SLOVENSKI STANDARD
SIST ENV 843-4:2000

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Advanced technical ceramics - Monolithic ceramics - Mechanical properties at room temperature - Part 4: Vickers, Knoop and Rockwell Superficial hardness tests

Advanced technical ceramics - Monolithic ceramics - Mechanical properties at room temperature - Part 4: Vickers, Knoop and Rockwell Superficial hardness tests

Hochleistungskeramik - Monolithische Keramik - Mechanische Eigenschaften bei Raumtemperatur - Teil 4: Vickers, Knoop und Rockwell Härteprüfung

Céramiques techniques avancées - Céramiques monolithiques - Propriétés a la température ambiante - Partie 4: Essais de dureté de Vickers, Knoop et Rockwell superficiel

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English version

Advanced technical ceramics - Monolitic ceramics - Mechanical properties at room temperature - Part 4: Vickers, Knoop and Rockwell Superficial hardness tests

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart,36 B-1050 Brussels

Contents

Foreword

This European prestandard has been prepared by CEN/TC 184 "Advanced technical ceramics" the secretariat of which is held by BSI.

EN 843 consists of four parts:

Part 1: Determination of flexural strength
Part 2: Determination of elastic moduli (ENV)
Part 3: Determination of subcritical crack growth parameters from constant stressing rate tests (ENV)
Part 4: Vickers, Knoop and Rockwell superficial hardness tests (ENV)

CEN/TC 184 approved this European Prestandard by resolution 1-12-92 during its sixth meeting held in Berlin, Germany on 8-9 December 1992.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to announce this European prestandard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

1 Scope

This part of ENV 843 defines conditions for conducting, and provides guidelines concerning the value that may be ascribed to the results of, standard hardness tests when applied to advanced monolithic technical ceramics. It is assumed that the calibration and test procedures employed are exactly those for metallic materials. This standard refers to Rockwell A, Rockwell Superficial (N-scale), Vickers, and Knoop hardness testing, as described in existing international standards.

2 Normative references

This European Prestandard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate place in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 10109-1	Metallic materials - Hardness test - Part 1: Rockwell test (scales A, B, C, D, E, F, G, H, K) and Rockwell superficial test (scales 15N, 30N, 45N, 15T, 30T, 45T)
EN 10109-2	Metallic materials - Hardness test - Part 2: Verification of Rockwell hardness testing machines (scales A, B, C, D, E, F, G, H, K, N, T)
EN 10109-3	Metallic materials - hardness test - Part 3 - calibration of standard test blocks to be used for Rockwell hardness testing machines (scales A, B, C, D, E, F, G, H, K, N, T)
EN 45001	General criteria for the operation of testing laboratories
ISO 146	Metallic materials - Hardness test - Verification of Vickers hardness testing machines HV 0,2 - HV 100
ISO 640	Metallic materials - Hardness test - Calibration of standard test blocks to be used for Vickers hardness testing machines HV 0,2 - HV 100.
ISO 3738-1	Hardmetals - Rockwell hardness test (scale A) - Part 1 : Test method
ISO 3738-2	Hardmetals - Rockwell hardness test (scale A) - Part 2: Preparation and calibration of standard test blocks.
ISO 3878	Hardmetals - Vickers hardness test.

ISO 9385	Glass and glass-ceramics - Knoop test.
OIML-RI36	Verification of indenters for hardness testing machines[1)]

3 Definitions

For the purposes of this prestandard, the following definitions apply:

3.1 Hardness

The resistance displayed by a material to penetration by a hard indenter of defined geometry and forced into the test surface in a prescribed manner.

3.2 Hardness number

The hardness calculated in a specified hardness test, usually without units specified, derived from the depth of penetration of the indenter or lateral dimension of the indentation, and the applied force.

3.3 Hardness indenter

A hard device of defined geometry, and for the purposes of testing ceramics usually fabricated from single-crystal diamond.

NOTE : Types of hardness test are defined in clause 5, clause 6, and clause 7 for Vickers, Knoop and Rockwell superficial tests respectively.

4 Introduction

4.1 General points

The three types of test defined in clause 5, clause 6 and clause 7, have been standardised for metallic materials, and are widely used as a guide to the state of thermal treatment or work-hardening. In advanced technical ceramics they are also widely used, especially to describe materials for applications in a wear environment. Whereas in a metal a hardness test is a measure of the yield stress, in a brittle material the deformation tends not to be homogeneous. In addition to plastic flow, there is usually some cracking and fragmentation occurring, the extent of which has a marked effect on the apparent hardness and the ability to perform meaningful measurements.

