
**Metallic materials — Instrumented
indentation test for hardness and materials
parameters —**

**Part 1:
Test method**

*Matériaux métalliques — Essai de pénétration instrumenté pour la
détermination de la dureté et de paramètres des matériaux —*

Partie 1: Méthode d'essai



PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

This document is a preview generated by EVS

© ISO 2002

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

	Page
Foreword	iv
Introduction.....	v
1 Scope.....	1
2 Normative references.....	1
3 Symbols and designations.....	2
4 Principle	4
5 Testing machine	4
6 Test piece	5
7 Procedure.....	5
8 Uncertainty of the results	7
9 Test report.....	8
Annex A (normative) Materials parameters determined from the force/indentation depth data set	9
Annex B (informative) Types of control use for the indentation process	19
Annex C (normative) Machine compliance and indenter area function	20
Annex D (informative) Notes on diamond indenters	22
Annex E (normative) Influence of the test piece surface roughness on the accuracy of the results	23
Annex F (informative) Correlation of indentation hardness H_{IT} to Vickers hardness	24
Bibliography	25

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 3.

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 part of ISO 14577 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 14577-1 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 3, *Hardness testing*.

ISO 14577 consists of the following parts, under the general title *Metallic materials — Instrumented indentation test for hardness and materials parameters*:

- *Part 1: Test method*
- *Part 2: Verification and calibration of testing machines*
- *Part 3: Calibration of reference blocks*

Annexes A, C and E form a normative part of this part of ISO 14577. Annexes B, D and F are for information only.

Introduction

Hardness has typically been defined as the resistance of a material to permanent penetration by another harder material. The results obtained when performing Rockwell, Vickers and Brinell tests are determined after the test force has been removed. Therefore, the effect of elastic deformation under the indenter has been ignored.

ISO 14577 has been prepared to enable the user to evaluate the indentation of materials by considering both the force and displacement during plastic and elastic deformation. By monitoring the complete cycle of increasing and removal of the test force, hardness values equivalent to traditional hardness values can be determined. More significantly, additional properties of the material, such as its indentation modulus and elasto-plastic hardness, can also be determined. All these values can be calculated without the need to measure the indent optically.

ISO 14577 has been written to allow a wide variety of post test data analysis.

This document is a preview generated by EVS

This document is a preview generated by EVS

Metallic materials — Instrumented indentation test for hardness and materials parameters —

Part 1:

Test method

1 Scope

This part of ISO 14577 specifies the method of instrumented indentation test for determination of hardness and other materials parameters for the three ranges given in Table 1.

Table 1 — Ranges of application

Macro range	Micro range	Nano range ^a
$2 \text{ N} \leq F \leq 30 \text{ kN}$	$2 \text{ N} > F; h > 0,2 \text{ }\mu\text{m}$	$h \leq 0,2 \text{ }\mu\text{m}$
^a For the nano range the mechanical deformation strongly depends on the real shape of indenter tip and the calculated materials parameters are significantly influenced by the contact area function of the indenter used in the testing machine. Therefore careful calibration of both instrument and indenter shape is required in order to achieve an acceptable reproducibility of the materials parameters determined with different machines.		

The macro and micro range are distinguished by the test forces in relation to the indentation depth.

Attention is drawn to the fact that the micro range has an upper limit given by the test force (2 N) and a lower limit given by the indentation depth of 0,2 μm .

The determination of hardness and other materials parameters is given in annex A.

At high contact pressures, damage to the indenter is possible. For this reason in the macro range, hardmetal indenters are often used. For test pieces with very high hardness and modulus of elasticity the influence of indenter deformation on the test result should be taken into account.

NOTE This test method can also be applied to thin metallic and non-metallic coatings and non-metallic materials. In this case the specifications in the relevant standards should be taken into account (see also 6.3).

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 14577. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 14577 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 4287, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*

3 Symbols and designations

For the purposes of this International Standard, the symbols and designations in Table 2 shall be applied (see also Figure 1 and Figure 2).

Table 2 — Symbols and designations

Symbol	Designation	Unit
$A_p(h_c)$	Projected area of contact of the indenter at distance h_c from the tip	mm ²
$A_s(h)$	Surface area of the indenter at distance h from the tip	mm ²
C_{IT}	Indentation creep	%
E_{IT}	Indentation modulus	N/mm ²
F	Test force	N
F_{max}	Maximum test force	N
h	Indentation depth under applied test force	mm
h_c	Depth of the contact of the indenter with the test piece at F_{max}	mm
h_{max}	Maximum indentation depth at F_{max}	mm
h_p	Permanent indentation depth after removal of the test force	mm
h_r	Point of intersection of the tangent c to curve b at F_{max} with the indentation depth-axis (see Figure 1)	mm
H_{IT}	Indentation hardness	N/mm ²
HM	Martens hardness	N/mm ²
HM _s	Martens hardness, determined from the slope of the increasing force/indentation depth curve	N/mm ²
r	Radius of spherical indenter	mm
R_{IT}	Indentation relaxation	%
W_{elast}	Elastic reverse deformation work of indentation	N·m
W_{total}	Total mechanical work of indentation	N·m
α	Angle, specific to the shape of the pyramidal indenter	°
η_{IT}	Relation W_{elast}/W_{total}	%
NOTE 1	To avoid very long numbers the use of multiples or sub-multiples of the units is permitted.	
NOTE 2	1 N/mm ² = 1 MPa.	

1) Published in 1993; corrected and reprinted in 1995.