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Hardmetals — Rockwell hardness test (scale A) —

Part 2 :

Preparation and calibration of standard test blocks

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Métaux durs — Essai de dureté Rockwell (échelle A) —

Partie 2: Préparation et étalonnage des blocs de référence

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 3738-2 was prepared by Technical Committee ISO/TC 119, *Powder metallurgy*.

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Hardmetals — Rockwell hardness test (scale A) —

Part 2 :

Preparation and calibration of standard test blocks

1 Scope and field of application

This part of ISO 3738 specifies the preparation and calibration of hardmetal primary standard test blocks, secondary standard test blocks and working standard test blocks from master standard test blocks to be used for the verification of Rockwell hardness testing machines (scale A) and indenters for testing hardmetals.

This document should be read in conjunction with ISO 3738-1.

2 Reference

ISO 3738-1, *Hardmetals — Rockwell hardness test (scale A) — Part 1 : Test method.*

3 Symbols and designations

Table 1

Symbol	Designation
s_1	Standard deviation of hardness determinations on the first surface of a primary standard test block
s_2	Standard deviation of hardness determinations on the test surface of a primary standard test block
s_p	Mean standard deviation of hardness determinations on a primary standard test block.

Standard deviations shall be calculated using the equation

$$s = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2}$$

4 Preparation of standard test blocks

4.1 All standard test blocks referred to in this part of ISO 3738 shall comprise hardmetals composed substantially of tungsten carbide and cobalt without other carbides or with less

than a total of 1 % (*m/m*) of other carbides (e.g. of titanium, tantalum, niobium). The composition and structure shall be chosen to give the desired hardness. Free carbon and eta-phase shall be absent.

4.2 Standard test blocks shall have a nominal diameter of 45 mm and a nominal thickness of 8 mm. The bottom face shall be chamfered 0,8 mm by 45°.

4.3 Every standard test block shall be ground on both flat faces. The face on which indentations are to be made shall have a surface finish of $R_a \leq 0,2 \mu\text{m}$, and may be polished.

The maximum deviation in flatness of the surfaces shall not exceed 0,010 mm. The bottom of the blocks shall not be convex.

The maximum deviation in parallelism shall not exceed 0,020 mm per 50 mm.

5 Master standard test blocks

5.1 Two sets of five master standard test blocks each shall be retained by the Cemented Carbide Producers Association (CCPA), USA, and one set shall be retained by the Secretariat of ISO/TC 119.

One of the sets retained in the USA shall be used for calibrating primary standard test blocks.

5.2 The markings and internationally agreed hardnesses and standard deviations of three sets of the five master test blocks are given in tables 2a), 2b) and 2c).

Table 2a) — Set one retained by CCPA

Marking	Hardness	Standard deviation
2 series I	85,70	0,07
6 series II	88,64	0,07
8 series III	91,08	0,06
2 series IV	91,59	0,04
8 series V	92,80	0,05

Table 2b) — Set two retained by CCPA

Marking	Hardness	Standard deviation
4 series I	85,68	0,08
10 series II	88,63	0,08
6 series III	91,06	0,06
12 series IV	91,62	0,04
5 series V	92,81	0,08

Table 2c) — Set retained by the secretariat of ISO/TC 119

Marking	Hardness	Standard deviation
6 series I	85,69	0,07
5 series II	88,56	0,07
1 series III	91,06	0,06
14 series IV	91,60	0,06
6 series V	92,79	0,08

NOTE — The standard deviation is calculated on 40 indentations made in such a way as to cover the whole test surface.

5.3 The blocks shall not be reground and, to ensure that this has not been done, their thickness at the time of the calibration shall be measured and recorded.

5.4 Of the three sets in tables 2a), 2b) and 2c), one of the sets retained by CCPA shall be used for calibrating primary standard test blocks. The other two sets shall be retained as permanent standards, to be used only when a new master standard is required. Blocks retained by ISO/TC 119 shall only be released by permission of ISO/TC 119/SC 4.

6 Primary standard test blocks

6.1 Primary standard test blocks shall be prepared in sets of nominal hardnesses of 93, 92, 91, 88,5 and 85,5 HRA. Each set shall comprise five blocks, one block of each nominal hardness.

To avoid excessive use of the test surface of the master standard test blocks, the primary standard test blocks shall be prepared and calibrated in groups of not less than 10 blocks of the same nominal hardness.

6.2 Each block shall be marked on the periphery with the letters CCPA, with a number I, II, III, IV or V, corresponding to the nominal hardness, and with one, two or three digits denoting the serial number.

6.3 Hardness measurements shall be made in accordance with the relevant clauses of ISO 3738-1, except that in 5.1 the testing equipment shall be such that the measurement can be made to the nearest 0,1 HRA and the form of the indenter shall be verified in accordance with sub-clause 5.2.2 of ISO 3738-1.

6.4 At least 0,35 mm shall be removed from the test surface (see 4.3).

6.5 Three indentations shall be made on any piece of hard-metal to ensure that the indenter is firm in the machine. Twenty

indentations shall then be made in such a way as to cover the whole test surface of the primary standard test block and the standard deviation (s_1) of the results shall be calculated.

6.6 After establishing uniformity, a further 0,35 mm shall be removed from the tested surface of the primary standard test block (see 4.3). The block is then ready to be calibrated.

6.7 Ten indentations shall be made on the test surface of the master standard test block whose hardness is nearest to that of the primary standard. The arithmetic mean of the results shall be calculated to the nearest 0,01 HRA and subtracted from the agreed hardness of the block (see 5.2). The result is the correction for the given combination of testing machine and indenter.

