

---

---

**Space systems — Measurements of  
thermo-optical properties of thermal  
control materials**

*Systèmes spatiaux — Mesures des propriétés thermo-optiques des  
matériaux de thermorégulation*



This document is a preview generated by ELS



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2022

All rights reserved. Unless otherwise specified, or required in the context of its implementation, 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  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

# Contents

Page

Foreword.....	v
Introduction.....	vi
<b>1 Scope.....</b>	<b>1</b>
<b>2 Normative references.....</b>	<b>1</b>
<b>3 Terms and definitions.....</b>	<b>1</b>
<b>4 Abbreviated terms.....</b>	<b>5</b>
<b>5 Preparatory conditions.....</b>	<b>5</b>
5.1 Hazards, health, and safety precautions.....	5
5.2 Preparation of samples.....	5
5.2.1 Sample property.....	5
5.2.2 Configuration.....	5
5.2.3 Cleaning.....	6
5.2.4 Handling and storage.....	6
5.2.5 Identification.....	6
5.3 Facilities.....	6
5.3.1 Cleanliness.....	6
5.3.2 Environmental conditions.....	6
5.3.3 Equipment.....	6
5.4 Standard materials.....	6
5.4.1 General.....	6
5.4.2 Reference standard material.....	7
5.4.3 Working standard material.....	7
5.4.4 Solar absorptance.....	7
5.4.5 Infrared emittance.....	7
<b>6 Solar absorptance (<math>\alpha_s</math>) test methods.....</b>	<b>7</b>
<b>7 Hemispherical infrared emittance (<math>\epsilon_h</math>) test method.....</b>	<b>8</b>
<b>8 Normal infrared emittance (<math>\epsilon_n</math>) test methods.....</b>	<b>8</b>
<b>9 Test report.....</b>	<b>9</b>
9.1 Standard tests.....	9
9.1.1 Complete identification of the material tested.....	9
9.1.2 Complete identification of the measurement condition.....	9
9.1.3 Measurement results.....	10
9.2 Non-standard tests.....	10
<b>10 Quality assurance.....</b>	<b>10</b>
10.1 Precision.....	10
10.2 Non-conformance.....	11
10.3 Calibration.....	11
10.4 Traceability.....	11
10.5 Uncertainty.....	11
<b>11 Audit of measurement equipment.....</b>	<b>11</b>
11.1 General.....	11
11.2 Initial audit of the system (acceptance).....	11
11.3 Annual regular review (maintenance) of the system.....	11
11.4 Special review.....	12
<b>Annex A (normative) Solar absorptance using a spectrophotometer (<math>\alpha_s</math>).....</b>	<b>13</b>
<b>Annex B (normative) Solar absorptance using the comparative test method (<math>\alpha_p</math>).....</b>	<b>18</b>
<b>Annex C (normative) Hemispherical infrared emittance using the thermal test method (<math>\epsilon_{h-t}</math>).....</b>	<b>20</b>
<b>Annex D (normative) Normal infrared emittance using an IR spectrometer (<math>\epsilon_{n-s}</math>).....</b>	<b>24</b>

<b>Annex E (normative) Normal infrared emittance using ellipsoid collector optics (<math>\epsilon_{n-e}</math>)</b>	<b>27</b>
<b>Annex F (normative) Normal infrared emittance using two rotating cavities (<math>\epsilon_{n-c}</math>)</b>	<b>32</b>
<b>Annex G (informative) Key parameters for measurement</b>	<b>35</b>
<b>Annex H (informative) Theoretical directional emissivity</b>	<b>36</b>
<b>Bibliography</b>	<b>37</b>

## 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](http://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](http://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 of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

This second edition cancels and replaces the first edition (ISO 16378:2013), which has been technically revised.

The main changes are as follows:

- updated terms and definitions according to the referenced document revision;
- revised description of sample thickness precision requirements;
- deleted solar absorptance measurement with central sample mounting sphere.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

Solar absorptance and infrared emittance are the key parameters of materials for both active and passive thermal design of space systems.

This document describes the methodology, instruments, equipment, and samples used to calculate the key parameters of thermal-control materials, i.e. solar absorptance ( $\alpha_s$  or  $\alpha_p$ ) and the infrared emittance ( $\epsilon_h$  or  $\epsilon_n$ ). The measurements defined in this document are performed at ground test facilities with the purpose of obtaining material properties. The measured properties are used for material selection, thermal design of spacecraft, process control, quality control, etc. Also, on-orbit temperature data in the beginning of life can be assessed using the data obtained by ground measurement.

# Space systems — Measurements of thermo-optical properties of thermal control materials

## 1 Scope

This document specifies the multiple measurement methods, instruments, equipment, and samples used to calculate the thermo-optical properties of thermal control materials. This document compares their features, indicates their limitations and biases, and guides the applications. This document also defines requirements for calibration and reference materials to ensure data quality.

This document specifies the following test methods, including the configuration of samples and calculations.

- a) Solar absorptance using a spectrophotometer ( $\alpha_s$ ) — [Annex A](#).
- b) Solar absorptance using the comparative test method ( $\alpha_p$ ) — [Annex B](#).
- c) Hemispherical infrared emittance using the thermal test method ( $\epsilon_{h-t}$ ) — [Annex C](#).
- d) Normal infrared emittance using an IR spectrometer ( $\epsilon_{n-s}$ ) — [Annex D](#).
- e) Normal infrared emittance using ellipsoid collector optics ( $\epsilon_{n-e}$ ) — [Annex E](#).
- f) Normal infrared emittance using two rotating cavities ( $\epsilon_{n-c}$ ) — [Annex F](#).

## 2 Normative references

There are no normative references in this document.

## 3 Terms and definitions

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

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

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

### 3.1

#### absorptance

$\alpha$

quotient of absorbed *radiant flux* ([3.8](#)) and incident radiant flux, expressed by

$$\alpha = \Phi_a / \Phi_m$$

where  $\Phi_a$  is absorbed radiant flux and  $\Phi_m$  is incident radiant flux

[SOURCE: ISO 80000-7:2019, 7-31.1]