
Steel — Determination of the thickness of surface-hardened layers

*Acier — Détermination de l'épaisseur des couches durcies
superficielles*

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 18203:2016

<https://standards.iteh.ai/catalog/standards/sist/dedc22b1-3c9d-41f3-9f4c-899835bd7655/iso-18203-2016>



iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 18203:2016

<https://standards.iteh.ai/catalog/standards/sist/dedc22b1-3c9d-41f3-9f4c-899835bd7655/iso-18203-2016>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2016, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

	Page
Foreword.....	iv
Introduction.....	v
1 Scope	1
2 Normative reference	1
3 Terms and definitions	1
4 Symbols, abbreviations and designations	3
5 Principle	3
6 Apparatus	3
7 Test specimen	4
7.1 Selection and preparation of samples.....	4
7.2 Preparation of the surface to be examined.....	5
8 Method of measurement	5
8.1 Hardness testing method.....	5
8.2 Microscopic methods.....	6
8.2.1 Total thickness of surface hardening depth (THD).....	6
8.2.2 Compound layer thickness (CLT).....	6
9 Evaluation of the results	7
9.1 Case hardening depth (CHD), surface hardening depth (SHD) and nitriding hardness depth (NHD).....	7
9.2 Total thickness of surface hardening depth (THD).....	7
9.3 Compound layer thickness (CLT).....	7
10 Test report	8
Annex A (normative) Interpolation method for determining the case hardening depth	9
Annex B (informative) Examples of CLT measurements	11
Bibliography	12

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.

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 17, Steel, Subcommittee SC 7, *Methods of testing (other than mechanical tests and chemical analysis)*.

This first edition of ISO 18203:2016 cancels and replaces ISO 2639:2002, ISO 3754:1976 and ISO 4970:1979, which have been technically revised.

Introduction

In the past, there are three ISO standards for measuring surface-hardened layer. Because those standards employed almost the same principle of measuring, it is intended to make it easy for maintenance of the standards and application of test by integrating these three standards.

The method of estimating uncertainty of measurement is not included in this document. In future revision, uncertainty of measurement may be reflected based on real applications to this test.

iTeh STANDARD PREVIEW (standards.iteh.ai)

ISO 18203:2016

<https://standards.iteh.ai/catalog/standards/sist/dedc22b1-3c9d-41f3-9f4c-899835bd7655/iso-18203-2016>

iTeh STANDARD PREVIEW **(standards.iteh.ai)**

ISO 18203:2016

<https://standards.iteh.ai/catalog/standards/sist/dedc22b1-3c9d-41f3-9f4c-899835bd7655/iso-18203-2016>

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, 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.

NOTE Surface-hardened layer can be produced by mechanical method (shot blasting, shot peening, etc.). The depth of these layers is generally shallow. Measuring a profile of hardened depth may require lower test force of hardness test.

2 Normative reference

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 4545-1, *Metallic materials — Knoop hardness test — Part 1: Test method*

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 terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

case hardening depth

CHD

perpendicular distance between the surface and the layer having a hardness of 550 HV in accordance with ISO 6507-1 or equivalent Knoop hardness in accordance with ISO 4545-1

Note 1 to entry: For steels which present a hardness greater than 450 HV at a distance of three times the case hardening depth (determined with a limiting hardness value of 550 HV) from the surface, a limiting hardness value greater 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: In general, case hardening consists of carburizing or carbonitriding followed by quench hardening (see ISO 4885).

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: Hardness limit is a function of the minimum surface hardness required for the part, given by the following formula:

$$\text{hardness limit (HV)} = A \times \text{minimum surface hardness (HV)}$$

Note 2 to entry: 0,80 is usually used for A. Other values can be applied.

Note 3 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 $3 \times \text{SHD}$ from the surface. Where these conditions are not satisfied, the definition of SHD should be agreed between interested parties.

Note 4 to entry: Recommended hardness limit values are listed in [Table 1](#).

Table 1 — Recommended hardness limit values of SHD

Minimum surface hardness HV	Hardness limit HV
300 to 330	250
335 to 355	275
360 to 385	300
390 to 420	325
425 to 455	350
460 to 480	375
485 to 515	400
520 to 545	425
550 to 575	450
580 to 605	475
610 to 635	500
640 to 665	525
670 to 705	550
710 to 730	575
735 to 765	600
770 to 795	625
800 to 835	650
840 to 865	675

3.3 compound layer thickness CLT

thickness of the surface layer formed during the thermochemical treatment and made up of the chemical compounds formed by the elements introduced during the treatment and certain elements from the base metal

3.4

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: The core hardness is determined by at least three hardness measurements and rounded to the nearest multiple of 10 HV.

3.5

total thickness of surface hardening depth THD

distance from the examined surface to the limit that shows the same hardness as the matrix 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.

4 Symbols, abbreviations and designations

The symbols and abbreviations 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
CHD	mm	case hardening depth
SHD	mm	surface hardening depth
CLT	μm	compound layer thickness
NHD	mm	nitriding hardness depth
THD	mm	total thickness of surface hardening depth
H_{limit}	HV	hardness limit

5 Principle

The case hardening depth, surface hardening depth and nitriding hardness depth are determined from the gradient of hardness on a cross-section normal to the surface.

They are derived graphically from a curve representing the variation in hardness as a function of the distance from the surface of the part.

The total thickness of surface hardening depth is determined from the structure variation observed by micrographic method or by measuring hardness variation.

