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Metallic materials - Rockwell hardness test - Part 1: Test method

金属材料 洛氏硬度试验 第1部分：试验方法

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1 Scope

This part of GB/T 230 specifies the test method for the Rockwell hardness and the surface Rockwell hardness of metallic materials for the scales A, B, C, D, E, F, G, H, K, 15N, 30N, 45N, 15T, 30T and 45T.

It applies to fixed and portable Rockwell hardness testers. For particular materials or products, other specific standards apply, for example GB/T 3849.1 and GB/T 9097.

Note: the cemented tungsten carbide ball is the standard Rockwell indenter; the steel ball indenter may be used only where the conditions of Annex A are met.

2 Normative references

The following documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition, including all amendments, applies.

GB/T 230.2-2012 Metallic materials - Rockwell hardness test - Part 2: Verification and calibration of testing machines (scales A, B, C, D, E, F, G, H, K, N, T) (ISO 6508-2:2005, MOD) · GB/T 230.3 Metallic materials - Rockwell hardness test - Part 3: Calibration of reference blocks (scales A, B, C, D, E, F, G, H, K, N, T) (GB/T 230.3-2012, ISO 6508-3:2005, MOD) · JJG 112 Rockwell hardness testing machines for metals (scales A, B, C, D, E, F, G, H, K, N, T) · JJF 1059.1 Evaluation and expression of uncertainty in measurement

3 Principle

An indenter of specified size, shape and material is forced into the surface of the test piece in two stages of test force as specified in Clause 7. The depth of penetration is measured after the initial test force has been applied; the additional test force is then applied and, after it has been removed, the final depth of indentation is measured while the initial test force is still applied. The Rockwell hardness is obtained from the difference h between the final and the initial depth of indentation and from the constants N and S , given in Figure 1, Table 1 and Table 2, by formula (1): Rockwell hardness = $N - h/S$.

4 Symbols, abbreviated terms and designations

The symbols, abbreviated terms and designations used in this part are given in Figure 1 and in Tables 1, 2 and 3. Where the product standard or the agreement permits, indenters of 6.350 mm and 12.70 mm diameter may also be used; for the indenters used in the other scales see ASTM E18. Note 1: for certain materials the range of application may be narrower than that shown in the tables. Note 2: the test force was formerly expressed in kgf - a total test force of 30 kgf, for instance, converts to 294.2 N.

Rockwell hardness scales (Table 1): scale A, HRA, diamond cone, initial force F_0 98.07 N, total force F 588.4 N, scale unit S 0.002 mm, full-scale constant N 100, range 20 HRA to 95 HRA; scale B, HRBW, 1.587 5 mm ball, 98.07 N, 980.7 N, 0.002 mm, 130, 10 HRBW to 100 HRBW; scale C, HRC, diamond cone, 98.07 N, 1.471 kN, 0.002 mm, 100, 20 HRC to 70 HRC; scale D, HRD, diamond cone, 98.07 N, 980.7 N, 0.002 mm, 100, 40 HRD to 77 HRD; scale E, HREW, 3.175 mm ball, 98.07 N, 980.7 N, 0.002 mm, 130, 70 HREW to 100 HREW; scale F, HRFW, 1.587 5 mm ball, 98.07 N, 588.4 N, 0.002 mm, 130, 60 HRFW to 100 HRFW; scale G, HRGW, 1.587 5 mm ball, 98.07 N, 1.471 kN, 0.002 mm, 130, 30 HRGW to 94 HRGW; scale H, HRHW, 3.175 mm ball, 98.07 N, 588.4 N, 0.002 mm, 130, 80 HRHW to 100 HRHW; scale K, HRKW, 3.175 mm ball, 98.07 N, 1.471 kN, 0.002 mm, 130,

40 HRKW to 100 HRKW. Where the surface and the tip of the diamond cone are polished, and the polishing extends along the axis of the cone to at least 0.4 mm from the tip, the range of the C scale may be extended down to 10 HRC.

Surface Rockwell hardness scales (Table 2): 15N, HR15N, diamond cone, initial force 29.42 N, total force 147.1 N, scale unit 0.001 mm, constant 100, range 70 HR15N to 94 HR15N; 30N, HR30N, diamond cone, 29.42 N, 294.2 N, 0.001 mm, 100, 42 HR30N to 86 HR30N; 45N, HR45N, diamond cone, 29.42 N, 441.3 N, 0.001 mm, 100, 20 HR45N to 77 HR45N; 15T, HR15TW, 1.587 5 mm ball, 29.42 N, 147.1 N, 0.001 mm, 100, 67 HR15TW to 93 HR15TW; 30T, HR30TW, 1.587 5 mm ball, 29.42 N, 294.2 N, 0.001 mm, 100, 29 HR30TW to 82 HR30TW; 45T, HR45TW, 1.587 5 mm ball, 29.42 N, 441.3 N, 0.001 mm, 100, 10 HR45TW to 72 HR45TW.

