SLOVENSKI STANDARD
SIST EN 17119:2018

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Neporušitveno preskušanje - Termografsko preskušanje - Aktivna termografija

Non-destructive testing - Thermographic testing - Active thermography

Zerstörungsfreie Prüfung - Thermografische Prüfung - Aktive Thermografie

Essais non destructifs - Analyse thermographique - Thermographie active

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19.100 Neporušitveno preskušanje Non-destructive testing

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Non-destructive testing - Thermographic testing - Active thermography

Essais non destructifs - Analyse thermographique - Thermographie active

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (EN 17119:2018) 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of an identical text or by endorsement, at the latest by February 2019, and conflicting national standards shall be withdrawn at the latest by February 2019.

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1 Scope

This document defines the procedures for non-destructive testing using active thermography.

These testing procedures can be applied to different materials (e.g. composites, metals and coatings) and are appointed, but not limited to the:

— detection of discontinuities (e.g. voids, cracks, inclusions, delaminations);

— determination of layer or part thicknesses;

— determination and comparison of thermophysical properties.

This standard is describing data acquisition and analysis principles for active thermography and is giving an informative guideline for appropriate selection of the excitation source. Acceptance criteria are not defined in this standard.

Active thermography is applied in industrial production (e.g. compound materials, vehicle parts, engine parts, power plant parts, joining technology, electronic devices) and in maintenance and repair (e.g. aerospace, power plants, civil engineering).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 16714-1, *Non-destructive testing - Thermographic testing - Part 1: General principles*

EN 16714-2, *Non-destructive testing - Thermographic testing - Part 2: Equipment*

EN 16714-3, *Non-destructive testing - Thermographic testing - Part 3: Terms and definitions*

EN 15042-2:2006, *Thickness measurement of coatings and characterization of surfaces with surface waves - Part 2: Guide to the thickness measurement of coatings by photothermic method*

CEN/TR 14748, *Non-destructive testing - Methodology for qualification of non-destructive tests*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 16714-3, EN 15042-2:2006 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
amplitude image
image of the spatial distribution of the amount of radiation emitted by the body at a frequency *f*

3.2
derivative image
image of the spatial distribution of the first or higher order temporal derivative of the temperature response to excitation

3.3
dynamic temperature contrast
local distribution of the temporally varying temperature difference relative to a reference temperature

3.4
lock-in thermography
modulated thermography
energy is introduced periodically in time at the modulation frequency f_{LI}, e.g., in a sinusoidal manner

3.5
phase image
image of the spatial distribution of the temporal delay of the temperature response at a frequency f

3.6
pulse thermography
energy is introduced by means of a short pulse that can be considered as a Dirac pulse

3.7
step thermography
energy source is switched on or/and off for a defined time during which thermal diffusion can occur

3.8
thermal diffusion length
μ
characteristic length of heat diffusion after pulsed or during periodic introduction of energy at a frequency f

$$\mu = \text{sqrt}\,(\alpha/\pi f)$$

3.9
thermal diffusivity
α
represents the temporal and spatial diffusion of thermal energy (heat) inside a body

Note 1 to entry: In thermodynamics, a is used as symbol.

Note 2 to entry: Depending on the material α might not be isotropic.

3.10
thermal effusivity
e
represents the temperature change of a material as a reaction to a transient input of energy

Note 1 to entry: In thermodynamics, b is used as symbol.

Note 2 to entry: Depending on the material e might not be isotropic.

3.11
thermal reflection coefficient
R_c
measure for the reflection of thermal waves (related to the model of thermal diffusion waves) at the interface between two layers having different thermal effusivities e_1 and e_2

$$R_c = (e_1 - e_2) / (e_1 + e_2)$$

3.12
thermal transmission coefficient
T_c
measure for the transmission of thermal waves (related to the model of thermal diffusion waves) at the interface between two layers having different thermal effusivities e_1 and e_2

$$T_c = 2\, e_1 / (e_1 + e_2)$$

4 Techniques of data acquisition

4.1 General

In active thermography, an additional artificial or natural energy source is applied introducing a time dependent heat flux inside the test specimen. This is only done for the purpose of testing (principle see Figure 1).

