Non-destructive Testing - Test Method for Residual Stress analysis by X-ray Diffraction

EESTI STANDARDIKESKUS
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NATIONAL FOREWORD

Käesolev Eesti standard EVS-EN 15305:2008 sisaldab Euroopa standardi EN 15305:2008 ingliskeelset teksti.	This Estonian standard EVS-EN 15305:2008 consists of the English text of the European standard EN 15305:2008.
Standard on kinnitatud Eesti Standardikeskuse 25.09.2008 käskkirjaga ja jõustub sellekohase teate avaldamisel EVS Teatajas.	This standard is ratified with the order of Estonian Centre for Standardisation dated 25.09.2008 and is endorsed with the notification published in the official bulletin of the Estonian national standardisation organisation.
Euroopa standardimisorganisatsioonide poolt rahvuslikele liikmetele Euroopa standardi teksti kättesaadavaks tegemise kuupäev on 13.08.2008.	Date of Availability of the European standard text 13.08.2008.
Standard on kättesaadav Eesti standardiorganisatsioonist.	The standard is available from Estonian standardisation organisation.

ICS 19.100

Võtmesõnad:

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 15305

August 2008

ICS 19.100

English Version

Non-destructive Testing - Test Method for Residual Stress analysis by X-ray Diffraction

Essais non-destructifs - Méthode d'essai pour l'analyse des contraintes résiduelles par diffraction des rayons X

Zerstörungsfreie Prüfung - Röntgendiffraktometrisches Prüfverfahren zur Ermittlung der Eigenspannungen

This European Standard was approved by CEN on 4 July 2008.

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 CEN Management Centre 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 CEN Management Centre has the same status as the official versions.

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Ref. No. EN 15305:2008: E

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Foreword

This document (EN 15305:2008) has been prepared by Technical Committee CEN/TC 138 “Non-destructive testing”, the secretariat of which is held by AFNOR.

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 2009, and conflicting national standards shall be withdrawn at the latest by February 2009.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This European Standard about “Non destructive testing - X-ray diffraction from polycrystalline and amorphous material” is composed of:

— EN 13925-1, *General principles*;

— EN 13925-2, *Procedures*;

— EN 13925-3, *Instruments*;

— EN 1330-11, *Non-destructive testing - Terminology - Terms used in X-ray diffraction from polycrystalline and amorphous materials*

In order to explain the relationship between the topics described in the different standards, a diagram illustrating typical operation involved in XRPD is given in Annex A.

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

Introduction

Residual strains in crystalline materials may be determined by X-ray diffraction analysis. Assuming linear elastic distortions, the related residual stresses are calculated.

In this document the principles of the measure procedure and the analysis technique are described.

1 Scope

This European Standard describes the test method for the determination of macroscopic residual or applied stresses non-destructively by X-ray diffraction analysis in the near-surface region of a polycrystalline specimen or component.

All materials with a sufficient degree of crystallinity can be analysed, but limitations may arise in the following cases (brief indications are given in Clause 12):

— Stress gradients;

— Lattice constants gradient ;

— Surface roughness;

— Non-flat surfaces (see 5.1.2);

— Highly textured materials;

— Coarse grained material (see 5.1.4);

— Multiphase materials;

— Overlapping diffraction lines;

— Broad diffraction lines.

The specific procedures developed for the determination of residual stresses in the cases listed above are not included in this document.

The method described is based on the angular dispersive technique with reflection geometry as defined by EN 13925-1.

The recommendations in this document are meant for stress analysis where only the diffraction line shift is determined.

This European Standard does not cover methods for residual stress analyses based on synchrotron X-ray radiation and it does not exhaustively consider all possible areas of application.

Radiation Protection. Exposure of any part of the human body to X-rays can be injurious to health. It is therefore essential that whenever X-ray equipment is used, adequate precautions should be taken to protect the operator and any other person in the vicinity. Recommended practice for radiation protection as well as limits for the levels of X-radiation exposure are those established by national legislation in each country. If there are no official regulations or recommendations in a country, the latest recommendations of the International Commission on Radiological Protection should be applied.

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 13925-1:2003, *Non-destructive testing – X-ray diffraction from polycrystalline and amorphous material – Part 1: General principles*

EN 13925-2:2003, *Non-destructive testing – X-ray diffraction from polycrystalline and amorphous materials – Part 2: Procedures.*

EN 13925-3:2005, *Non-destructive testing – X-ray diffraction from polycrystalline and amorphous materials – Part 3: Instruments*

ISO 5725-1, *Accuracy (trueness and precision) of measurement methods and results – Part 1: General principles and definitions*

ISO 5725-2*, Accuracy (trueness and precision) of measurement methods and results – Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

3 Terms, definitions and symbols

For the purposes of this document, the following term, definition and symbols apply

3.1 Terms and definitions

3.1.1
Residual stress
self-equilibrating internal stresses existing in a free body which has no external forces or constraints acting on its boundary

3.2 Symbols and abbreviations

—	2θ	The diffraction angle; this is the angle between the incident and diffracted X-ray beams.
—	θ	The Bragg angle; this is the angle between the diffracting lattice planes and the incident beam.
—	ω	The angle between the incident X-ray beam and the specimen surface at $\chi = 0$.
—	ϕ	The angle between a fixed direction in the plane of the specimen and the projection in that plane of the normal to the diffracting lattice planes.
—	ψ	The angle between the normal of the specimen and the normal of the diffracting lattice planes.
—	χ	The angle χ rotates in the plane perpendicular to that containing ω and 2θ; the rotation axis of χ is orientated perpendicular to both the ω and the φ axis.
—	{hkl	Family of crystal lattice planes defined by the indices h, k and l.
—	$\varepsilon_{\phi\psi}$	Strain measured in the direction defined by the angles ϕ and ψ.
—	d_0	Interplanar distance (d spacing) of a strain free specimen.
—	$d_{\phi\psi}$	Interplanar distance (d spacing) of strained material in the direction of measurement defined by the angles ϕ and ψ.
—	(S_1, S_2, S_3)	Specimen coordinate system.
—	(L1, L2, L3)	Laboratory coordinate system.