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Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for air-purification performance of semiconducting photocatalytic materials by test chamber method under indoor lighting environment —

Part 1:
Removal of formaldehyde

Céramiques techniques — Méthode d'essai pour la performance de la purification de l'air des matériaux photocatalytiques semiconducteurs selon la méthode de la chambre d'essai dans un environnement d'éclairage intérieur —

Partie 1: Élimination du formaldéhyde

ICS 81.060.30

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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.

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 18560-1 was prepared by Technical Committee ISO/TC 206, *Fine ceramics*.

This second/third/... edition cancels and replaces the first/second/... edition (), [clause(s) / subclause(s) / table(s) / figure(s) / annex(es)] of which [has / have] been technically revised.

ISO 18560 consists of the following parts, under the general title *Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for air-purification performance of semiconducting photocatalytic materials by test chamber method under indoor lighting environment*:

— *Part 1: Removal of formaldehyde*

Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for air-purification performance of semiconducting photocatalytic materials by test chamber method under indoor lighting environment — Part 1: Removal of formaldehyde

1 Scope

This part of ISO 18560 specifies a test method for the determination of the air-purification performance of materials that contain a indoor light-active photocatalyst or have indoor light-active photocatalytic films on the surface, usually made from semiconducting metal oxides, such as titanium dioxide or other ceramic materials, by continuous exposure of a test piece to the model air pollutant under illumination with indoor light. This part of ISO 18560 is intended to evaluate the photocatalytic performance for building materials, such as boards, wallpapers, etc.. This part of ISO 18560 does not apply to powder or granular photocatalytic materials.

This test method is usually applicable to indoor light-active photocatalytic materials produced for air purification. This method is not suitable for the determination of other performance attribute of photocatalytic materials, i.e., decomposition of water contaminants, self-cleaning, antifogging and antibacterial actions. This test method is based on ISO 16000-23 and is adjusted for the measurement of indoor light-active photocatalytic materials.

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.

ISO 80000-1:2009, *Quantities and Units — Part 1: General*

ISO 554:1976, Standard atmospheres for conditioning and / or testing - Specifications

ISO 4677-1:1985, *Atmospheres for conditioning and testing — Determination of relative humidity — Part 1: Aspirated psychrometer method*

ISO 4892-1:1999, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guideline*

ISO 4892-3:2006, *Plastics — Methods of exposure to laboratory light sources — Part 3: Fluorescent UV lamps*

ISO 5725-2:1994, *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*

ISO 6145-7:2009, *Gas analysis — Preparation of calibration gas mixtures using dynamic volumetric methods — Part 7: Thermal mass-flow controllers*

ISO 6353-3:1987, Reagents for chemical analysis — *Part 3: Specifications — Second series*

ISO 16000-3:2001, *Indoor air — Part 3: Determination of formaldehyde and other carbonyl compounds — Active sampling method*

ISO 16000-6:2004, *Indoor air — Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA® sorbent, thermal desorption and gas chromatography using MS/FID*

ISO 16000-9:2006, *Indoor air — Part 9: Determination of the emission of volatile organic compounds from building products and furnishing — Emission test chamber method*

ISO 16000-11:2006, Indoor air — Part 11: *Determination of the emission of volatile organic compounds from building products and furnishing — Sampling, storage of samples and preparation of test specimens*

ISO 16000-23:2009, *Indoor air — Part 23: Performance test for evaluating the reduction of formaldehyde concentrations by sorptive building materials*

ISO/IEC 17025: 2005, *General requirements for the competence of testing and calibration laboratories*

ISO 22197-1:2006, *Fine Ceramics (Advanced ceramics, advanced technical ceramics) — Test method for air purification performance of semiconducting photocatalytic materials — Part 1: Removal of nitric oxide*

ISO/DIS 14605, *Fine Ceramics (Advanced ceramics, advanced technical ceramics) — Indoor light source for testing semiconducting photocatalytic materials*

3 Terms and definitions

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

3.1
photocatalyst
substance that performs one or more functions based on oxidation and reduction reactions under photoirradiation, including decomposition and removal of air and water contaminants, deodorization, and antibacterial, self-cleaning and antifogging actions.

3.2
indoor lighting environment
indoor lighting environment with artificial light source for general lighting service. Not include sunlight.

