



SLOVENSKI STANDARD
SIST-TS CEN/TS 1071-8:2005
01-januar-2005

**Sodobna tehnična keramika – Metode za preskušanje keramičnih prevlek – 8. del:
Preskus z vtiskanjem po Rockwellu za ovrednotenje sprijemnosti**

Advanced technical ceramics - Methods of test for ceramic coatings - Part 8: Rockwell indentation test for evaluation of adhesion

Hochleistungskeramik - Verfahren zur Prüfung keramischer Schichten - Teil 8: Rockwell-Eindringprüfung zur Bewertung der Haftung

Céramiques techniques avancées - Méthodes d'essai pour revêtements céramiques - Partie 8: Evaluation de l'adhérence par test de pénétration Rockwell

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ICS:

25.220.99	Druge obdelave in prevleke	Other treatments and coatings
81.060.30	Sodobna keramika	Advanced ceramics

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English version

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Hochleistungskeramik - Verfahren zur Prüfung keramischer Schichten - Teil 8: Rockwell-Eindringprüfung zur Bewertung der Haftung

This Technical Specification (CEN/TS) was approved by CEN on 6 June 2004 for provisional application.

The period of validity of this CEN/TS is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the CEN/TS can be converted into a European Standard.

CEN members are required to announce the existence of this CEN/TS in the same way as for an EN and to make the CEN/TS available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the CEN/TS) until the final decision about the possible conversion of the CEN/TS into an EN is reached.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Contents		Page
Foreword.....		3
1 Scope		4
2 Normative references		4
3 Principle		4
4 Apparatus		4
5 Sampling and preparation of test specimens		4
6 Method of test		5
7 Limits		6
8 Test report		6
Annex A (informative) Indentation and classification.....		7
Bibliography		9

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[SIST-TS CEN/TS 1071-8:2005](https://standards.iteh.ai/catalog/standards/sist/5fedcfa6-347c-4703-92a4-f02a16834b73/sist-ts-cen-ts-1071-8-2005)

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Foreword

This document (CEN/TS 1071-8:2004) has been prepared by Technical Committee CEN/TC 184 "Advanced technical ceramics", the secretariat of which is held by BSI.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to announce this Technical Specification: 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 the United Kingdom.

EN 1071 *Advanced technical ceramics — Methods of test for ceramic coatings* consists of eleven parts:

Part 1: *Determination of coating thickness by contact probe profilometer*

Part 2: *Determination of coating thickness by the crater grinding method*

Part 3: *Determination of adhesive and other mechanical failure modes by a scratch test*

Part 4: *Determination of chemical composition by electron probe microanalysis (EPMA)*

Part 5: *Determination of porosity*

Part 6: *Determination of the abrasion resistance of coatings by a micro-abrasion wear test*

Part 7: *Determination of hardness and modulus by depth sensing indentation*

Part 8: *Rockwell indentation test for evaluation of adhesion*

Part 9: *Determination of fracture strain*

Part 10: *Determination of coating thickness by cross sectioning*

Part 11: *Measurement of internal stress with the Stoney formula.*

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CEN/TS 1071-8:2004 (E)**1 Scope**

This document specifies a method for the evaluation of the adhesion of ceramic coatings by indentation with a Rockwell diamond indenter. The formation of cracks after indentation may also reveal cohesive failure. The indentations are made with a Rockwell hardness test instrument.

The method described in this document may also be suitable for evaluating the adhesion of metallic coatings.

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.

EN ISO 6508-1 *Metallic materials - Rockwell hardness test - Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T) (ISO 6508-1:1999)*

EN ISO 6508-2 *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 6508-2:1999)*

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3 Principle

An indentation is made into the coated surface of the specimen to be tested whereby the coating near the indent can be damaged. The indentation and surrounding area are examined for cracks and/or flaking with the aid of an optical microscope.

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4 Apparatus

The indentations shall be made according to EN ISO 6508-1 following the procedure for a Rockwell hardness indentation.

The Rockwell hardness testing machine shall conform with the requirements of EN ISO 6508-2.

The contour of the diamond indenter shall be checked regularly by optical means (magnifying glass, optical microscope, stereomicroscope or projection screen). This check shall be made for at least four different axial sections. The indenter shall be replaced if this examination reveals any damage of the indenter (e.g. chipping). A magnification of at least 200:1 is recommended to detect ring cracks or microwear.

NOTE Although a research project to evaluate the effect of indentation parameters showed no major influence of load rate or holding time on the results (see [1]) they should be kept constant for reasons of repeatability. To conform with EN ISO 6508-1 requires that the loading time be between 1 s and 8 s and the hold time at $4 \text{ s} \pm 2 \text{ s}$. Neither loading time nor holding time need to be recorded.

5 Sampling and preparation of test specimens

Select a representative test specimen from the coating to be tested. Clean the specimen so that it is free from dust and other particles, and also from oil or other surface films.

6 Method of test

Indentation shall be made in a direction perpendicular to the specimen surface. Therefore specimens shall be prepared plane parallel and/or levelled before indentation.

Depending on the coating/substrate combination a suitable load range shall be selected.

The following rules shall apply:

- for metallic substrates harder than 54 HRC a load of 150 kgf (1471,5N) shall be used (Rockwell C scale);
- for metallic substrates softer than 54 HRC and for medium case-hardened steel substrates a load of 100 kgf (981N) shall be used (Rockwell D scale);
- for all other substrates, e.g. shallow case-hardened steel, thin substrates, cemented carbides, solid ceramics and cermets, a load of 60 kgf (588,6N) shall be used (Rockwell A scale).

