International Standard

ISO 18203

Steel — Determination of the thickness of surface-hardened layers

Acier — Détermination de l'épaisseur des couches durcies superficielles

Second edition
2026-01

Reference number
ISO 18203:2026(en)

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 7, *Methods of testing (other than mechanical tests and chemical analysis),* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 459/SC 1, *Test methods for steel (other than chemical analysis),* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 18203:2016), which has been technically revised.

The main changes are as follows:

— removal of the reference to shot peening;

— removal of the compound layer thickness (CLT);

— introduction of standard test loads for the determination of hardness depths, and the procedure for measurements in the event of arbitration;

— extension of Table 1 by Rockwell test methods;

— extension of Table 2 by further abbreviations;

— precise definition of how the core hardness shall be tested;

— determination of the edge distance of the first hardness impression from the edge;

— explanation of how to determine the total thickness of surface hardening depth THD.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

There are several ways of creating a surface-hardened layer in steel, but the measurement of its thickness follows the same principle, regardless of the chemical composition or heat treatment of the sample. This document presents the basic principle of determining the thickness of surface-hardened layers as well as the differences particular to the different methods of creating the surface-hardened layer.

No method of estimating uncertainty is presented in this document. As real applications of this procedure accrue, the need may arise to address this topic in future revisions.

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Steel — Determination of the thickness of surface-hardened layers

1 Scope

This document specifies a method of measuring the case hardening depth, surface hardening depth, nitriding hardness depth and total thickness of surface hardening depth obtained using, e.g. thermal (flame and induction hardening, electron beam hardening, laser beam hardening, etc.) or thermochemical (carbonitriding, carburizing and hardening, hardening and nitriding, etc.) treatment.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 4545-2, *Metallic materials — Knoop hardness test — Part 2: Verification and calibration of testing machines*

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

ISO 6507-2, *Metallic materials — Vickers hardness test — Part 2: Verification and calibration of testing machines*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
case hardening depth
CHD
perpendicular distance between the surface and the layer having a hardness of 550 HV or equivalent Knoop hardness of 550 HK

Note 1 to entry: For steels which present a hardness higher than 450 HV at a distance three times of the case hardening depth (determined with a limiting hardness value of 550 HV in accordance with ISO 6507-1 or equivalent Knoop hardness of 550 HK in accordance with ISO 4545-1) from the surface, a limiting hardness value higher than 550 HV, in steps of 25 units, can be selected for the determination of the case hardening depth by agreement between interested parties.

Note 2 to entry: To measure the core hardness, five individual hardness measurements should be made, and the average value of these measurements should be taken. To determine the depth for the core hardness measurement, use three times the upper value of the case depth tolerance.

EXAMPLE CHD $1{,}0^{+0{,}4}_{-0}$ = depth for core hardness 4,2 mm. If this is not geometrically possible (e.g. in case the workpiece is too thin), separate agreements can be made to specify the core hardness check position. The core hardness is only determined once for several hardness curves and is taken for all hardness curves measured on the sample.

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Note 3 to entry: In general, case hardening consists of carburizing or carbonitriding followed by quench hardening (see ISO 4885).

Note 4 to entry: A distinction shall be made between the case hardening hardness depth CHD in the case-hardened condition only and the CHD in the case-hardened and tempered condition. This shall be noted in the report. If the surface hardness after tempering is so tolerated that the rule of the distance of 100 HV between core hardness and limit hardness cannot be complied, separate agreements shall be made for this.

3.2
surface hardening depth
SHD
distance between the surface and the layer where HV is equal to the value specified by the term "hardness limit"

Note 1 to entry: Recommended hardness limit values are listed in Table 1.