3.3
indoor light-active photocatalytic materials
photocatalytic materials which performs one or more functions based on oxidation and reduction reactions under indoor lighting environment.

3.4
photocatalytic materials
materials in which or on which the photocatalyst is added by coating, impregnation, mixing, etc..

3.5
zero-calibration gas
air that does not contain pollutants (i.e. in which common pollutants are below 0,01 µl/l).

NOTE The zero-calibration gas is prepared from indoor air using a laboratory air purification system, or supplied as a synthetic air in a gas cylinder.

3.6
formaldehyde gas
gases of organic compound with the formula HCHO of known concentrations used for test and calibration.

3.7
test gas
mixture of air and pollutant(s) of known concentration prepared from a standard gas or a zero-calibration gas, to be used for the performance test of a photocatalytic material.

3.8
air change rate
ratio of the volume of test gas brought into the test chamber per hour and the free test chamber volume measured in identical units.

3.9
air flow rate
air volume entering into the test chamber per unit time.

3.10
product loading factor
ratio of exposed surface area of the test specimen and the free test chamber volume.

3.11
dark condition
test condition of no light illumination by the light source for testing and room lightings.

3.12
equivalent ventilation rate per area
apparent increase of clean air ventilation rate converted from the reduction of formaldehyde concentration by light-active photocatalytic materials.

3.13
guideline concentration
guideline indoor air concentration for formaldehyde as specified by the World Health Organization (WHO) .

NOTE The guideline indoor air concentration for formaldehyde specified by the WHO is 100μg/m^3. Reference to national standards is possible if this is clearly highlighted in test report and certificate.

3.14
mass transfer coefficient
coefficient arising from the concentration difference between the test specimen and ambient air over its surface.

NOTE Mass transfer coefficient is expressed by meter per hour.

3.15
recovery
measured mass of formaldehyde in the air leaving the test chamber with no sample present conditioned over a given time period divided by the mass of formaldehyde added to the test chamber in the same time period.

NOTE The recovery which expressed as a percentage and provides information about the performance of the entire method.

3.16
sampling time
period of time during which air is sampled from the outlet of the test chamber using sampling tubes or other devices.

3.17
supply air concentration
mass concentration of formaldehyde in air for supply to the test chamber.

3.18
irradiation start
time of starting irradiation of indoor light to the specimen.

3.19
elapsed time
time from irradiation start to the start of air sampling.

3.20
test chamber concentration
concentration of formaldehyde measured at the outlet of a test chamber, derived by dividing the mass of the formaldehyde sampled at the outlet of the chamber by the volume of sampled air.

4 Symbols

$\rho_{in,\,t}$	concentration of formaldehyde at test chamber inlet at elapsed time *t* (microgram per cubic metre)
$\rho_{out,\,t}$	test chamber concentration at elapsed time *t* (microgram per cubic metre)
ρ_{gl}	guideline concentration (microgram per cubic metre)
k_a	mass transfer coefficient determined using water vaper (metres per hour)
L	product loading factor (square metres per cubic metre)
n	air change rate (changes per hour)
q_a	area specific air flow rate (cubic metres per square metre per hour)
q_c	air flow rate of test chamber (cubic metres per hour)
q_{eq}	equivalent ventilation rate (cubic metres per square metre per hour)
r	removal rate (microgram per square metre per hour)
r_{gl}	removal rate when test chamber concentration is equal to guideline concentration (microgram per square metre per hour)
t_e	elapsed time (hours or days)
V	air volume of test chamber (cubic metres)
A	surface area of test specimen (square metres)

5 Principle

This part of ISO 18560 concerns the development, comparison, quality assurance, characterization, reliability, and design data generation of indoor light-active photocatalytic materials. The method described is intended to obtain the air-purification performance of indoor light-active photocatalytic materials by exposing a test piece to model polluted air under illumination by indoor light source. Formaldehyde (HCHO) is chosen because it is a typical indoor air pollutant that causes the so-called sick building syndrome. The test piece, placed in a test chamber, is activated by indoor light illumination, and adsorbs and oxidizes gas-phase formaldehyde to form carbon dioxide (CO_2) and other oxidation products. The air purification performance is determined from monitoring the reduction of formaldehyde concentration inside a test chamber containing a sample of the indoor light-active photocatalytic material under test.