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1) This International recommandation is available from the International Organization of Legal Metrology (OIML)
11, rue Turgot, 75009 PARIS - France

A hardness test on a range of widely differing ceramics will enable them to be ranked in order of resistance to localised penetration, which may be correlated with other behavioral characteristics of similar type, e.g. abrasive wear or erosion resistance. Such an interpretation may not be possible if materials show similar characteristics because the discrimination shown by hardness tests may be inadequate.

Uses beyond this application should be viewed with caution. It is for example recommended that hardness tests are not used as a pass/fail criterion in a specification. The potential differences between observers and/or test machines, as explained below, are too great for high levels of confidence in the test results, leading to possible dispute between parties to the specification.

4.2 Verification of test equipment

Hardness standard test blocks are usually supplied with the test machine. It is imperative that they be used for checking the machine behaviour and, in the case of Vickers and Knoop tests, also the visual criteria being employed by the operator for measurement. The test block should also be used to ensure that the indenter is free from chips or cracks which might easily develop when used on very hard materials. Very high hardness calibration blocks are recommended when testing ceramics.

The test force for hardness measurements on ceramics may not be the normal one for which the test machine has previously been calibrated. If this situation occurs, it is desirable to carry out checks that the intended force is actually being applied to the test surface for the required period of time.

Verification of test equipment is described in ISO 146 (Vickers), and in EN 10109-2 (Rockwell N).

> NOTE : There are currently no EN or ISO standards for Vickers at lower loads or for Knoop testing but are covered by Reference 1 A.1 (Annex A).

Calibration of standard reference blocks is described in ISO 640 (Vickers), and in EN 10109-3 (Rockwell N). There are currently no CEN or ISO standards for Knoop test verification and calibration. Verification of the geometry of indenters is dealt with in OIML RI-36.

4.3 Conversion of hardness numbers to other scales

Whereas for metallic materials there are conversion tables to convert between various hardness numbers on particular alloy types, there is no equivalent for ceramic materials. Since ceramics tend to show a strong force dependence of hardness characteristics, it is highly unlikely that there could be a unique relationship between hardness values determined using different forces or different types of indenter. Attempts to convert hardness numbers from one scale to another are strongly discouraged.

5 Test procedure : Method A : Vickers test

5.1 Test method

A hardness test in which a square-based sharp pyramidal diamond indenter having specified face angles is forced into the test-piece surface under a defined force, held for a defined duration and removed. The indentation diagonal lengths are measured, the mean result calculated, and this value then employed to calculate a hardness number which is equivalent to the mean force per actual unit area of indenter surface contacting the test surface (no units are given, but kgf/mm^2 are implied):

$$HV\ F = 1.8544\ F/d^2 \quad (1)$$

where HV F is the Vickers hardness number at applied force F (expressed as the mass in kg from which F is derived), and where d is the mean length of the diagonals of the indentation (expressed as mm). The Vickers test for metallic materials is described in detail in ISO 146 for applied forces derived from masses of 0,2 - 100 kg, and in ISO 3878 for hardmetals.

NOTE : Other references to the Vickers test method, including microhardness tests may be found in References A1 and A2 (Annex A).

Unless otherwise agreed between parties, for the purposes of testing advanced monolithic technical ceramics, the applied force shall be that derived from a mass of 1 kg (i.e. 9.81 N), i.e. test type HV 1.

5.2 Machine calibration

Ensure that the test machine is constructed and operates in conformance with ISO 146. Using a high hardness reference test block certified in accordance with ISO 640, make at least three indentations at a test force of HV 1 (unless otherwise agreed, see 5.1), spaced at least 2 mm apart. Measure the diagonal lengths to the nearest 0,2 μm using either the machine graticule or micrometer stage, or using a separate microscope with a micrometer stage. Check that the indentations are regular in shape and show no damage of the indenter. Calculate the Vickers hardness in accordance with Equation 1. If there is a small difference between the test block calibrated value and the observed values of hardness, check the visual reading criteria employed, and adjust it appropriately. If there is a large difference, check the function of the machine, particularly that the applied force is correctly calibrated.

NOTE : Adjustment of eyesight may be necessary before beginning a measurement session on test-pieces. The use of a reference block is considered to be a useful method of getting the eye accustomed to making measurements before testing the test-piece.