SLOVENSKI STANDARD
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Sodobna tehniļna keramika ï Monolitna keramika ï Sploġne in strukturne lastnosti ï 4. del: Ugotavljanje povrġinske hrapavosti

Advanced technical ceramics - Monolithic ceramics - General and textural properties - Part 4: Determination of surface roughness

Hochleistungskeramik - Monolithische Keramik - Allgemeine und strukturelle Eigenschaften - Teil 4: Bestimmung der Oberflächenrauheit

Céramiques techniques avancées - Céramiques monolithiques - Propriétés générales et texturales - Partie 4: Détermination de la rugosité de surface

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Advanced technical ceramics - Monolithic ceramics - General and textural properties - Part 4: Determination of surface roughness

Céramiques techniques avancées - Céramiques monolithiques - Propriétés générales et texturelles - Partie 4: Détermination de la rigidité de surface

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Contents

Foreword

This document (EN 623-4:2004) has been prepared by Technical Committee CEN/TC 184 “Advanced technical ceramics”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2005, and conflicting national standards shall be withdrawn at the latest by April 2005.

This document supersedes ENV 623-4 :1993.
This part of EN 623 includes a Bibliography.

EN 623 *Advanced technical ceramics — Monolithic ceramics — General and textural properties* consists of five parts:

Part 1: *Determination of the presence of defects by dye penetration tests*

Part 2: *Determination of density and porosity*

Part 3: *Determination of grain size and size distribution (characterized by the Linear Intercept Method)*

Part 4: Guidance on the *determination of surface roughness*

Part 5: *Determination of phase volume fraction by evaluation of micrographs*

At the time of publication of this part of EN 623, part 5 is a European Prestandard.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This part of EN 623 concerns the use of conventional stylus type instruments for the measurement of surface texture of advanced monolithic technical ceramics, sets the test machine measuring parameters, and recommends the adoption of certain precautions and conditions of measurement.

NOTE Non-contact optical methods of surface texture measurement employ a different concept using a narrow laser beam. The interaction of the beam with the surface is influenced by the angle of the surface to the beam and the reflectivity/translucence of the surface. The reflected beam is detected in a number of ways based on spot focus or beam deflection and converted into a height profile. Results from such a test are not directly equivalent to those obtained by the stylus method.

2 Normative references

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

ENV 1006, *Advanced technical ceramics — Monolithic ceramics — Guidance on the selection of test pieces for the evaluation of properties*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:1999)*

EN ISO 3274, *Geometrical product specifications (GPS) — Surface texture: Profile method – Nominal characteristics of contact (stylus) instruments (ISO 3274:1996)*

EN ISO 4287:1998, *Geometrical product specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters (ISO 4287:1997)*

EN ISO 4288:1997, *Geometrical product specifications (GPS) — Surface texture: Profile method — Rules and procedures for the assessment of surface texture (ISO 4288:1996)*

EN ISO 5436-1:2000, *Geometrical product specifications (GPS) — Surface texture: Profile method; Measurement standards — Part 1: Material measures* (ISO 5436-1:2000)

EN ISO 5436-2, *Geometrical product specifications (GPS) — Surface texture: Profile method; Measurement standards — Part 2: Software measurement standards (ISO 5436-2:2001)*

EN ISO 11562, *Geometrical product specifications (GPS) — Surface texture: Profile method — Metrological characteristics of phase correct filters (ISO 11562:1996)*

EN ISO 12179, *Geometrical product specifications (GPS) — Surface texture: Profile method — Calibration of contact (styles) instruments (ISO 12179:2000)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 4287:1998, EN ISO 4288:1997 and EN ISO 5436-1:2000 apply.

4 Principles of conventional surface texture measurement

4.1 Surface texture parameters

The characterisation of surface texture of engineering materials generally is conventionally determined by a profile following stylus drawn across the surface. The profile is amplified and recorded, and the trace is further processed to determine single-valued parameters that may be used to describe it.

Parameters (see EN ISO 4287) that are typically used for characterisation of ceramic surface texture include:

Ra the *arithmetic mean deviation of the assessed profile*, i.e. the arithmetic mean of the absolute ordinate values (i.e. the average deviation of the trace from the computed centre line) within a *sampling length* (normally set to be equal to the *cut-off length* = 0,8 mm for typical scales of surface texture in ceramics); normally, the results from five sampling lengths (= the *evaluation length* = 4 mm) are then averaged;

Rt the *total height of the profile*, i.e. the sum of the maximum profile peak height and the maximum profile valley depth within the evaluation length;

Rz *the maximum height of the profile*, i.e. the sum of the largest profile peak height and the lowest profile valley depth within a sampling length; normally the results from five sampling lengths would be averaged.

NOTE Earlier, but different, ISO definitions of *Rz* may still be in use on older machines, i.e. the 'ten point height of irregularities' method, taking the mean of the five highest peaks and five lowest valleys in a sampling length. The present standard employs the current definition.

