

SVENSK STANDARD

SS-EN 15305:2008

Fastställt/Approved: 2008-08-22

Publicerad/Published: 2008-10-06

Utgåva/Edition: 1

Språk/Language: engelska/English

ICS: 19.100

Oförstörande provning – Provningsmetod för analys av restspänning genom röntgendiffraktion

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

This preview is downloaded from www.sis.se. Buy the entire standard via <https://www.sis.se/std-67048>

Hitta rätt produkt och ett leveranssätt som passar dig

Standarder

Genom att följa gällande standard både effektiviserar och säkrar du ditt arbete. Många standarder ingår dessutom ofta i paket.

Tjänster

Abonnemang är tjänsten där vi uppdaterar dig med aktuella standarder när förändringar sker på dem du valt att abonnera på. På så sätt är du säker på att du alltid arbetar efter rätt utgåva.

e-nav är vår online-tjänst som ger dig och dina kollegor tillgång till standarder ni valt att abonnera på dygnet runt. Med e-nav kan samma standard användas av flera personer samtidigt.

Leveranssätt

Du väljer hur du vill ha dina standarder levererade. Vi kan erbjuda dig dem på papper och som pdf.

Andra produkter

Vi har böcker som underlättar arbetet att följa en standard. Med våra böcker får du ökad förståelse för hur standarder ska följas och vilka fördelar den ger dig i ditt arbete. Vi tar fram många egna publikationer och fungerar även som återförsäljare. Det gör att du hos oss kan hitta över 500 unika titlar. Vi har även tekniska rapporter, specifikationer och "workshop agreement".

Matriser är en översikt på standarder och handböcker som bör läsas tillsammans. De finns på sis.se och ger dig en bra bild över hur olika produkter hör ihop.

Standardiseringsprojekt

Du kan påverka innehållet i framtida standarder genom att delta i någon av SIS ca 400 Tekniska Kommittéer.

Find the right product and the type of delivery that suits you

Standards

By complying with current standards, you can make your work more efficient and ensure reliability. Also, several of the standards are often supplied in packages.

Services

Subscription is the service that keeps you up to date with current standards when changes occur in the ones you have chosen to subscribe to. This ensures that you are always working with the right edition.

e-nav is our online service that gives you and your colleagues access to the standards you subscribe to 24 hours a day. With e-nav, the same standards can be used by several people at once.

Type of delivery

You choose how you want your standards delivered. We can supply them both on paper and as PDF files.

Other products

We have books that facilitate standards compliance. They make it easier to understand how compliance works and how this benefits you in your operation. We produce many publications of our own, and also act as retailers. This means that we have more than 500 unique titles for you to choose from. We also have technical reports, specifications and workshop agreements.

Matrices, listed at sis.se, provide an overview of which publications belong together.

Standardisation project

You can influence the content of future standards by taking part in one or other of SIS's 400 or so Technical Committees.

Europastandarden EN 15305:2008 gäller som svensk standard. Detta dokument innehåller den officiella engelska versionen av EN 15305:2008.

The European Standard EN 15305:2008 has the status of a Swedish Standard. This document contains the official English version of EN 15305:2008.

© Copyright/Upphovsrätten till denna produkt tillhör SIS, Swedish Standards Institute, Stockholm, Sverige. Användningen av denna produkt regleras av slutanvändarlicensen som återfinns i denna produkt, se standardens sista sidor.

© Copyright SIS, Swedish Standards Institute, Stockholm, Sweden. All rights reserved. The use of this product is governed by the end-user licence for this product. You will find the licence in the end of this document.

Upplysningar om sakinnehållet i standarden lämnas av SIS, Swedish Standards Institute, telefon 08-555 520 00.

Standarder kan beställas hos SIS Förlag AB som även lämnar allmänna upplysningar om svensk och utländsk standard.

Information about the content of the standard is available from the Swedish Standards Institute (SIS), tel +46 8 555 520 00.

Standards may be ordered from SIS Förlag AB, who can also provide general information about Swedish and foreign standards.

SIS Förlag AB, SE 118 80 Stockholm, Sweden. Tel: +46 8 555 523 10. Fax: +46 8 555 523 11.

E-mail: sis.sales@sis.se Internet: www.sis.se

EUROPEAN STANDARD

EN 15305

NORME EUROPÉENNE

EUROPÄISCHE NORM

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.

CEN members are the national standards bodies of 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 United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Contents	Page
Foreword.....	5
Introduction	6
1 Scope	7
2 Normative references	7
3 Terms, definitions and symbols.....	8
3.1 Terms and definitions	8
3.2 Symbols and abbreviations	8
4 Principles.....	10
4.1 General principles of the measurement	10
4.2 Biaxial stress analysis	12
4.3 Triaxial stress analysis	13
5 Specimen.....	14
5.1 Material characteristics	14
5.1.1 General.....	14
5.1.2 Shape, dimensions and weight	15
5.1.3 Specimen composition/homogeneity	15
5.1.4 Grain size and diffracting domains.....	16
5.1.5 Specimen X-ray transparency	16
5.1.6 Coatings and thin layers	16
5.2 Preparation of specimen.....	17
5.2.1 Surface preparation.....	17
5.2.2 Stress depth profiling.....	17
5.2.3 Large specimen or complex geometry.....	17
6 Equipment	17
6.1 General.....	17
6.2 Choice of equipment	18
6.2.1 General.....	18
6.2.2 The ω -method.....	19
6.2.3 The χ -method	20
6.2.4 The modified χ -method	21
6.2.5 Other geometries	21
6.3 Choice of radiation	21
6.4 Choice of the detector	23
6.5 Performance of the equipment.....	24
6.5.1 Alignment	24
6.5.2 Performance of the goniometer	24
6.6 Qualification and verification of the equipment	24
6.6.1 General.....	24
6.6.2 Qualification	24
6.6.3 Verification of the performance of the qualified equipment	26
7 Experimental Method	27
7.1 General.....	27
7.2 Specimen positioning	27
7.3 Diffraction conditions.....	28
7.4 Data collection	29
8 Treatment of the data	30
8.1 General.....	30
8.2 Treatment of the diffraction data.....	30
8.2.1 General.....	30