Table 1 — Recommended hardness limit values of SHD

Hardness limit HV	Minimum surface hardness in HV, HRC, HRA or HRN					
	HV	HRC	HRA	HR15N	HR30N	HR45N
250	300 to 330	30 to 33	65 to 67	75, 76	51 to 53	32 to 35
275	335 to 355	34 to 36	68	77, 78	54, 55	36 to 38
300	360 to 385	37 to 39	69, 70	79	56 to 58	39 to 41
325	390 to 420	40 to 42	71	80, 81	58 to 62	42 to 46
350	425 to 455	43 to 45	72, 73	82, 83	63, 64	47 to 49
375	460 to 480	46, 47	74	84	65, 66	50 to 52
400	485 to 515	48 to 50	75	85	67, 68	53, 54
425	520 to 545	51, 52	76	86	69, 70	55 to 57
450	550 to 575	53	77	87	71	58, 59
475	580 to 605	54, 55	78	89	72, 73	60, 61
500	610 to 635	56, 57	79	-	74	62, 63
525	640 to 665	58	80	90	75, 76	64, 65
550	670 to 705	59, 60	81	-	77	66, 67
575	710 to 730	61	82	91	78	68
600	735 to 765	62	-	-	79	69
625	770 to 795	63	83	92	80	70
650	800 to 835	64, 65	-	-	81	71, 72
675	840 to 865	66	84	-	82	73
This table shall not be used as a table of comparison of hardness values. In ISO 15787 it is noted that Vickers hardness values are ending with 5 or 0, and Rockwell values with a full number. See ISO 15787:2016, Figures 2 to 39.						

Note 2 to entry: Hardness limit is a function of the minimum surface hardness required for the part, given by the following Formula (1):

$$H_L = \mathrm{A} \times H_{\mathrm{msh}} \tag{1}$$

where

H_L is the hardness limit;
A is a coefficient (usually 0,8);
H_{msh} is the minimum surface hardness (lowest value of the tolerance).

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If the required minimum surface hardness is not specified, the parties involved shall agree on the limit hardness to be used.

Note 3 to entry: 0,80 is usually used for A. Other values can be applied.

Note 4 to entry: SHD measurement should be applied for parts which, in the surface hardened condition, have a hardness less than (hardness limit – 100 HV) at a distance 3 × minimum SHD tolerance from the surface. Where these conditions are not satisfied, the definition of SHD should be agreed between interested parties.

Note 5 to entry: To measure the core hardness, five individual hardness measurements should be made, and the average value of these measurements should be taken. To determine the depth for the core hardness measurement, use the triple value of the upper hardness surface depth tolerance, e.g. SHD $2{,}0^{+1{,}0}_{-0}$ = depth for core hardness measurement 9,0 mm. If this is geometrically not possible (e.g. in case the workpiece is too thin), separate agreements should be made to specify the core hardness check position. The core hardness is only determined once for several hardness curves and is taken for all hardness curves measured on the sample.

3.3
nitriding hardness depth
NHD
distance from the surface of nitride layer to the point where the material hardness limit is 50 HV above core hardness

Note 1 to entry: To determine the depth for the core hardness measurement, use the triple value of the upper hardness nitriding depth tolerance. E.g. NHD $0{,}5^{+0{,}3}_{-0}$ = depth for core hardness measurement 2,4 mm. If this is geometrically not possible (e.g. in case the workpiece is too thin), separate agreements should be made to specify the core hardness check position.

Note 2 to entry: To measure the core hardness, five individual hardness measurements should be made, and the average value of these measurements should be taken and rounded to the nearest multiple of 10 HV. The core hardness is only determined once for several hardness curves and is taken for all hardness curves measured on the sample.

3.4
total thickness of surface hardening depth
THD
distance from the examined surface to the limit that shows the same hardness as the core hardness

Note 1 to entry: The distance is often measured by the microstructural method, which is the distance from the surface examined to the limit beyond which no visible structure variation is detected, as compared with the structure of the unaffected metal. The microstructural method does not measure as deep as the hardness method.

Note 2 to entry: To measure the core hardness, five individual hardness measurements should be made, and the average value of these measurements should be taken and rounded to the nearest multiple of 10 HV. The core hardness is only determined once for several hardness curves and is taken for all hardness curves measured on the sample.

4 Symbols, abbreviated terms and designations

The symbols and abbreviated terms used in this document and their corresponding designations are given in Table 2.

Table 2 — Symbols, abbreviations and designations

Symbol/ abbreviation	Unit	Designation
d_i	mm	distance of the centre of each impression from the surface
Δd	mm	distance of the centre of two adjacent impression
CH	HV / HK	core hardness
HD	mm	hardness depth
ΔW	mm	distance between the measurement series
W	mm	maximum range of 1,5 mm in which the measurement series may be set

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