
**Plastics — Determination of tension-
tension fatigue crack propagation
— Linear elastic fracture mechanics
(LEFM) approach**

*Plastiques — Détermination de la propagation de fissure par fatigue
en traction — Approche de la mécanique linéaire élastique de la
rupture (LEFM)*

Sample Document

get full document from standards.iteh.ai



Sample Document

get full document from standards.iteh.ai



COPYRIGHT PROTECTED DOCUMENT

© ISO 2014

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Principle	5
5 Significance and use	5
6 Test specimens	6
6.1 Shape and size	6
6.2 Preparation	9
6.3 Notching.....	9
6.4 Side grooves.....	10
6.5 Conditioning.....	10
7 Apparatus	10
7.1 Test machine	10
7.2 Grips.....	11
7.3 Crack length measurement	11
7.4 Test atmosphere	15
8 Test procedure	15
8.1 Measurement of specimen dimensions.....	15
8.2 Specimen mounting.....	15
8.3 Loading.....	15
8.4 Out-of-plane crack propagation.....	15
8.5 Discontinuous crack propagation.....	15
8.6 Number of tests.....	15
9 Calculation and interpretation of results	16
9.1 Crack length versus number of cycles.....	16
9.2 Crack curvature correction.....	16
9.3 Crack growth rate da/dN	16
9.4 Stress intensity factor range ΔK	16
9.5 Energy release rate range ΔG	17
10 Test report	17
10.1 General.....	17
10.2 For fatigue crack propagation test.....	17
10.3 For fatigue crack propagation to failure test.....	18
Annex A (informative) Abnormality in the use of cyclic fatigue crack propagation test for ranking long-term static fatigue behaviour	19
Bibliography	23

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information.

The committee responsible for this document is ISO/TC 61, *Plastics*, Subcommittee SC 2, *Mechanical properties*.

This second edition cancels and replaces the first edition (ISO 15850:2002) of which it constitutes a minor revision.

Plastics — Determination of tension-tension fatigue crack propagation — Linear elastic fracture mechanics (LEFM) approach

1 Scope

This International Standard specifies a method for measuring the propagation of a crack in a notched specimen subjected to a cyclic tensile load varying between a constant positive minimum and a constant positive maximum value. The test results include the crack length as a function of the number of load cycles and the crack length increase rate as a function of the stress intensity factor and energy release rate at the crack tip. The possible occurrence of discontinuities in crack propagation is detected and reported.

The test can be also used for the purpose of determining the resistance to crack propagation failure. In this case, the results can be presented in the form of number of cycles to failure or total time taken to cause crack propagation failure versus the stress intensity factor (see [Annex A](#)).

The method is suitable for use with the following range of materials:

- rigid and semi-rigid thermoplastic moulding and extrusion materials (including filled and short-fibre-reinforced compounds) plus rigid and semi-rigid thermoplastic sheets;
- rigid and semi-rigid thermosetting materials (including filled and short-fibre-reinforced compounds) plus rigid and semi-rigid thermosetting sheets.

2 Normative references

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

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 527 (all parts), *Plastics — Determination of tensile properties*

ISO 2818, *Plastics — Preparation of test specimens by machining*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 cycle

smallest segment of a load-time or stress-time function which is repeated periodically

Note 1 to entry: The terms fatigue cycle, load cycle, and stress cycle are also commonly used.

3.2 number of cycles completed

N

number of load cycles since the beginning of a test

3.3

waveform

shape of the load-time curve within a single cycle

3.4

maximum load

$P_{\max}$

highest value of the load during a cycle

Note 1 to entry: It is expressed in newtons.

Note 2 to entry: Only positive, i.e. tensile, loads are used in this test method.

3.5

minimum load

$P_{\min}$

lowest value of the load during a cycle

Note 1 to entry: It is expressed in newtons.

Note 2 to entry: Only positive, i.e. tensile, loads are used in this test method.

3.6

load range

ΔP

difference between the maximum and the minimum loads in one cycle, given by:

$$\Delta P = P_{\max} - P_{\min}$$

3.7

load ratio

stress ratio

R

ratio of the minimum to the maximum load in one cycle, i.e.:

$$R = \frac{P_{\min}}{P_{\max}}$$

3.8

stress intensity factor

K

limiting value of the product of the stress $\sigma(r)$ perpendicular to the crack area at a distance r from the crack tip and of the square root of $2\pi r$, as r tends to zero:

$$K = \lim_{r \rightarrow 0} \sigma(r) \sqrt{2\pi r}$$

[SOURCE: ISO 13586:2000, 3.3]

Note 1 to entry: It is expressed in pascal root metres ($\text{Pa} \cdot \text{m}^{1/2}$).

Note 2 to entry: The term factor is used here because it is in common usage, even though the quantity has dimensions.

3.9

maximum stress intensity factor

$K_{\max}$

highest value of the stress intensity factor in one cycle

3.10**minimum stress intensity factor** $K_{\min}$

lowest value of the stress intensity factor in one cycle

3.11**stress intensity factor range** ΔK

difference between the maximum and minimum stress intensity factors in one cycle, given by:

$$\Delta K = K_{\max} - K_{\min}$$

3.12**energy release rate** G difference between the external work δU_{ext} done on a body to enlarge a cracked area by an amount δA and the corresponding change in strain energy δU_S :

$$G = \frac{\delta U_{\text{ext}}}{\delta A} - \frac{\delta U_S}{\delta A}$$

Note 1 to entry: It is expressed in joules per square metre.

Note 2 to entry: Assuming linear elastic behaviour, the following relationship between the stress intensity factor K and the energy release rate G holds:

$$G = \frac{K^2}{E'}$$

where

$$E' = E \quad \text{for plane stress;}$$

$$E' = \frac{E}{1-\nu^2} \quad \text{for plane strain conditions;}$$

 E and ν are the tensile modulus and Poisson's ratio, respectively.**3.13****maximum energy release rate** $G_{\max}$

highest value of the energy release rate in one cycle

3.14**minimum energy release rate** $G_{\min}$

lowest value of the energy release rate in one cycle

3.15**energy release rate range** ΔG

difference between the maximum and minimum energy release rates in one cycle, given by:

$$\Delta G = G_{\max} - G_{\min}$$