Compound layer thickness is determined from the chemical compound layer observed by microscopic method.

6 Apparatus

The hardness testing machine for determining Vickers hardness shall be verified and calibrated in accordance with ISO 6507-2.

By agreement between the parties concerned, measurement of the Knoop hardness may be used. The hardness testing machine for determining Knoop hardness shall be verified and calibrated in accordance with ISO 4545-2.

For measuring the total thickness of surface hardening depth, it is recommended that a microscope that can display the hardened layer as 1/3 to 2/3 of the view field should be used (see ISO 1463).

7 Test specimen

7.1 Selection and preparation of samples

The measurement shall be made, unless otherwise specially agreed, on a cross-section of the part in the following specified condition:

- a section perpendicular to the longitudinal axis of the product, or, if the product has no longitudinal axis, a section perpendicular to the surface at a location to be agreed between the parties concerned;

For thin hardened layers, the following sample can be applied by agreement between interested parties.

NOTE Because stepped test piece and oblique test piece may result in a different outcome from cross-section measurements, using lower test force including microhardness test to cross-section measurement is a better alternative (see ISO 6507-1, ISO 4545-1 and ISO 14577-1).

- a test piece with steps: These steps are precision-ground from the surface of the product to the point where the structure is that of the basis metal, and are 0,05 mm or 0,10 mm thick. The stepped test piece is to be used when a limiting value for the thickness of the surface layer is specified (see [Figure 1](#) and [Figure A.2](#));
- an oblique section (see [Figure 2](#)).

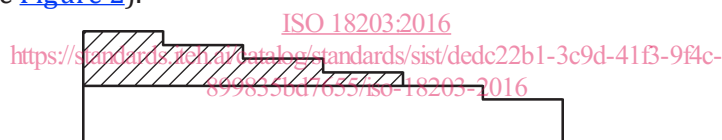
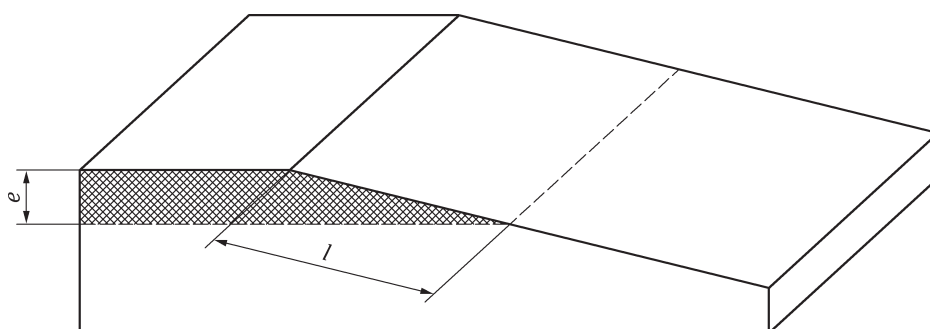


Figure 1 — Stepped test piece



Key

- l distance measured
 e actual depth

NOTE The values of the distance measured should be adjusted by the slope (e/l).

Figure 2 — Oblique section

7.2 Preparation of the surface to be examined

Cut specimens for preparation with the gentlest possible technique, using only laboratory equipment. Mount specimens with a high-quality resin designed to provide excellent edge retention. Grind and polish using a proper sequence of abrasives to remove the damage from sectioning and grinding while maintaining edge retention. Exercise care to ensure that the region of interest is not altered by the sample preparation. The lower the test load in hardness testing, the higher the preparation quality must be. After polishing, etch the specimen with an appropriate solution to determine if the preparation was adequate and to see if there is a modification to the surface. Repeat one or more of the final preparation steps, if the quality is inadequate. Carefully clean off any films or residue on the surface. Do not touch the surface with fingers. For microindentation hardness testing, it is recommended to test an as-polished, non-etched surface. For the micrographic method, use the appropriate etch to reveal and discriminate between the different constituents present.

8 Method of measurement

8.1 Hardness testing method

Make hardness impressions along one or more parallel lines normal to the surface and within a band of width, W , of 1,5 mm (see [Figure 3](#)). The distance between these lines shall meet the requirement of ISO 6507-1.

The distance, Δd , separating two adjacent impressions shall be not less than three times their diagonal (see [Figure 3](#)). The difference between the successive distances of each impression from the surface (e.g. $d_2 - d_1$) shall not exceed 0,1 mm and the cumulative distances from the surface shall be measured to an accuracy of $\pm 25 \mu\text{m}$. The diagonals of the impression shall be measured with the accuracy specified in ISO 6507-2.

The centre of the first impression shall be at a distance, d_1 , from the surface of at least 2,5 times its diagonal.

<https://standards.iteh.ai/catalog/standards/sist/dedc22b1-3c9d-41f3-9f4c-899835bd7655/iso-18203-2016>

Tests using Vickers or Knoop indents are performed at forces from 0,980 7 N to 9,807 N. Measurements of the impressions shall be made with a high quality light optical microscope and proper illumination, with or without a camera system (and possible by image analysis), at a high enough magnification so that the diagonals are between 25 % and 75 % of the eyepiece or screen width or height and the indent tips can be focused without distortion.

NOTE Due to the spacing of indents shown in [Figure 3](#), test forces of 0,980 7 N to 2,942 N are normally used for this work.

Make the measurements on the prepared surface in two or more bands, the location of which shall be agreed between the parties concerned, and for each band plot the results in order to obtain the curve representing the variations in hardness as a function of distance from the surface.