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

Part 4:
Removal of formaldehyde

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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.

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 document 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).

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This document was prepared by Technical Committee ISO/TC 206, *Fine ceramics*.

This second edition cancels and replaces the first edition (ISO 17168-4:2018), which has been technically revised.

The main changes are as follows:

— normative reference to ISO 24448 added to Clause 2 and 6.4.

A list of all parts in the ISO 17168 series can be found on the ISO website.

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.

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Introduction

A photocatalyst is a substance that performs decomposition and removal of contaminants, self-cleaning, antifogging, deodorization and antibacterial actions under photoirradiation. Its application has expanded considerably in recent years. The application of photocatalysts for indoor spaces has increasingly been sought as a solution to indoor environmental problems. Since conventional photocatalysts are responsive only to ultraviolet light, studies have been made to develop an indoor-light-active photocatalyst that makes effective use of indoor light, which room lights mainly emit, and thus demonstrates high photocatalytic performance indoors. The development has recently led to the commercialization of various indoor-light-active photocatalytic products, and there has been demand for the establishment of test methods to evaluate the performance of this type of photocatalyst.

This document, with ISO 17168-1 and ISO 22197-4 as the basis, is intended to provide a testing method to determine the performance of indoor-light-active photocatalytic materials with regards to the removal of formaldehyde, a particularly relevant volatile organic compound (VOC) that can cause sick-house syndrome, enabling swift distribution of photocatalytic products and thus contributing to a safe and clean environment.

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

Part 4: Removal of formaldehyde

WARNING — The use of this document can involve hazardous materials, operations and equipment. It is necessary to check that there are no leaks from the gas flow paths, and to properly dispose of exhaust gas and wastewater. This document does not purport to address all of the safety or environmental problems associated with its use.

1 Scope

This document specifies a test method for the determination of the air-purification performance, with regards to the removal of formaldehyde, of materials that contain a photocatalyst or have 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 from indoor light.

This document is applicable for use with different kinds of materials, such as construction materials in flat sheet, board or plate shape, which are the basic forms of materials for various applications. This document also applies to materials in honeycomb form, and to plastic or paper materials containing ceramic microcrystals and composites. This document does not apply to powder or granular photocatalytic materials.

This test method is usually applicable to photocatalytic materials produced for air purification. This method is not suitable for the determination of other performance attributes of photocatalytic materials, i.e. decomposition of water contaminants, self-cleaning, antifogging and antibacterial actions.

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.

ISO 14605, *Fine ceramics (advanced ceramics, advanced technical ceramics) — Light source for testing semiconducting photocatalytic materials used under indoor lighting environment*

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

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

ISO 17168-1, *Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for air purification performance of semiconducting photocatalytic materials under indoor lighting environment — Part 1: Removal of nitric oxide*

ISO 24448, *Fine ceramics (advanced ceramics, advanced technical ceramics) — LED light source for testing semiconducting photocatalytic materials used under indoor lighting environment*

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3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17168-1 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/

4 Symbols

f	flow rate of test gas converted into that at the standard state (0 °C, 101,3 kPa)
ϕ_F	formaldehyde volume fraction at the reactor exit (µl/l)
ϕ_{FD}	formaldehyde volume fraction at the reactor exit under dark conditions (µl/l)
ϕ_{F0}	supply volume fraction of formaldehyde (µl/l)
n_F	removal quantity, by test piece, of formaldehyde (µmol)
R_F	removal percentage, by test piece, of formaldehyde (%)

5 Principle

This document deals with the development, comparison, quality assurance, characterization, reliability and design data generation of photocatalytic materials[1]. The method described is intended to obtain the air-purification performance of photocatalytic materials by exposing a test piece to model polluted air under illumination by indoor light. Formaldehyde (HCHO) is chosen because it is a typical indoor air pollutant that causes the so-called sick building syndrome[2]. The test piece, placed in a flow-type photoreactor, 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 the amount of formaldehyde removed by the test piece (µmol). The simple adsorption of HCHO by the test piece (not due to photocatalysis) is evaluated by tests in the dark. However, some test pieces are very absorbent, and it is possible that a stable concentration of formaldehyde is not attained in the designated test time. The photocatalytic activity can depend on physical and chemical properties of pollutants, mainly due to the adsorption process involved. For a better evaluation of air purification performance of photocatalytic materials, it is recommended that one or more suitable test methods are combined, as provided in other parts of the ISO 17168 series.

6 Apparatus

6.1 Test equipment

The test equipment enables a photocatalytic material to be examined for its pollutant-removal capability by supplying the test gas continuously, while providing photoirradiation to activate the photocatalyst. It is the same as that used in the test method for the removal of nitric oxide (see ISO 17168-1) and consists of a test gas supply, a photoreactor, a light source, a UV sharp cut-off filter and pollutant measurement equipment. Since low concentrations of pollutants are to be tested, the system shall be constructed with materials of low absorption and resistant to ultraviolet (UV) radiation, for example acrylic resin, stainless steel, glass and fluorocarbon polymers. An example of a testing system is shown in Figure 1.

6.2 Test gas supply

The test gas supply provides air polluted with model contaminant at a predetermined concentration, temperature and humidity, and supplies it continuously to the photoreactor. It consists of flow regulators, a

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