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Non-destructive testing — Infrared thermography — Vocabulary

Essais non destructifs — Thermographie infrarouge — Vocabulaire

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Foreword

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The committee responsible for this document is ISO/TC 135, *Non-destructive testing*, Subcommittee SC 8, *Infrared thermography for non-destructive testing*.

Introduction

This International Standard is a compilation of terms and definitions to provide a precise understanding or interpretation of infrared thermography and thermal/infrared non-destructive testing. These serve to secure the foundation of infrared thermography technology growth within the academic and industrial communities.

Non-destructive testing — Infrared thermography — Vocabulary

Scope

This International Standard defines terms used in infrared thermography for non-destructive testing and forms a common basis for standard general use.

1 Terms and definitions

1.1
absorptivity
α
absorptance
absorptance coefficient
proportion (as a fraction of 1) of the radiant energy impinging on a material's surface that is absorbed by the material

NOTE 1 Absorptivity is dimensionless.

NOTE 2 For a blackbody, this is unity (1,0). Technically, absorptivity is the internal absorptance per path length. In thermography, the two terms, absorptivity and absorptance, are often used interchangeably.

NOTE 3 Absorptance is the ratio between the radiation energy absorbed by a body and the total radiation incident on the body.

NOTE 4 Absorptivity can vary with wavelength and be quoted for a specified band width or a specific wavelength. See 1.136, Spectral absorption coefficient.

1.2
active thermography
infrared thermographic examination of materials and objects which requires additional thermal stimulation

NOTE The thermal stimulation can be optical, sonic (ultrasonic), inductive, microwave or use any other form of energy.

1.3
ambient operating range
range of ambient temperatures over which an instrument is designed to operate within reported performance specifications

1.4
ambient temperature
temperature of the air in the vicinity of a test object (target)

NOTE "Ambient temperature" is not to be confused with "reflected ambient temperature", which is a term often used to mean "reflected apparent temperature".

1.5
ambient temperature compensation
correction built into infrared instruments to provide automatic compensation of temperature readings affected by the ambient temperature

1.6
angular subtense
angular diameter of an optical system or subsystem

NOTE 1 Angular subtense is expressed in angular degrees or milliradians.

NOTE 2 In infrared thermography, the angle over which a sensing instrument collects radiant energy.

1.7
anomalous thermal image
observed thermal pattern of a structure that is not in accordance with the expected (reference) thermal pattern

1.8
anomaly
irregularity or abnormality in a system

EXAMPLE An irregularity, such as an anomalous thermal pattern or any indication that deviates from what is normally expected in the absence of any anomaly.

1.9
anti-reflectance coating
coating of infrared optical elements (lenses, windows) used to increase the sensitivity of a specified wavelength range through minimization or suppression of reflections causing signal loss

1.10
apparent temperature
uncompensated reading from an infrared thermography camera containing all radiation incident on the detector, regardless of its source

[ISO 18434-1:2008[6], 3.1]

1.11
area effect
change in infrared radiometer output depending on the area of the measuring target

1.12
artefact
⟨1⟩ product of artificial character due to an extraneous agency
⟨2⟩ error caused by an uncompensated anomaly

EXAMPLE In thermography, an emissivity artefact simulates apparent variation of surface temperature.

1.13
atmospheric absorption
absorption of specific wavelengths of solar radiation, due largely to moisture, atmospheric gases and pollutants

1.14
atmospheric temperature
temperature of the atmosphere between the infrared camera and the object

1.15
atmospheric window
⟨infrared⟩ any spectral interval within the infrared spectrum in which the atmosphere transmits radiant energy well (atmospheric absorption is minimal)

EXAMPLE Atmospheric windows are roughly defined to lie in the wavelength ranges:

a) 0,78 µm to 2,0 µm in the near infrared (NIR);

b) 2,0 µm to 5,5 µm in the mid-wave infrared (MWIR);

c) 7,5 µm to 14,0 µm in the long-wave infrared (LWIR).