Using an optical microscope, at a magnification of 100, relate the indentation with the classification given in table 1. A pictorial representation and sample photographs of these classes can be found in Annex A.

Table 1 — Classes and observation

Class	Observation
Class 0	no cracks nor adhesive delamination
Class 1	cracking without adhesive delamination of the coating
Class 2	partial adhesive delamination with or without cracking
Class 3	complete adhesive delamination

NOTE 1 Class 0 does not necessarily indicate good adhesion. The absence of any visual failure can be due to the test not being suitable for the substrate/coating system under investigation (e.g. thin elastic coatings on hard substrates).

NOTE 2 The test may also reveal cohesive failure of the coating, e.g. cracking. The observation of cracks can be facilitated by using optical contrasting techniques, e.g. Nomarski.

NOTE 3 Delamination can be due to adhesive as well as cohesive failure of the coating. *Adhesive delamination* is defined as a removal of the coating whereby the underlying substrate can be clearly seen, or a removal of one or more sublayers in a multilayer coating whereby the substrate or an underlying sublayer can be clearly distinguished. *Cohesive delamination* is defined as a partial removal of the coating whereby the underlying substrate stays covered by the coating, or a removal of one or more sublayers in a multilayer coating whereby the substrate and none of the underlying sublayers can be clearly distinguished.

NOTE 4 Complete delamination is defined as an uninterrupted removal of the coating along the circumference of the indent.

When a Class 2 failure is observed an estimate of the percentage of delamination in relation to the surface area of the indent shall be given.

When a Class 3 failure is observed the size of the adhesive delamination shall be described by the ratio of the radius of adhesive delamination (r) to the radius of the indent (a).

NOTE 5 For a Class 3 failure the radius of adhesive delamination is defined as the maximum radius of the delamination related to the centre of the indent excluding any needle like delaminations away from the indent.

CEN/TS 1071-8:2004 (E)

NOTE 6 It is recommended that at least 3 measurements be made on representative locations.

7 Limits

Results shall only be compared when a similar substrate/coating combination and coating thickness are used.

When comparing results, class designations shall be linked to the load used. Only indents made at the same load shall be compared.

8 Test report

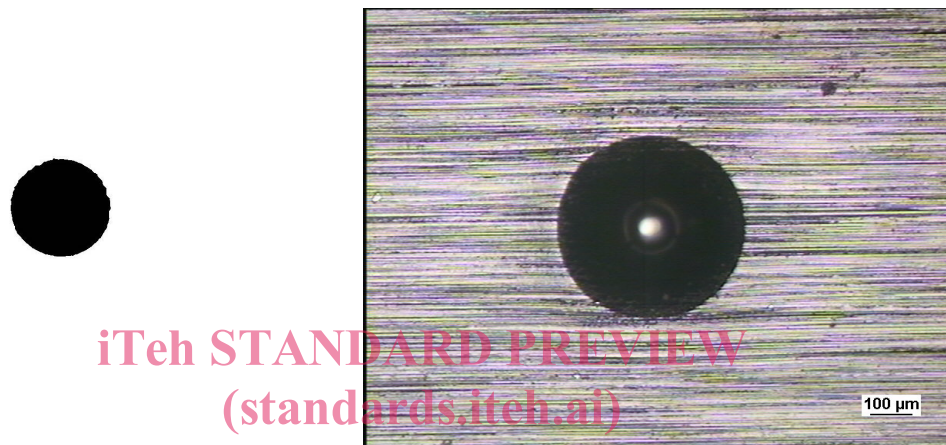
The test report shall include the following information:

- a) name and address of testing establishment;
- b) date of the test, unique identification of the report and of each page, customer name and address, signature of responsible individual(s);
- c) reference to this standard, i.e. determined in accordance with CEN/TS 1071-8;
- d) manufacturer and type of test equipment, date of last calibration;
- e) description of the test material: type of substrate, type of coating, date of receipt;
- f) method of test (load used), specimen sampling and preparation;
- g) results of at least three tests for the load used, including descriptions for Class 2 or Class 3 failures;
- h) comments about the test or the test results, e.g. the observation of cohesive failure.

Annex A (informative)

Indentation and classification

Figures A.1 to A.4 illustrate the classification of coating damage given in Table 1.



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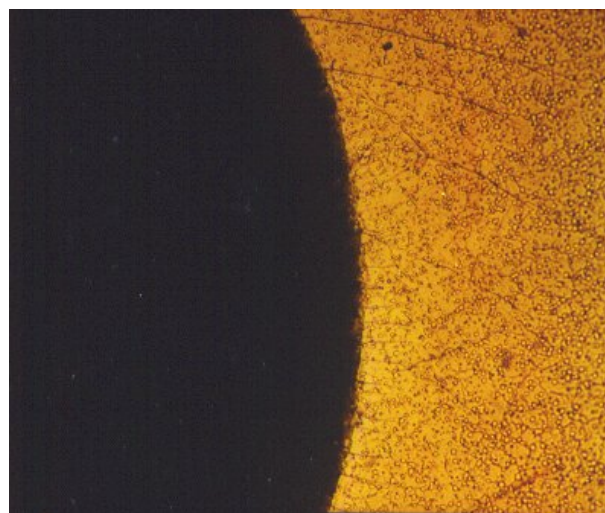
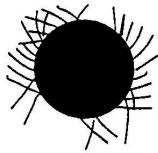


Figure A.2 — Class 1