6.8 If the correction is greater than 0,20 HRA absolute, the machine and indenter shall be examined to ascertain the cause. The test in 6.7 shall then be repeated.

6.9 Twenty indentations shall be made on the new test surface of the primary standard test block and the standard deviation (s_2) of the result shall be calculated.

6.10 The mean standard deviation (s_p) shall be calculated using the equation

$$s_p = \sqrt{\frac{s_1^2 + s_2^2}{2}}$$

If s_p is greater than 0,07 HRA, the block is too variable and shall be discarded.

6.11 If the standard deviation is acceptable, the arithmetic mean of the 20 results obtained according to 6.9 shall be calculated to the nearest 0,01 HRA and corrected for the error of machine and indenter obtained according to 6.7.

The result shall be rounded off to the nearest 0,02 HRA and shall be recorded together with the date as the hardness of the primary standard test block.

6.12 When calibrating a number of primary standard test blocks of the same nominal hardness in an uninterrupted series, the correction may be determined only at the commencement of the series, unless there is reason to believe that the correction may have altered.

6.13 The thickness of the primary standard test block shall be measured and recorded together with the date on which it was calibrated.

6.14 The test surface of primary standard test blocks shall not be reground unless they are then recalibrated against the master standard test blocks.

NOTE — Primary standard test blocks can be obtained from the CCPA.

7 Secondary standard test blocks

7.1 Secondary standard test blocks shall be prepared and calibrated against primary standard test blocks, to avoid using the test surface of primary standard test blocks excessively.

7.2 Secondary standard test blocks shall be prepared in sets of five of nominal hardnesses of 93, 92, 91, 88,5 and 85,5 HRA.

7.3 Each block shall be marked on the periphery with the letter S and a serial number.

7.4 Hardness measurements shall be made in accordance with 6.3 except that the indenter shall be checked in accordance with 7.6 and 7.7.

7.5 Secondary standard test blocks shall conform to the requirements of clause 4, and at least 0,35 mm shall be ground off the test surface.

7.6 A primary standard test block shall be chosen having a hardness nearest to that of the secondary standard test block, and 20 indentations shall be made on its test surface. The arithmetic mean of the 20 results shall be calculated to the nearest 0,01 HRA and subtracted from the calibrated hardness of the primary standard test block. The result is the correction for the given combination of testing machine and indenter.

7.7 If the correction is greater than 0,3 HRA absolute, the machine and indenter shall be examined to ascertain the cause. The test in 7.6 shall then be repeated.

7.8 Twenty indentations shall be made on the test surface of the secondary standard test block and the standard deviation (s_g) of the results shall be calculated.

7.9 If the standard deviation is greater than 0,10 HRA, the block shall be discarded, but if it is not greater than 0,10 HRA, the arithmetic mean of the 20 results shall be calculated to the nearest 0,01 HRA and corrected for the error of machine and indenter obtained according to 7.6.

The result shall be rounded off to the nearest 0,02 HRA and shall be recorded together with the date as the hardness of the secondary standard test block.

The actual hardness values may be marked on the periphery if desired.

7.10 When calibrating a number of secondary standard test blocks of the same nominal hardness in an uninterrupted series, the correction may be determined only at the commencement of the series, unless there is reason to believe that the correction may have altered.

7.11 The thickness of the secondary standard test block shall be measured and recorded together with the actual hardness value and the date on which it was calibrated.

7.12 The test surface of secondary standard test blocks shall not be reground unless they are then recalibrated against the primary standard test blocks.

NOTE — Secondary standard test blocks may be manufactured by any organization possessing the equipment which meets the requirements of this part of ISO 3738.

8 Working standard test blocks

8.1 Working standard test blocks shall be prepared and calibrated against secondary standard test blocks to avoid excessive use of the test surface of secondary standard test blocks.

8.2 Working standard test blocks may be prepared in sets of from one to five (depending on the range of hardnesses of test pieces to be measured), so as to have some or all of the following nominal hardnesses: 93, 92, 91, 88,5 and 85,5 HRA.

8.3 Each block shall be marked on the periphery with the letter W and a serial number.

8.4 Working standard test blocks shall conform to the requirements of 7.5.

8.5 The blocks shall be calibrated in accordance with 7.6 to 7.12, with the following alterations.

8.5.1 The words "primary standard test blocks" shall be replaced by "secondary standard test blocks", and the words "secondary standard test blocks" shall be replaced by "working standard test blocks".

8.5.2 In 7.6, 7.8 and 7.9, "20" shall be replaced by "10".

8.5.3 The standard deviation shall be indicated as s_w .

9 Use of standard test blocks

Secondary standard test blocks or working standard test blocks may be used to conform with ISO 3738-1, sub-clauses 5.2.1, 5.3, 5.4 and 7.2.

10 Expression of results

The hardness values shall be rounded off according to table 3.

Table 3

Standard test block	Reading precision HRA	Mean hardness HRA round to the nearest	Standard deviation HRA
Master	0,1	0,01	0,01
Primary	0,1	0,02	0,02
Secondary	0,1	0,02	0,02
Working	0,1	0,1	0,1

11 Test report

A test report or certificate shall be supplied with every primary, secondary or working standard test block, and shall include the following information :

- a) a reference to this part of ISO 3738;

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- b) all details necessary for the identification of the test block;
- c) the hardness as determined in accordance with this part of ISO 3738;
- d) the standard deviation of hardness over the test surface;
- e) the thickness of the block and the date when it was calibrated;
- f) the serial number and the letter designation of the block from which it was calibrated;
- g) the name of the institution, association or laboratory responsible for the calibration.

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