1.16
attenuating medium
material or other medium that attenuates infrared radiation emitted from a source

EXAMPLE Attenuating media include windows, filters, atmospheres, external optics.

1.17
blackbody
ideal perfect emitter and absorber of thermal radiation at all wavelengths

NOTE A blackbody is described by Planck's law. In its classical form, Planck's law describes the spectral distribution of the radiant energy emitted by a blackbody.

1.17.1
blackbody equivalent temperature
apparent temperature of a test object that is equal to the temperature of a blackbody emitting the same amount of radiant energy

1.17.2
blackbody radiator
radiator with the effective emissivity ε close to unity ($\varepsilon \geq 0{,}98$ across all relevant wavelengths)

1.17.3
blackbody reference
calibrated, traceable device used to check the calibration of infrared imaging radiometers or infrared thermometers

1.17.4
blackbody simulator
device whose radiation is close to that of a blackbody at the same temperature

EXAMPLE A cavity or a flat plate with a structured or coated surface characterized by a stable and uniform temperature and with emissivity close to 1.

1.18
centre wavelength
wavelength in the middle of the spectral sensitivity band of an infrared detector

1.19
cooled sensor
sensor that needs cooling to improve sensitivity to infrared radiant energy by reducing thermal noise influence

1.20
detecting element
sensitive part of a detector which is directly affected by the quantity to be measured

EXAMPLE For temperature-sensing devices: a thermocouple junction; resistive element; photoelectric, pyroelectric or quantum sensor.

1.21
differential blackbody
device for establishing two parallel isothermal planar zones of different temperatures and with effective emissivities close to 1,0

1.22
diffraction limit
limit of geometric diffraction of optical systems

1.23
diffuse reflector
lambertian reflector
surface that reflects incident radiation equally in all directions

NOTE 1 A lambertian diffuser is a surface that reflects a portion of the incident radiation in such a manner that the reflected radiation is equal in all directions, such as a gold perfect sphere.

NOTE 2 A mirror is not a diffuse reflector.

1.24
edge effect
(1) effect caused by measurement error mainly at the edge due to solid displacement or deformation by variable loading in thermoelastic stress measurement
(2) change in thermal properties at the edge of a target object as a result of different thermal conduction and convection properties

EXAMPLE Effect caused by measurement error at an edge due to solid displacement or deformation by variable loading in thermoelastic stress measurement.

1.25
effective emissivity
ε^*
measured emissivity value of a particular target surface under existing measurement conditions (rather than the generic tabulated value for the same material) that can be used to correct specific temperature readings

NOTE 1 Effective emissivity is also called emittance; however, the latter term is not preferred because it has been used to describe radiant exitance.

NOTE 2 Effective emissivity is context dependent, and is not purely a property of a material.

1.26
effective number of pixels
spatial resolution of a measured infrared image

NOTE The effective number of pixels is determined for a scanning infrared thermographic instrument according to the scanning pitch, and for an infrared thermographic instrument with an array sensor according to the number of pixels of the detector.

1.27
EMI/RFI noise
disturbance to electrical signals caused by electromagnetic interference (EMI) or radio frequency interference (RFI)

NOTE In infrared thermography, EMI/RFI noise can cause patterns to appear on the display and is sometimes due to poor grounding or earthing.