RSm the *mean width of the profile elements*, i.e. the mean spacing of the profile irregularities (as defined by the mean spacing between crossovers of the trace and the mean line)

Other parameters exist which may have value for ceramic surface characterisation, including measures of skewness, and are defined in EN ISO 4287.

4.2 Trace manipulation

Various types of equipment to perform this measurement are commercially available, and the procedures for calibration and measurement should conform to existing international standards EN ISO 3274, EN ISO 4288, EN ISO 5436-1, and EN ISO 12169. The equipment usually incorporates proprietary signal processing routines designed to produce single-valued parameters from an appropriate length of trace, usually by first digitising the signal. Many instruments then apply a trace levelling routine to take out general tilt of the surface relative to the axis of measurement. Finally, the trace is divided into sampling lengths and analysed. Parameters derived from 10 such traces are typically analysed in order to ensure adequate sampling of the test surface.

4.3 Instrument calibration

Calibration procedures are covered in EN ISO 12179. The calibration of the vertical height measurement is normally determined by drawing the stylus over steps of calibrated height (or depth) in a reference specimen (EN ISO 5436-1 type A). Horizontal movement calibration is less critical, and may be determined from the horizontal spacing of the steps in the type A reference specimen. Checking the condition of the stylus tip is normally performed using a type B reference specimen, which may have sensitive and insensitive grooves, the former being typically a profile of an isosceles triangle. Checking of meters or other indicators of surface texture parameters is performed with type C reference specimens with a variety of profiles either of isosceles triangles, sine waves or simulated sine waves of regular shape. Checking overall behaviour of meters or other indicators of surface texture parameters is performed with type D reference specimens with an irregular profile repeated every five cut-off wavelengths. An artefact such as a hemisphere (type E) can be used to check the coordinate system in the machine.

For instruments using computer processing of the roughness traces, EN ISO 5436-2 provides a reference dataset (type F1) with which to validate the calculation routines employed by a particular instrument. Alternatively, a dataset can be processed by reference software (type F2) for comparison with instrument supplied software results.

In the absence of a suitable certified ceramic surface texture reference material, it is recommended that these procedures are adopted for calibration of stylus machines to be used for measuring surface texture of advanced monolithic technical ceramics. However it is to be recognised that such calibration artefacts do not necessarily evaluate the machine behaviour over short wavelength surface texture where factors such as stylus inertia and tip radius become more important.

NOTE 1 If appropriate, it is suggested that disagreements between parties may possibly be reduced by exchanging agreed marked and measured ceramic "reference" surfaces, preferably of a type similar to that causing the disagreement, for measurement in the respective test machines in order to identify differences in intrinsic machine performance.

NOTE 2 A determination of the uncertainty of a measurement should also be made in accordance with the procedures in EN ISO 12179.

NOTE 3 A guide to the calibration and use of stylus surface texture measurements is available [1].

5 Factors affecting the determination of surface texture of ceramics

5.1 Microstructural influences

5.1.1 Advanced monolithic technical ceramics which do not possess open porosity may contain isolated pores as a result of their incomplete elimination during fabrication. Pores produce large occasional depressions in the recorded surface texture trace which can bias the surface texture parameters in a manner which:

a) may not be relevant to the application of the surface;

b) may give a misleadingly high value of surface texture parameter;

c) may depend on their frequency along the path of the stylus.

If the surface texture of the non-porous regions of the ceramic surface is required, lengths of the stylus trace which avoid obvious pores should be chosen.

5.1.2 As-fired advanced technical ceramic surfaces are frequently free from significant pores typical of bulk material, but may contain occasional pits and/or surface debris (adherent dust, kiln furniture fragments or granular material used to separate components in firing).

NOTE A glossary of terms for surface defects in ceramics is given in ASTM F109 [2].

Surface debris should be removed before making surface texture measurements, and lengths of trace which avoid obvious pits shall be chosen to characterise the surface.

5.1.3 Damage introduced during surface preparation of the ceramic component is dependent on the machining procedure adopted, and influences the measured surface texture parameters. Single grains or groups of grains may be fractured from the surface, and the resulting pits may be indistinguishable from pre-existing internal pores intercepted by the new surface. Plastically deformed grooving may occur which is particularly noticeable in unidirectional grinding operations. Grinding debris may be compacted onto the surface, or into pores or pits. All these factors may influence the apparent surface texture determined.

It is recommended that, where possible, machining procedures are closely defined and reported together with the apparent surface texture parameters. Further, in the case of unidirectional grinding, the directions on the test-piece in which surface texture is determined should be agreed and should be recorded in the report.

Heavy grinding with coarse grit sizes may introduce a significant depth of sub-surface damage in the form of microcracks, which may influence the performance of the product in end-use. The extent of this damage is not directly related to the apparent surface texture, especially in cases where further finishing processes have been employed to smooth the surface. Under such conditions, surface texture measurements have little value for determining the extent of damage.

NOTE It is recommended that dye penetration tests (see EN 623-1 [3]), followed if necessary by fracturing the component, should be used to reveal extensive sub-surface damage if its existence is suspected.