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Copper and copper alloys — Estimation of average grain size

Cuivre et alliages de cuivre — Évaluation de la dimension moyenne du grain

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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.

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.

International Standard ISO 2624 was prepared by Technical Committee ISO/TC 26, *Copper and copper alloys.*

This second edition cancels and replaces the first edition (ISO 2624 : 1973), of which it constitutes a minor revision.

Annex A forms an integral part of this International Standard.

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Introduction

On a section of metal, a grain is that area within the boundary of a crystal. For the purpose of applying the methods described in this International 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.

It is important, in using these methods, to recognize that the estimation of grain size is not a precise measurement. A metal structure is an aggregate of three-dimensional crystals of varying sizes and shapes. Even if all these crystals were identical in size and shape, the grain cross-sections produced by a random plane (surface of observation) through such a structure would have a distribution of areas varying from a maximum value to zero, depending upon where the plane cuts each individual crystal. Clearly, no two fields of observation can be exactly the same.

Practical reasons limit the number of grains that can reasonably be counted to less than the number statistically desirable.

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Copper and copper alloys — Estimation of average grain size

1 Scope

This International Standard specifies three procedures for estimating, and rules for expressing, the average grain size of copper and copper alloys consisting principally of a single phase. The respective procedures are termed the comparison procedure, the intercept procedure and the planimetric procedure.

The comparison procedure (comparing the specimen with a standard chart) is most convenient and is sufficiently accurate for most commercial purposes.

Higher degreees of accuracy in estimating grain size are obtainable by using the intercept (Heyn) or planimetric (Jeffries) procedures. In cases of dispute, it is recommended that the use of one of these procedures be agreed between the parties.

For material with non-equiaxial structures it is recommended that the intercept procedure be used.

2 Symbols and designations

Symbol	Designation
f	Jeffries' multiplier used to obtain number of grains per square millimetre by planimetric method
m	Number of grains per square millimetre
d	Average grain "diameter" in millimetres; an arbitrary measure defined as $1/\sqrt{m}$
l	Average intercept length
γ	Magnification

3 Test samples

3.1 Grain size estimations shall be made on three or more representative fields of each sample section. In known equiaxial structures only a representative section need be taken on the sample. For non-equiaxial or unknown structures three sections must be prepared, each at right angles to the other.

3.2 The specimen shall be carefully prepared to reveal the grain boundaries using a contrast etch to match the standard charts.

4 Procedures

4.1 Comparison procedure

The estimation of grain size is made by direct comparison of a projected image of a photomicrograph of a representative field of the test specimen, either with the photomicrographs of the standard grain size series or with suitable reproductions of them (for standard grain size charts, see annex A); when a projection microscope is not available a bench microscope may be used. It is recommended that, to facilitate comparison, mechanical arrangements be made to permit bringing the standard photomicrographs successively into juxtaposition with the projected image.

4.2 Intercept procedure

4.2.1 The grain size is estimated by counting, on the ground glass screen of a projection microscope, on the image in a bench microscope fitted with a graticule, on a photomicrograph of a representative field of the specimen, or on the specimen itself, the number of grains intercepted by one or more straight lines sufficiently long to yield at least 10 intercepts per line and at least 50 intercepts for all lines for normal purposes and at least 200 intercepts for referee purposes. Grains touched by the end of the line count only as half grains. The length of the line or lines in millimetres at the surface of the section, divided by the number of grains intersected by it, gives the average intercept length l. For practical purposes, the average intercept length, l, may be regarded as equal to the average grain diameter d[1].

4.2.2 For non-equiaxial structures, measurements should be made on longitudinal and transverse sections along lines that lie in all three principal directions of the specimen. For each direction, the average grain "diameters" should be calculated as in 4.2.1.

1) To achieve compatibility with estimations of grain "diameter" made by the planimetric or comparison procedure, the intercept length, l, should be multiplied by the factor 1,13.