1.28
emissivity
ε
ratio of the radiance of a target surface to that of a blackbody at the same temperature and over the same spectral interval

1.29
emittance
ratio of the radiant flux emitted by a real target and that emitted by a blackbody at the same temperature and under the same conditions

NOTE 1 The total radiance, R^0, is obtained by an integration of the monochromatic radiance between wavelengths zero and infinity.

$$R^0 = \int_0^\infty \frac{2\pi hc^2 \lambda^{-5}}{\exp(\frac{hc}{k\lambda T}) - 1} \mathrm{d}\lambda = \frac{\sigma}{\pi} T^4$$

where

- c is the speed of light in a vacuum;
- h is the Planck constant;
- k is the Boltzmann constant;
- T is the thermodynamic temperature;
- σ is the Stefan-Boltzmann constant, in watts per square metre per kelvin to the power four, given by

$$\sigma = \frac{2\pi k^4}{15 c^2 h^3} = 5{,}67 \times 10^{-8}$$

Radiance and emittance being connected, the total emittance, M^0, is given by

$$M^0 = \pi R^0 = \sigma T^4$$

NOTE 2 In thermography, the terms “radiance” and “emittance” are technically often used interchangeably.

NOTE 3 Refer to ISO 80000-7

1.30
environmental rating
rating assigned to an operating unit (typically an electrical or mechanical enclosure) to indicate the limits of the environmental conditions under which the unit functions reliably and within reported performance specifications

1.31
extended source
source of infrared radiation whose image fills completely or a larger part of the field of view of the infrared camera

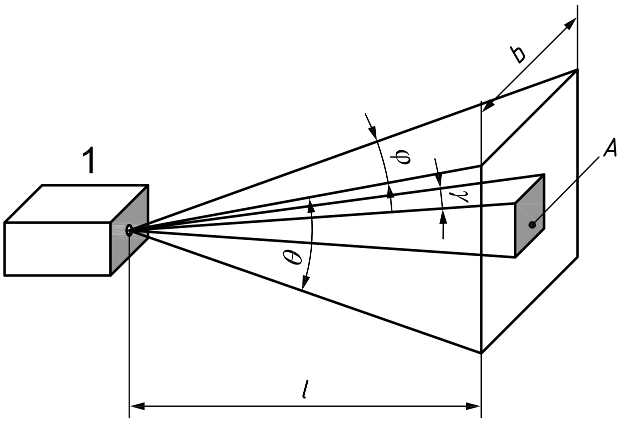
1.32
field of view
field of vision
FOV
angular subtense over which an instrument integrates total incoming radiant energy

NOTE 1 Angular subtense is expressed in angular degrees or radians per side if rectangular or square and in angular degrees or radians if circular.

NOTE 2 In infrared thermometers, field of view defines the target spot size; in a scanning/staring imager, it defines the scan angle or picture size or a total field of view (TFOV).

NOTE 3 The field of view is the angular extent of the observable world that is seen at any given moment.

See Figure 1.



Key

1 detector

A minimum detecting size

b view

l working distance

γ instantaneous view angle (scanning type); spatial resolution (2D sensor type)

θ vertical view angle

φ horizontal view angle

Figure 1 — Field of view

1.33
fill factor
⟨focal plane arrays⟩ ratio of the total surface of sensitive detector elements to the total area of the detector

1.34
filter
⟨infrared thermography⟩ optical element, usually transmissive, which is used to limit spectral sensitivity of infrared detectors

1.35
fixed pattern noise
FPN
non-temporal variations between pixels that are exposed to the same scene radiation

NOTE These variations can be caused by non-linearities in the detector, non-perfections in gain and offset maps, and slow temporal changes that are too slow for the eye or brain to interpret as a temporal change. In uncooled detectors, the slow temporal term is, most of the time, the dominant term of the spatial noise equivalent temperature difference.

1.36
focal plane array
FPA
type of infrared detector which involves a one- or two-dimensional array consisting of many individual sensing elements (called “pixels”)

NOTE Detector arrays are typically placed at the focal plane of an instrument. In thermography, rectangular or square FPAs are used in “staring” (non-scanning) infrared imagers. These are called IRFPA imagers.

1.37
focal point
⟨infrared thermography⟩ image point conjugate to an infinitely distant object point on the optical axis

NOTE In infrared thermometers, this is where the spot size is the smallest. In scanning or staring imagers, this point corresponds to the minimum instantaneous field of view (IFOV).

