grain size is not a precise measurement because a metal structure is an aggregate of three-dimensional crystals of varying sizes and shapes. Clearly, no two areas of observation then can be exactly the same.

1 Scope

This European Standard specifies a method for the estimation of the average grain size of copper and copper alloy products by ultrasound. This standard can be applied for seamless round tubes as well as for flat products.

This method can be used in place of test methods according to EN ISO 2624, mentioned in the relevant product standards. As reference method and in case of doubt the intercept procedure or planimetric procedure has to be used.

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.

EN 473:2008, *Non-destructive testing — Qualification and certification of NDT personnel — General principles*

EN 583-1:1998, *Non-destructive testing — Ultrasonic examination — Part 1: General principles*

EN 1330-4, *Non-destructive testing — Terminology — Part 4: Terms used in ultrasonic testing*

EN ISO 2624:1995, *Copper and copper alloys — Estimation of average grain size (ISO 2624:1990)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1330-4 and the following apply.

3.1

grain

area in a metal within the boundary of a crystal

NOTE For the purpose of applying the method described in this European Standard, a crystal and its twin bands are considered as one grain. Sub-grains, minor constituent phases, inclusions and additives are not considered in the estimation of the grain size.

4 General requirements

4.1 Personnel qualification

The ultrasonic test shall be made by operators trained in this technique and it shall be done under the responsibility of qualified staff. The qualified staff shall be competent. When agreed upon between the purchaser and the supplier, qualification of the personnel shall be certified according to EN 473:2008.

The qualified staff is especially responsible for the

- issue and release of test procedures for operators;
- training of operators in ultrasonic testing;
- compilation and release of correlation of ultrasonic signals and grain size (calibration curve).

4.2 Condition of products to be tested

Products shall be sufficiently clean to permit satisfactory test operation and adequate coupling. Products shall be free of deep cracks and grooves generating ultrasonic signals.

This method is only applicable for products in the material condition:

- annealed;
- light-annealed;
- light-drawn;
- soft annealed.

4.3 Test equipment

Ultrasonic equipment with pulse echo technique shall be used as described in EN 583-1:1998, 5.4. It is recommended to use test equipment according to EN 12668-1 and EN 12668-2.

Ultrasonic testing and result analysis typically is done in an automated system against pre-determined criteria without human intervention.

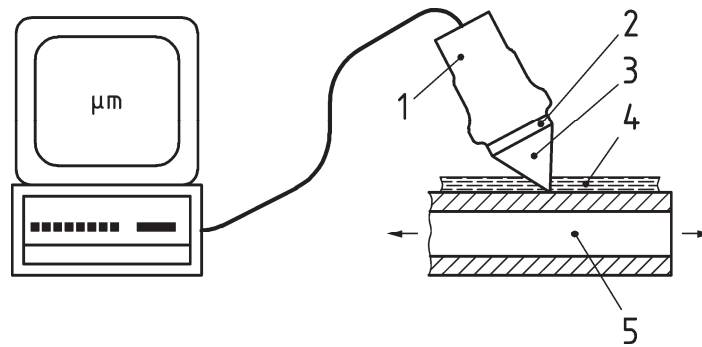
When driving mechanics are used for the sample they have to be as vibration-free as possible. In general, if samples will be moved during the test (in axial direction or by rotation), it is required to keep the distance between sample and probe constant.

Probes within the frequency range of 1 MHz to 60 MHz have to be applied.

Coupling of the ultrasonic waves is provided by a coupling fluid, e.g. water or oil (see EN 583-1:1998, 6.3). For constant coupling an automated ultrasonic testing is recommended to apply the immersion technique.

Tube-curvature (ovality, roundness) is not to be considered as the ultrasonic spot size (focal point) is very small.

Parasitic echoes and echoes of discontinuities should be eliminated from the ultrasonic evaluation process by adequate means.



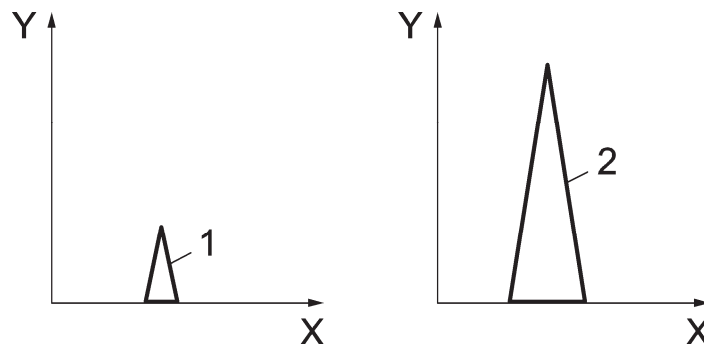
Key

- 1 housing
- 2 single Transducer
- 3 ultrasonic beam
- 4 coupling medium
- 5 sample

Figure 1 — Simplified representation of ultrasonic technique for grain size estimation

4.4 Procedure

Prepare sample (cut to length, clean if necessary). Adjust instrument once per day before the first test (see Clause 5). Couple sample with transducer by using a coupling fluid. Estimate the grain size by using the reflection of ultrasonic waves on grain boundaries. The backscattered signals from the grains in the product are analysed in an A-scan presentation. The signals vary in dependence of the average grain size (see Figure 2).



Key

- 1 small grains
- 2 large grains
- X time of flight
- Y backscattered intensity

Figure 2 — Simplified illustration of backscattered signals

5 Instrument adjustment

The test equipment shall be adjusted previous to the test of samples using a reference sample in accordance with Clause 6.

The control survey for adjustment of the ultrasonic equipment should be repeated at least every working day with the relevant reference sample.

IMPORTANT — In the event of deviations during adjustment greater than $\pm 3 \mu\text{m}$, the ultrasonic equipment has to be re-calibrated! If re-calibration is not successful, calibration according to Clause 6 has to be done again. All tubes tested since the last adjustment shall be considered as not been tested.

6 Reference samples and calibration

Ultrasonic testing is a comparative method. Calibrations for every alloy or group of alloys (calibration-graph) considering the thickness are required.

The reference samples shall represent the whole range of grain sizes as specified in the relevant product standard. The reference samples are tested in parallel

- 1) with the ultrasonic technique, and
- 2) according to intercept procedure or planimetric procedure as described in EN ISO 2624:1995.

Test results of both methods have to be matched and this correlation of ultrasonic signals and grain size (calibration curve) is used as a basis for future ultrasonic testing and instrumental adjustment.

7 Acceptance criteria

The acceptance criteria are specified in the relevant product standards. In the event that the sample fails to meet the test requirements the procedures for retest in the relevant product standard apply. Samples for retests shall be tested with one of the methods described in EN ISO 2624:1995.

Bibliography

EN 12668-1, *Non-destructive testing — Characterization and verification of ultrasonic examination equipment — Part 1: Instruments*

EN 12668-2, *Non-destructive testing — Characterization and verification of ultrasonic examination equipment — Part 2: Probes*

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