INTERNATIONAL STANDARD

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Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for antifungal activity of semiconducting photocatalytic materials

Céramiques techniques — Méthode d'essai pour l'activité antifongique des matériaux photocatalytiques semiconducteurs

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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.

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.

ISO 13125 was prepared by Technical Committee ISO/TC 206, *Fine ceramics*.

Introduction

Under the illumination of ultraviolet (UV) light, photocatalysts show diverse functions, such as the decomposition of air and water contaminants, as well as deodorization, self-cleaning, antifogging, antibacterial and antifungal actions. These functions of photocatalysts are generally based on the action of active oxygen species such as hydroxyl (OH) radicals formed on the surface of photocatalysts. The energy- and labour-saving nature of photocatalysis has attracted keen interest when the photocatalyst is activated by sunlight (or artificial lighting).

Practical applications of photocatalysts for both indoor and outdoor use have rapidly expanded in recent years. Many kinds of photocatalytic materials have been proposed or are already commercialized, based on ceramics, glass, concrete, plastics, paper, etc. Such materials have been proposed by either coating or mixing of a photocatalyst; in most cases, titanium dioxide (TiO_2).

However, the effect of photocatalysis is not easily inspected visually, and no appropriate and standardized evaluation methods have been available to date. Some confusion has thus arisen as photocatalytic materials have been introduced. Furthermore, the above-mentioned diverse functions of photocatalysts cannot be evaluated with a single method: thus it is required to provide different evaluation methods for air purification, water decontamination, and self-cleaning.

This International Standard applies to testing the antifungal activity of photocatalytic ceramics and other materials.

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WARNING — Handling and manipulation of microorganisms that are potentially hazardous requires a high degree of technical competence. Only personnel trained in microbiological techniques should carry out the test.

1 Scope

This International Standard specifies a test method covering the determination of the antifungal activity of materials that contain a photocatalyst or have photocatalytic films on their surface, by counting the number of pre-incubated fungal spores that survive exposure to ultraviolet (UV-A) light.

This International Standard provides for the assessment of different kinds on materials used in various applications, such as construction materials in flat coating, sheet, board or plate form, etc. Powder, granular, fibrous or porous photocatalytic materials are not included.

Values expressed in this International Standard are in accordance with the International System of Units (SI).

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 27447, *Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for antibacterial activity of semiconducting photocatalytic materials*

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

IEC 60068-2-10, *Environmental testing — Part 2-10: Test J and guidance: Mould growth*

3 Terms and definitions

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

3.1
photocatalyst
substance that carries out many functions based on oxidization and reduction reactions under UV irradiation, including decomposition and removal of air and water contaminants, deodorization, antibacterial, antifungal, self-cleaning and antifogging

3.2
photoirradiation
irradiation to ultraviolet (UV-A) light at wavelength 300 nm to 400 nm

3.3
photocatalytic materials
surface or material to which a photocatalyst has been applied with the intention of making it photocatalytically active; photocatalytic treated materials, samples and pieces are included

3.4
antifungal activity
inhibition of germination or inactivation of fungal spores

3.5
antifungal activity value in irradiation condition *L*
common logarithm of the ratio of the number of surviving fungal spores on a photocatalytic non-treated piece after UV irradiation condition *L* for a given period of time to the number of surviving spores on a treated piece after the same UV irradiation condition for the same period

3.6
antifungal activity value with UV irradiation by removing the effect in the dark
difference value between antifungal activity value in irradiation condition *L* and common logarithm of the ratio of the number of surviving fungal spores on a photocatalytic non-treated piece in the dark to the number of surviving spores on a treated piece stored in the dark for the same period of time

4 Symbols

S	concentration of fungal spores
K	average of colony numbers
D	dilution factor
F	number of surviving spores
V	volume of recovery solution
L	ultraviolet exposure
A	average of colony numbers of photocatalytic non-treated pieces following inoculation
B_L	average of surviving spore numbers of photocatalytic non-treated pieces at exposure L after several hours
C_L	average of surviving spore numbers of photocatalytic non-treated pieces at exposure L after several hours
R_L	antifungal activity value in irradiation condition L
C_D	average of surviving spore numbers of photocatalytic treated test pieces in the dark after several hours
B_D	average of surviving spore numbers of photocatalytic non-treated test pieces in the dark after several hours
ΔR	antifungal activity value with UV irradiation by removing the effect in the dark

NOTE The term “several hours” means the period of time between 3 h (minimum) and 24 h (maximum).

5 Principle

This International Standard is for development, comparison, quality assurance, characterization, reliability, and design data generation of photocatalytic materials.[1] Photocatalyst is capable of decomposition of organic substances, including living cells such as fungal spores. A suspension of fungal spores on photocatalytic treated test piece is inactivated under photoirradiation. After the irradiation, fungal spores are recovered and cultivated on agar medium, and formed spore colonies are counted.

Antifungal activity of the photocatalytic reaction is estimated as the decrease in surviving spore number on a test sample compared to a blank test of non-coated surface.

NOTE This International Standard is adapted from the common methodological concept for ISO 27447. Namely, same apparatus and test piece size, similar procedure and calculation are adapted between this International Standard and ISO 27447. Therefore, ISO 27447 is recommended to be used as a reference during the actual test of this International Standard.

6 Materials

6.1 Test fungi

a) *Aspergillus niger*

b) *Penicillium pinophilum*

The test fungi shall be obtained from national or international culture collections. The strains to be used are listed in Table 1. These strains are sorted by References[2],[3] and IEC 60068-2-10.

Table 1 — Fungal strains to be used in test

Fungal species and strains	WDCM code
Aspergillus niger	WDCM 00144 http://refs.wdcm.org/getinfo.htm?sid=WDCM_00144
Penicillium pinophilum	WDCM 00194 http://refs.wdcm.org/getinfo.htm?sid=WDCM_00194
NOTE Refer to WDCM and its website: http://refs.wdcm.org/search.htm . (Note that WDCM stands for World Data Centre for Microorganisms.)	

6.2 Chemicals and implements

6.2.1 Potato-Dextrose-Agar (PDA) Medium

Agar slants or agar plates used for the test shall be PDA medium with the following composition:

PDA medium

potato infusion	200 g
glucose	20 g
agar	20 g
purified water	1000 ml

PDA medium shall be sterilized at 121 °C ± 1 °C for 15 min - 20 min in an autoclave with an atmosphere saturated with steam (autoclaving).

NOTE PDA medium is able to use available preparation, for example Difco (Becton, Dickinson and company, USA), MERCK (Merck KGaA, Germany), etc.

6.2.2 Purified water

The water used for the preparation of all solutions and culture medium shall be distilled or deionized water.

NOTE Germination and growth of fungal spores might be inhibited by contained material (e.g. metal ions) of tap water.