

**Advanced technical ceramics - Methods
of test for ceramic coatings - Part 3:
Determination of adhesion and other
mechanical failure modes by a scratch
test**

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ceramic coatings - Part 3: Determination of adhesion
and other mechanical failure modes by a scratch test

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

<p>Käesolev Eesti standard EVS-EN 1071-3:2005 sisaldab Euroopa standardi EN 1071-3:2005 ingliskeelset teksti.</p> <p>Käesolev dokument on jõustatud 29.09.2005 ja selle kohta on avaldatud teade Eesti standardiorganisatsiooni ametlikus väljaandes.</p> <p>Standard on kättesaadav Eesti standardiorganisatsioonist.</p>	<p>This Estonian standard EVS-EN 1071-3:2005 consists of the English text of the European standard EN 1071-3:2005.</p> <p>This document is endorsed on 29.09.2005 with the notification being published in the official publication of the Estonian national standardisation organisation.</p> <p>The standard is available from Estonian standardisation organisation.</p>
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<p>Käsitlusala:</p> <p>This Part of EN 1071 describes a method of testing ceramic coatings by scratching with a loaded diamond stylus so as to promote adhesive and/or cohesive failure of the coating-substrate system.</p>	<p>Scope:</p> <p>This Part of EN 1071 describes a method of testing ceramic coatings by scratching with a loaded diamond stylus so as to promote adhesive and/or cohesive failure of the coating-substrate system.</p>
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Võtmesõnad:

English Version

Advanced technical ceramics - Methods of test for ceramic coatings - Part 3: Determination of adhesion and other mechanical failure modes by a scratch test

Céramiques techniques avancées - Méthodes d'essai pour revêtements céramiques - Partie 3 : Détermination de l'adhérence et autres modes de défaillance mécanique par essai de rayure

Hochleistungskeramik - Verfahren zur Prüfung keramischer Schichten - Teil 3: Bestimmung der Haftung und Formen des mechanischen Versagens mit dem Ritztest

This European Standard was approved by CEN on 27 June 2005.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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Foreword

This European Standard (EN 1071-3:2005) 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 February 2006, and conflicting national standards shall be withdrawn at the latest by February 2006.

This European Standard supersedes ENV 1071-3:1994.

EN 1071 – *Advanced technical ceramics – Methods of test for ceramic coatings* has 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 adhesion 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 Young's modulus by instrumented indentation testing*

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*

Parts 7 to 11 are Technical Specifications.

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.

Introduction

The test method in this Part of EN 1071 consists of drawing a loaded stylus across a coated surface. The load on the stylus is increased until failure of the coating/substrate system occurs. Alternatively repetitive scratching at a fixed load can be used to promote failure. The normal load on the stylus at which a particular failure mode initiates is recorded and is referred to as the critical load, L_c , for that mode of failure. Failure events are detected by the use of microscopic examination, acoustic emission and/or friction force measurement.

Knowledge of the failure mode is essential to assess the mechanical behaviour of coated surfaces. Only some of the observed failure events in scratch testing are related to detachment at the coating-substrate interface and are thus relevant as a measure of adhesion. Other failures, such as cracks and cohesive damage within the coating or substrate may be equally important to determine the behaviour of a coated component in a particular application.

1 Scope

This Part of EN 1071 describes a method of testing ceramic coatings by scratching with a loaded diamond stylus so as to promote adhesive and/or cohesive failure of the coating-substrate system. The test is suitable for evaluating ceramic coatings up to a thickness of 20 µm and can also be suitable for evaluating other coating types and thicknesses. The test is intended for use with specimens of limited surface roughness.

This European Standard is intended for use in the macro (1 N – 100 N) load range. The procedures can also be applicable to other load ranges. However, appropriate calibration is essential if the normal loads at which failure events occur are to be quantified.

2 Normative references

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

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

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)*

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

3 Principle

The scratch test is designed for the assessment of the mechanical integrity of coated surfaces. The test method consists of generating scratches with a stylus of defined shape (usually diamond with a Rockwell C geometry) by drawing it across the surface of the coating-substrate system to be tested, either under constant or progressive load (see Figure 1). Failure events are detected by direct microscopic observation of the scratch and sometimes by using acoustic emission and/or friction force measurement.

The driving forces for the failure of the coating-substrate system in the scratch test are a combination of elastic-plastic indentation stresses, frictional stresses and the residual internal stress present in the coating. The normal load at which failure occurs is called the critical load L_c .

NOTE 1 In a scratch test, a number of consecutive coating failure events may be observed at increasing critical load values. Failure by cracking through the coating thickness (through-thickness cracking) usually occurs at lower loads than detachment of the coating. Therefore, it is quite common to characterise the onset of cracking by the critical normal load L_{c1} , while the onset of coating detachment defines the critical normal load L_{c2} . In general, a series of failure modes are observed and used to study the mechanical behaviour of the coated surface, where the onset of the n^{th} failure mode defines the critical load L_{cn} (see Annex B).

NOTE 2 The critical loads at which the failure events appear depend not only on the coating adhesion strength but also on other parameters, such as loading rate, traverse speed, diamond tip wear, substrate and coating roughness, some of which are directly related to the test itself, while others are related to the coating-substrate system.