INTERNATIONAL STANDARD

ISO 10677

First edition
2011-07-01

Fine ceramics (advanced ceramics, advanced technical ceramics) — Ultraviolet light source for testing semiconducting photocatalytic materials

Céramiques techniques — Sources lumineuses UV destinées aux essais des matériaux photocatalytiques semi-conducteurs

Reference number
ISO 10677:2011(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

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 10677 was prepared by Technical Committee ISO/TC 206, *Fine ceramics*.

Introduction

This International Standard describes the light source which is used for the performance test of photocatalysts excited by ultraviolet (UV) radiation. A photocatalyst displays its performance by light irradiation and the type of light source used depends on its applied product. Its performance includes self-cleaning, air purification, anti-bacteria, anti-mold, water purification, etc.

While it is possible to describe the light source individually depending on each performance test, this International Standard specifies independently a common standard, considering that photocatalytic materials offer complex effects and there are many common items in the light source.

Fine ceramics (advanced ceramics, advanced technical ceramics) — Ultraviolet light source for testing semiconducting photocatalytic materials

1 Scope

This International Standard describes an ultraviolet (UV) light source and specifies a method of measuring the radiation intensity which is used in testing the performance of semiconducting photocatalytic materials in a laboratory.

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 22197-1:2007, *Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for air-purification performance of semiconducting photocatalytic materials — Part 1: Removal of nitric oxide*

IEC 50 (845):1987/CIE Publication No.17.4:1987, *International lighting vocabulary*

CIE Publication No.85:1989, *Solar spectral irradiance*

3 Terms and definitions

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

3.1
fluorescent UV lamps
fluorescent UV lamps in which radiant intensity in the UV region of the spectrum, i.e. below 400 nm, makes up at least 80 % of the total output

3.2
xenon arc lamps
arc discharge lamp radiating by excited xenon gas and of the quartz-sealed type

3.3
UV radiometer
UV irradiance meter
UV radiometer that measures UV irradiance in wavelengths 300 nm to 400 nm

NOTE In general, a UV radiometer is an instrument that measures the optical radiation in wavelengths 1 nm to 400 nm.

4 Light source

4.1 General

Photocatalysts, including TiO_2, are excited by UV radiation of wavelength less than 400 nm. When irradiated by UV radiation, oxidation and reduction reactions can occur at the surface of the photocatalyst. Therefore, photocatalytic materials are activated by sunlight or UV light sources. The photocatalytic efficiency depends upon the spectral distribution and radiant intensity. Light sources which include radiation of wavelength between 300 nm and 400 nm are therefore suitable for the testing of photocatalytic materials. As the UV irradiance can differ depending upon the location, it is preferable that the irradiance of the UV light source used for the test should be representative of the actual irradiance where the photocatalytic material will be utilized.

UV light sources include a fluorescent UV lamp, xenon arc lamp, germicidal lamp, mercury lamp, metal halide lamp and UV-LED. Considering the wavelength distribution, stability of irradiance and ability to produce a continuous spectrum, a fluorescent UV lamp and xenon arc lamp shall be used for testing of photocatalyst materials.

4.2 Fluorescent ultraviolet lamps

Fluorescent lamps use the emission from a low-pressure mercury arc to excite a phosphor that produces a continuous spectrum. In a fluorescent UV lamp, phosphors emitting UV radiation of wavelength 300 nm to 400 nm are used, and a spectral distribution depends on the type of phosphors. Moreover, in fluorescent UV lamps, a blacklight lamp (BL lamp) made of a colourless transparent glass tube, and a blacklight blue lamp (BLB lamp) made of a blue glass which absorbs a visible radiation, exist.