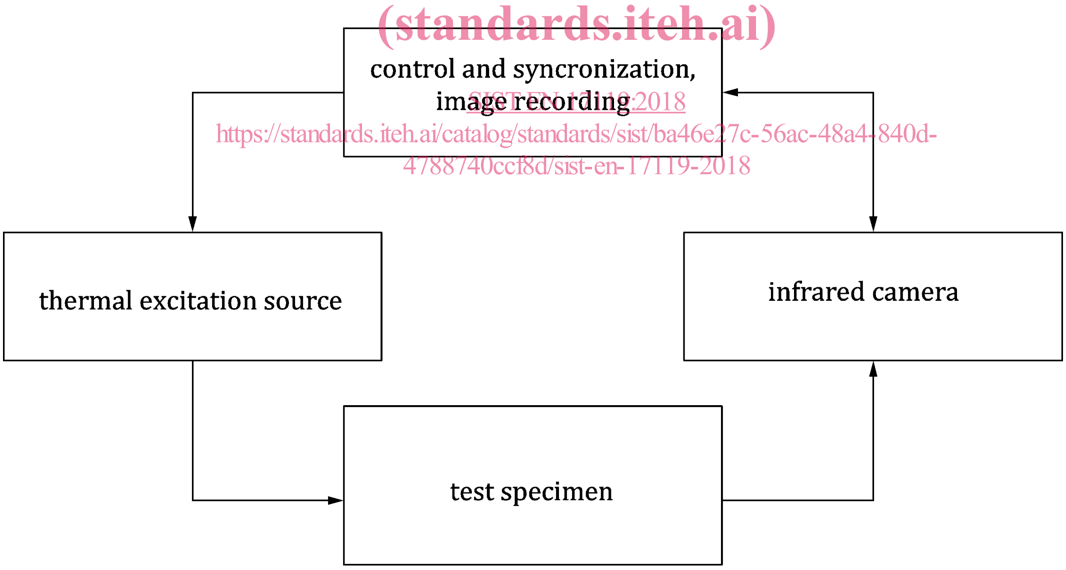

Figure 1 — Principle of active thermography

Thermal excitation can be generated in the test object with different energy sources based on various effects such as:

— absorption of optical radiation (e.g. light or infrared) and/or microwaves;

— electromagnetic induction and/or electric current;

— conversion of mechanical waves (e.g. ultrasonic);

— convection (e.g. hot/cold air);

— conduction (e.g. hot blanket).

Discontinuities inside the test object may affect the heat generation and propagation process and become indirectly visible by recording the emitted radiation with an infrared camera (IR camera). A controller can provide synchronization between energy source and image recording. Generally, a sequence consisting of a number of images is recorded, which may be analysed subsequently.

4.2 Types of temporal excitation

4.2.1 Pulse thermography

For excitation, an energy source is used that provides a short pulse (e.g. flash lamp or a laser). Short means that it can be considered as a Dirac pulse and that the duration of the pulse is significantly less than the time needed for recording a thermal signature of the defects or of the rear side of the layer.

The image sequence may be analysed in time domain, as described in 5.2, or in frequency domain, as described in 5.3.

4.2.2 Step thermography

For excitation, an energy source (e.g. halogen lamp or induction) is switched on or/and off at a particular time. Contrary to pulse thermography, the thermal signature of the defects or of the rear side of the layer already appears during excitation.

The image sequence may be analysed in time domain, as described in 5.2, or in frequency domain, as described in 5.3.

4.2.3 Lock-in thermography

For excitation, the energy source (e.g. halogen lamp or ultrasound) used is periodically modulated in intensity. The signal shape used for excitation can be e.g. a sinus or a square. The selection of the appropriate modulation frequency range depends mainly on the depth range to be investigated and is related to the thermal diffusion length.

Each pixel of the thermal image sequence is correlated in frequency domain with the excitation signal or a reference. This procedure should be performed during a sufficient time of observation of typically several modulation periods.

The image sequence should be analysed in frequency domain, as described in 5.3.

4.3 Types of spatial excitation

4.3.1 Local excitation

A local excitation (e.g. by applying a laser spot) is used to generate a three dimensional heat diffusion within the field of view of the IR camera. Defects with all orientations to the surface can be located. Linear excitation sources can also be used.

4.3.2 Two-dimensional excitation

A two-dimensional excitation (e.g. by using halogen lamps or an array of cold air guns) is used in order to homogeneously heat or cool the surface of the test object. As heat diffuses perpendicular to the surface mainly defects oriented parallel to the surface can be located.

4.3.3 Excitation of the whole volume

The whole volume of the test object is excited in order to induce dissipative processes at the location of defects. For the detection of cracks, e.g. power ultrasonic excitation can be used and for the detection of moisture, e.g. microwave excitation can be used.