
**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





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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.

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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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 WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 3, *Hardness testing*.

This second edition cancels and replaces the first edition (ISO 14577-1:2002), which has been technically revised.

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*
- *Part 4: Test method for metallic and non-metallic coatings*

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 (all parts) 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. Furthermore, by a variety of techniques, the instrumented indentation test allows to record hardness and modulus depth profiles within a, probably complex, indentation cycle.

ISO 14577 (all parts) has been written to allow a wide variety of post-test data analysis.

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 following three ranges:

- macro range: $2\text{ N} \leq F \leq 30\text{ kN}$;
- micro range: $2\text{ N} > F$; $h > 0,2\text{ }\mu\text{m}$;
- nano range: $h \leq 0,2\text{ }\mu\text{m}$.

For the nano range, the mechanical deformation strongly depends on the real shape of indenter tip and the calculated material 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 ranges 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 material 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, permanent indenter deformation can occur and can be detected using suitable reference materials. It is necessary that its influence on the test result be taken into account.

This test method can also be applied to thin metallic and non-metallic coatings and non-metallic materials. In this case, it is recommended that the specifications in the relevant standards be taken into account (see also [6.3](#) and ISO 14577-4).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14577-2:2015, *Metallic materials — Instrumented indentation test for hardness and materials parameters — Part 2: Verification and calibration of testing machines*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*