8.2.2	Intensity corrections	30
8.2.3	Determination of the diffraction line position.....	31
8.2.4	Correction on the diffraction line position.....	32
8.3	Stress calculation.....	32
8.3.1	Calculation of strains and stresses.....	32
8.3.2	Errors and uncertainties [16], [17].....	33
8.4	Critical assessment of the results	34
8.4.1	General	34
8.4.2	Visual inspection	34
8.4.3	Quantitative inspection.....	34
9	Report	35
10	Experimental determination of XECs	36
10.1	Introduction.....	36
10.2	Loading device	37
10.3	Specimen.....	37
10.4	Loading device calibration and specimen accommodation	38
10.5	Diffraction measurements	38
10.6	Calculation of XECs	38
11	Reference specimens.....	39
11.1	Introduction.....	39
11.2	Stress-free reference specimen.....	39
11.2.1	General	39
11.2.2	Preparation of the stress-free specimen.....	39
11.2.3	Method of measurement	40
11.3	Stress-reference specimen	40
11.3.1	Laboratory qualified (LQ) stress-reference specimen.....	40
11.3.2	Inter-laboratory qualified (ILQ) stress-reference specimen.....	41
12	Limiting cases.....	41
12.1	Introduction.....	41
12.2	Presence of a subsurface stress gradient.....	42
12.3	Surface stress gradient.....	42
12.4	Surface roughness	42
12.5	Non-flat surfaces	42
12.6	Effects of specimen microstructure	43
12.6.1	Textured materials.....	43
12.6.2	Multiphase materials.....	43
12.7	Broad diffraction lines	44
Annex A (informative) Schematic representation of the European XRPD Standardisation Project		46
Annex B (informative) Sources of Residual Stress		47
B.1	General	47
B.2	Mechanical processes	47
B.3	Thermal processes.....	47
B.4	Chemical processes.....	47
Annex C (normative) Determination of the stress state - General Procedure.....		48
C.1	General	48
C.2	Using the exact definition of the deformation.....	49
C.2.1	General	49
C.2.2	Determination of the stress tensor components	49
C.2.3	Determination of θ and d_0	50
C.3	Using an approximation of the definition of the deformation.....	50
C.3.1	General	50
C.3.2	Determination of the stress tensor components	51
C.3.3	Determination of θ_0 and d_0	51
Annex D (informative) Recent developments.....		52
D.1	Stress measurement using two-dimensional diffraction data.....	52
D.2	Depth resolved evaluation of near surface residual stress - The Scattering Vector Method.....	54

SS-EN 15305:2008 (E)

D.3 Accuracy improvement through the use of equilibrium conditions for determination of stress profile	55
Annex E (informative) Details of treatment of the measured data	56
E.1 Intensity correction on the scan	56
E.1.1 General.....	56
E.1.2 Divergence slit conversion	56
E.1.3 Absorption correction	57
E.1.4 Background correction	58
E.1.5 Lorentz-polarisation correction.....	58
E.1.6 K-Alpha2 stripping.....	59
E.2 Diffraction line position determination.....	59
E.2.1 Centre of Gravity methods.....	59
E.2.2 Parabola Fit	60
E.2.3 Profile Function Fit	60
E.2.4 Middle of width at x% height method	61
E.2.5 Cross-correlation method.....	61
E.3 Correction on the diffraction line position.....	61
E.3.1 General.....	61
E.3.2 Remaining misalignments	61
E.3.3 Transparency correction.....	62
Annex F (informative) General description of acquisition methods	64
F.1 Introduction	64
F.2 Definitions	64
F.3 Description of the various acquisition methods	67
F.3.1 General method.....	67
F.3.2 Omega (ω) method.....	68
F.3.3 Chi (χ) method.....	69
F.3.4 Combined tilt method (also called scattering vector method).....	71
F.3.5 Modified chi method.....	73
F.3.6 Low incidence method	76
F.3.7 Modified omega method	77
F.3.8 Use of a 2D (area) detector	78
F.4 Choice of Φ and Ψ angles	79
F.5 The stereographic projection	80
Annex G (informative) "Normal Stress Measurement Procedure" and "Dedicated Stress Measurement Procedure".....	82
G.1 Introduction	82
G.2 General.....	82
G.2.1 Introduction	82
G.2.2 Normal stress measurement procedure for a single specimen.....	82
G.2.3 Dedicated Stress Measurement Procedure for very similar specimens.....	82
Bibliography	84

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.

SS-EN 15305:2008 (E)

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*