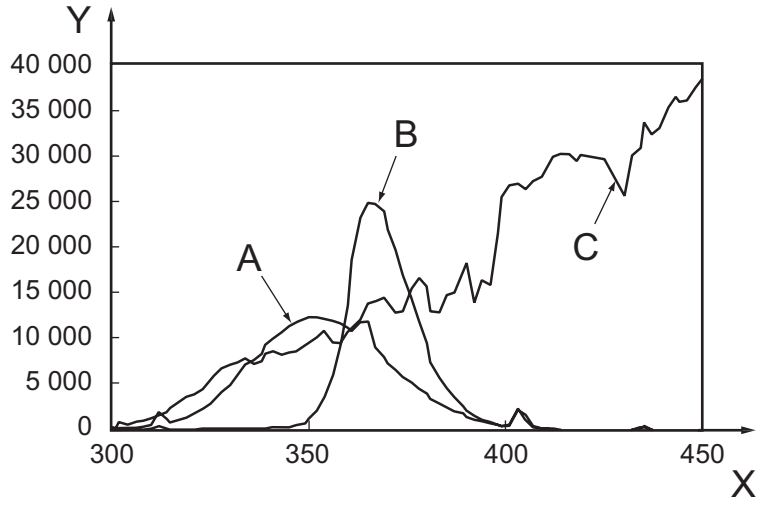
In evaluating a photocatalyst excited by UV radiation, fluorescent UV lamps that have peak irradiance at 351 nm or 368 nm shall be used. Examples of relative spectral irradiances are shown in Table 1.

Table 1 — Relative spectral irradiance of fluorescent UV lamps

Wavelength λ nm	351 nm **peak** **(351 BLB)** %	368 nm **peak** **(368 BLB)** %
$270 \leq \lambda < 300$	0	0
$300 \leq \lambda < 320$	2,2	0,4
$320 \leq \lambda < 340$	17,6	0,1
$340 \leq \lambda < 360$	43,3	5,3
$360 \leq \lambda < 380$	29,7	76,9
$380 \leq \lambda < 400$	7,2	17,3
NOTE Irradiance between 270 nm and 400 nm is defined as 100 %.		

Example of spectral irradiance of BLB lamps and sunlight on the earth's surface are shown in Figure 1.

A spectral irradiance of a fluorescent UV lamp with a 351 nm peak is widely distributed in the UV-A region, and its short wavelength is close to sunlight transmitting window glass, thus is suitable in evaluating photocatalytic materials for indoor application.



Key

X wavelength, nm
Y relative irradiance
A 351 BLB
B 368 BLB
C sunlight

Figure 1 — Spectral distribution of fluorescent UV lamps and sunlight

4.3 Xenon arc lamps

Xenon arc lamps emit radiation in a range that extends from below 200 nm in the UV through the visible and into the infrared (IR) range.

Xenon arc lamps shall be used in evaluating photocatalytic materials utilizing sunlight.

Relative spectral irradiance of xenon arc lamps (Reference [1]) and sunlight on the earth's surface are shown in Table 2.

Table 2 — Relative spectral irradiance of xenon arc lamps and sunlight on the earth's surface

Wavelength, λ nm	Xenon arc lamp %	Sunlight[a] %
$270 \leq \lambda < 300$	15,6	0,0
$300 \leq \lambda < 320$	12,9	4,5
$320 \leq \lambda < 340$	15,1	16,8
$340 \leq \lambda < 360$	17,0	21,0
$360 \leq \lambda < 380$	18,8	26,5
$380 \leq \lambda < 400$	20,6	31,2
NOTE Irradiance between 270 nm and 400 nm is defined as 100 %.		
[a] Adapted from Table 4 of CIE No.85:1989. (Unit is modified from W/m^2 to %).		

Since radiation from a xenon arc lamp contains predominatly UV radiation of short wavelengths which are not present in sunlight on the earth's surface, optical filters shall be used in order to make the spectral distribution closer to that on the earth's surface, when evaluating photocatalytic materials excited by sunlight. Table 4 of CIE Publication No.85:1989 shall be used for spectral distribution of sunlight.

In the case of photocatalytic material utilizing for light transmitted by window glass, a soda-lime glass of thickness 3 mm or more shall be added.