Symbols and abbreviated terms (Table 3): F_0 is the initial test force in newtons; F_1 the additional test force, that is the total test force less the initial test force, in newtons; F the total test force in newtons; S the scale unit of the given scale in millimetres; N the full-scale constant of the given scale; and h the permanent depth of indentation remaining under the initial test force after the additional test force has been removed, in millimetres. For HRA, HRC and HRD the Rockwell hardness is $100 - h/0.002$; for HRBW, HREW, HRFW, HRGW, HRHW and HRKW it is $130 - h/0.002$; and for HRN and HRTW the surface Rockwell hardness is $100 - h/0.001$.

Designation of the result: in the example 70 HR 30T W, 70 is the Rockwell hardness value, HR the Rockwell hardness symbol, 30T the scale symbol from Table 1 or Table 2, and W the type of ball indenter used, W standing for cemented tungsten carbide. Note 1: earlier editions of GB/T 230 allowed a steel ball indenter, marked by a trailing S. Note 2: HR30Tsm and HR15Tsm are defined in Annex A, the capital S and the lower-case m denoting the use of a steel ball indenter and of a diamond test piece support.

5 Testing equipment

Hardness testing machine: the machine shall be able to apply the test forces of some or all of the scales of Tables 1 and 2 as required by Clause 7 and shall comply with GB/T 230.2-2012 or JJG 112.

Diamond cone indenter: it shall meet GB/T 230.2-2012 or JJG 112, with a cone angle of 120 degrees and a tip radius of curvature of 0.2 mm; it may be certified for use as a Rockwell hardness scale indenter only, as a surface Rockwell hardness scale indenter only, or for both.

Ball indenter: cemented tungsten carbide balls of 1.587 5 mm or 3.175 mm diameter meeting GB/T 230.2-2012. Note 1: the ball indenter is normally made of a ball and an indenter body; a one-piece indenter with a spherical end may also be used where that end meets the requirements of 6.3.1 of GB/T 230.2-2012 for dimensions, shape, finish and

hardness and the performance requirement of 6.3.2. Note 2: the cemented tungsten carbide ball is the standard Rockwell indenter; the steel ball is used only for HR30T_{Sm} and HR15T_{Sm}, see Annex A.

6 Test piece

Unless the material standard or the contract specifies otherwise, the surface of the test piece shall be flat and smooth and free of oxide scale and foreign matter, and above all of grease. Where the hardness test is made on a reactive metal likely to stick to the indenter, such as titanium, a suitable oily medium - kerosene, for example - may be used; the medium used shall be stated in the test report.

The test piece shall be prepared so as to keep to a minimum any effect of heating or cold working on the surface hardness; particular care is needed where the depth of indentation is small.

Annex B gives the relation between Rockwell hardness and the minimum thickness of the test piece. For tests with the diamond cone indenter, the thickness of the test piece or of the layer under test shall be not less than ten times the permanent depth of indentation; for tests with the ball indenter, not less than fifteen times. Unless it can be shown that a thinner test piece does not affect the result, no deformation shall normally appear on the back of the test piece after the test. Particularly thin sheet metal shall meet the special requirements of the HR30T_{Sm} and HR15T_{Sm} scales, see Annex A.

For tests on convex cylindrical and convex spherical surfaces, the Rockwell hardness corrections of 7.11 shall be applied.

7 Test procedure

The test is generally carried out at a room temperature of 10 degrees Celsius to 35 degrees Celsius. Where the ambient temperature falls outside that range, the laboratory shall assess its effect on the test data, and the test temperature shall be recorded and stated in the report. Note: a marked change of temperature during the test or the calibration may increase the measurement uncertainty and cause the measurement to exceed the tolerance.

Before the hardness tester is used on any day, the user shall carry out the routine check of Annex C for each scale to be used; the diamond indenter shall be checked as required by Annex D.

After the indenter, the indenter ball or the test-piece support has been changed or refitted, at least two indentations shall be made and their results discarded, and the routine check of Annex C shall then be carried out to make sure the indenter and the support are correctly mounted.