INTERNATIONAL STANDARD

ISO 4498

First edition
2005-06-01

Sintered metal materials, excluding hardmetals — Determination of apparent hardness and microhardness

Matériaux métalliques frittés, à l'exclusion des métaux-durs — Détermination de la dureté apparente et de la microdureté

Reference number
ISO 4498:2005(E)

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Published in Switzerland

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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 4498 was prepared by Technical Committee ISO/TC 119, *Powder metallurgy*, Subcommittee SC 3, *Sampling and testing methods for sintered metal materials (excluding hardmetals)*.

This first edition of ISO 4498 cancels and replaces: ISO 4498-1:1990, and ISO 4498-2:1981.

Introduction

Sintered metal materials generally have a porous structure. Therefore, they can be understood as composite metal/pore materials. That is why this International Standard describes two procedures to determine their hardness:

— Procedure 1 for the macro hardness (this is the apparent hardness);

— Procedure 2 for the micro hardness (this is the hardness of the metallic phase only).

Tests in Procedure 1 determine Vickers, Brinell and/or Rockwell macrohardnesses — their acronyms are: HV, HB, and HR. These tests determine the apparent hardness (macrohardness) of the materials because indentations generally include both the solid phase and a number of pores. The usual test forces applied to an indenter are from 10 N to 2 000 N.

The apparent hardness value is often used as an expression of the mechanical strength of the material as a whole; it is usually lower than that of a solid material of the same composition and metallurgical condition. However, this does not imply that the functional characteristics (for example wear resistance) are necessarily inferior to those of an equivalent full-density material.

The apparent hardness is a macrostructural property. It characterises the material taken as a whole.

Tests in Procedure 2 determine the Vickers and/or Knoop microhardnesses of the material — their acronyms are: HVa, HKa [1)]. The usual test forces applied to an indenter are from 0,147 N to 1,960 N for Vickers, and 0,981 N for Knoop.

The microhardness is a microstructural property used to control chemical composition, heat treatment or surface treatment. For these purposes, it is necessary to ensure that hardness test indentations are small enough not to include any visible pores, but only the solid phase.

1) Where a is the test load, in kilograms.

Sintered metal materials, excluding hardmetals — Determination of apparent hardness and microhardness

1 Scope

This International Standard specifies methods of hardness testing of sintered metal materials, excluding hardmetals.

1.1 Procedure 1 determines the apparent hardness of the whole material.

Procedure 1

— applies to sintered metal materials which have either not been subjected to any heat treatment, or which have been heat treated in such a way that the hardness is essentially uniform to a depth of at least 5 mm below the surface,

— applies to the surfaces of sintered metal materials which have been treated in such a way that the hardness is not uniform in the section to a depth of 5 mm below the surface,

— therefore applies to materials in which the hardness is obtained essentially by surface enrichment by carbon, or by carbon and nitrogen (for example, and by carburising, carbonitriding, nitrocarburising or sulphidising), and

— applies to materials which have been induction hardened.

1.2 Procedure 2 determines the microhardness of the metal phase.

Procedure 2

— applies to all types of sintered metal materials.

— is used, in particular, to determine the hardness profile of case-hardened or carbonitrided materials according to the method described in ISO 4507.

— also applies to any sintered metallic materials which have been subjected to surface treatments such as electrodeposited plating, chemical coating, chemical vapour deposition (CVD), physical vapour deposition (PVD), laser, ion bombardment, etc. To determine the microhardness of treated surfaces, Procedure 2 applies.

NOTE However, it should be noted that international agreement has not yet been reached on a number of factors involved in microhardness testing. Nevertheless, the parameters defined in Procedure 2 are important enough to enable a considerable measure of standardisation of extensively used practices.

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 4507:2000, *Sintered ferrous materials, carburized or carbonitrided — Determination and verification of case-hardening depth by a micro-hardness test.*

ISO 4516:2002, *Metallic and other inorganic coatings — Vickers and Knoop microhardness tests*

ISO 6506-1:1999, *Metallic materials — Brinell hardness test — Part 1: Test method*

ISO 6507-1— [2], *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 6508-1:1999, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

3 Apparatus

Procedure 1: Vickers, Brinell and Rockwell hardness testing machines and test methods meeting the requirements of ISO 6506-1, ISO 6507-1 and ISO 6508-1, respectively.

Procedure 2: Vickers and Knoop microhardness testing machines and test methods meeting the requirements of ISO 4516.

4 Sampling and preparation of test pieces

4.1 Since the apparent hardness of a sintered material is affected by density, which can vary throughout a part, the position of the hardness indentations, for the purpose of quality control, shall be agreed between the parties.

4.2 The sintered metal surface shall be clean, smooth and flat to obtain well-defined hardness indentations. Test samples will have anvil support surfaces filed or ground flat wherever practicable, so as to prevent burrs from affecting results. This is particularly important when determining Vickers and Brinell hardness. Emery paper of 180 to 240 grit is acceptable for grinding. It is generally found sufficient to clean the surface with a suitable solvent. If not, the surface may be lightly polished, provided that laboratory measurements have shown that the influence of such polishing is insignificant.

NOTE This polishing may be carried out, for example, by using metallographic paper or a 6 µm diamond paste.

4.3 Microhardness can be measured either on the surface of a part or on a cross-section of the part normal to the surface. For microhardness determinations, it is necessary to ensure that the surface is smooth enough to allow measurement of the indentation diagonal length accurately. The sample may then be chemically cleaned, electrochemically or mechanically polished to reveal porosity. Mechanical polishing should involve minimum local heating or working, so as not to affect hardness.

Previous impregnation of the part with a thermosetting resin can be beneficial, if the part has more than 8 % open porosity. The surface to be measured shall be flat and smooth. Indentations should have sharp edges in order to carry out accurate diagonal measurement. The thickness of the test piece shall be greater than 1,5 times the length of the impression diagonal.

4.4 Surface curvature introduces a certain error in determining microhardness, which increases as the radius decreases. On convex surfaces, higher hardness values and, on concave surfaces, lower hardness values, than the actual values are obtained. If the Vickers hardness test (apparent hardness or microhardness) has to be performed on a curved surface sample, the influence of the curvature will have to be compensated for by correction factors (see: ISO 6507-1 and ISO 4516).

4.5 The measurement of microhardness shall not be valid if the test surface is not perpendicular to the indenter axis. Non-perpendicularity will be probable with isotropic materials, if one leg [3] of the diagonal is noticeably longer than the other leg [2] (Vickers or Knoop microhardness). The specimen for microhardness testing shall be positioned on the supporting table, or presented in such a way that the test surface is perpendicular to the direction of the test force, otherwise the indentation will be distorted. This position shall be maintained during the entire test.

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2) To be published. (Revision of ISO 6507-1:1997)

3) The leg is the distance from the center of the indentation to the outer corner.