When ozone is generated from a lamp, it is necessary to exhaust this ozone so that it does not come into contact with the test piece.

Unfiltered xenon arc lamps are not suitable for test substances and reaction products that absorb in the visible spectral region, such as methylene blue.

Xenon arc lamps emit much IR radiation. In order to prevent a rise in temperature, either a water filter or an IR absorption filter can be used.

5 Test chamber and apparatus

5.1 Test chamber

The test chamber shall irradiate a test piece uniformly. Moreover, UV irradiance shall be adjusted by the distance between a test piece and lamp.

If installing a reflection plate or a test-piece cover, a material which has small ultraviolet absorption or small deterioration shall be used and the structure shall be able to measure irradiance at the test piece.

5.2 Test chamber for testing of low irradiance

In the case of testing for low irradiance, a metal mesh or a light insulation metal plate shall be inserted between a lamp and a test piece in order to reduce irradiance. The metal mesh or a light insulation plate shall be set near the lamp so that irradiance on the test piece shall be uniform.

5.3 UV radiometer

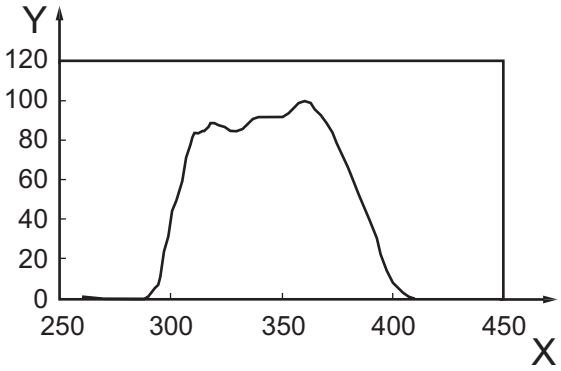
a) The UV radiometer shall be used for measurement of UV irradiance at the test piece. In the case of not being able to measure UV irradiance at the test piece, the UV irradiance measured shall be corrected for the irradiance on the surface of test piece.

b) In the case of a large light source, such as fluorescent UV lamps, or using multi-light sources, a UV radiometer with a good cosine response shall be used.

c) The UV radiometer shall be calibrated against the light source of testing.

The spectral sensitivity of a UV radiometer generally depends on the wavelength, and is mainly calibrated at the specified wavelength (such as the 365 nm mercury line). If using a light source with a different spectral distribution from the calibrated light source, the UV radiometer shall be recalibrated against the light source for testing, or the measurement values have to be corrected using measured calibration factors.

An example of the spectral sensitivity of a UV radiometer in which the spectral sensitivity is constant in the range between 310 nm and 380 nm is shown in Figure 2.



Key

X wavelength, nm

Y spectral sensitivity, %

Figure 2 — Spectral sensitivity of a UV radiometer with constant spectral sensitivity

6 Mesurement of UV radiation

UV irradiance depends on the material and structure of the test chamber. Especially when a painted plate or plastic is used as a reflection plate or cover, which absorbs UV radiation. In such a case, the measurement of UV irradiance shall be done on a test piece with the same conditions of testing.

The measurement value shall be expressed in watts per square metre (W/m^2) or milliwatts per square centimetre (mW/cm^2).

Since UV irradiance depends on the lamp's temperature, the measurement of UV irradiance shall be done at least 15 min after switching the lighting on.

The UV radiation of lamps decreases with hours of operation. The UV irradiance shall be measured at both the start and end of the test period.

7 Test report

The test report shall include the items described in the test method used.

For irradiation conditions, the following information shall be included.

a) Type of lamp used (peak wavelength, catalogue number, manufacturers' name).

b) Type of filter used (catalogue number, manufacturers' name, thickness).

c) Type of UV radiometer used in the measurement (spectral sensitivity of the UV radiometer and details of the calibration).

d) UV irradiance (if the operation time of lamp is 100 h or more, UV irradiance at the start and finish of testing).