Nederlandse norm

NEN-ISO 10678

(en)

Fine ceramics (advanced ceramics, advanced technical ceramics) - Determination of photocatalytic activity of surfaces in an aqueous medium by degradation of methylene blue (ISO 10678:2010,IDT)

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Als Nederlandse norm is aanvaard:

- ISO 10678:2010,IDT

Normcommissie 342032 "Technische keramiek"

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INTERNATIONAL STANDARD

ISO 10678

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Fine ceramics (advanced ceramics, advanced technical ceramics) — Determination of photocatalytic activity of surfaces in an aqueous medium by degradation of methylene blue

Céramiques techniques — Détermination de l'activité photocatalytique des surfaces dans un milieu aqueux par dégradation du bleu de méthylène

Reference number
ISO 10678:2010(E)

Contents

Page

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.

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 10678 was prepared by Technical Committee ISO/TC 206, *Fine ceramics*.

Fine ceramics (advanced ceramics, advanced technical ceramics) — Determination of photocatalytic activity of surfaces in an aqueous medium by degradation of methylene blue

1 Scope

This International Standard specifies a method for the determination of the photocatalytic activity of surfaces by degradation of the dye molecule methylene blue (MB) in aqueous solution using artificial ultraviolet (UV) radiation, and characterizes the ability of photoactive surfaces to degrade dissolved organic molecules on ultraviolet radiation.

The test method specified is also applicable to evaluation of the specific photocatalytic self-cleaning activity of surfaces covered with respective coatings.

This method is not applicable to characterizing the photoactivity of surfaces on visible illumination, regarding direct soiling, degradation of gaseous molecules and the determination of antimicrobial photoactivity of surfaces.

NOTE Correlations between these different kinds of photocatalytic activity can, however, exist, in particular at surfaces exhibiting low photonic efficiencies.

2 Terms and definitions

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

2.1
specific photocatalytic activity
P_{MB}
measure of the photochemical conversion

NOTE Specific photocatalytic activity is expressed in moles per square metre and hour [mol/(m^{2}h)].

2.2
photonic efficiency
ζ_{MB}
measure of the selectivity of the incident photons to induce the decolourization of methylene blue

NOTE 1 Photonic efficiency is expressed as a percentage of the incident photon flux.

NOTE 2 It is assumed that one photon can induce the decolourization of one dye molecule.

2.3
test solution
aqueous methylene blue solution used to determine the photocatalytic activity of surfaces

2.4
measuring solution
part of **test solution** (2.3) with a volume of $\leqslant$ 10 % of the volume of the test solution used for external determination of the optical absorbance employing a spectrophotometer

2.5
conditioning solution
aqueous methylene blue solution used for the pre-adsorption of methylene blue on the test surfaces prior to the determination of the photocatalytic activity of surfaces

3 Symbols and units

For the purposes of this document, the symbols and units in Table 1 apply.

Table 1 — Symbols and units

Designation	Symbol	Unit
Planck's constant ($h = 6{,}626 \times 10^{-34}$ Js)	h	Js
Avogadro number ($N_A = 6{,}022 \times 10^{23}$ 1/mol)	N_A	1/mol
Relative molar mass	M	g/mol
Molar extinction coefficient	ε	m^2/mol
Time	t	h
Time of measurement	t_m	h
Concentration	c	mol/l
Absorbance	A_λ	unitless
Length	d	cm
Volume of test solution	V	l
Irradiated area	A	m^2
Wavelength	λ	m
UV-radiation intensity	E	W/m^2
Average UV-radiation intensity	$E_{av} = \frac{\int E dt}{t_m}$	W/m^2
Specific degradation rate	$R = \frac{\Delta A_\lambda V}{\Delta t \varepsilon d A}$	$mol/(m^2h)$
Specific degradation rate with UV radiation	$R_{irr} = \frac{\Delta A_{\lambda,irr} V}{\Delta t \varepsilon d A}$	$mol/(m^2h)$
Specific degradation rate without UV radiation	$R_{dark} = \frac{\Delta A_{\lambda,dark} V}{\Delta t \varepsilon d A}$	$mol/(m^2h)$
Specific photoactivity	$P_{MB} = R_{dark} - R_{irr}$	$mol/(m^2h)$
Photonic UV-radiation intensity	$E_P = \frac{\lambda_{max} E_{av}}{h c N_A} \times 3\,600$	$mol/(m^2h)$
Average photonic UV-radiation intensity	$E_{P,av}$	$mol/(m^2h)$
Photonic efficiency	$\zeta_{MB} = \frac{P_{MB}}{E_P} \times 100$	%

4 Principle

Methylene blue is degraded in an aqueous solution that is in contact with the potentially photocatalytically active surface by UV radiation of this surface through the solution, with light not capable of inducing the direct photolysis of the dye (320 nm $\leqslant \lambda \leqslant$ 400 nm), with the overall result being the decolourization of the solution. The amount of dye remaining in the solution is determined at regular intervals during the UV-radiation period using UV/visible (vis)-spectroscopy. A reference measurement is either performed with the same sample without UV radiation or with an identical sample in a second container with the photoactive surface protected by a cover from the incident light beam. The results are used to calculate the specific degradation rates and the respective photonic efficiencies characteristic of the surface tested.

5 Apparatus

5.1 General

Apparatus that will be in contact with the methylene blue solution shall be made from materials exhibiting no or just a very small tendency to adsorb this dye on its surface, e.g. glass, stainless steel, polyethylene, polypropylene, polyacrylate, silicones with low organic emission. The test arrangement shall exhibit minimal stray light.

5.2 Measuring device, either two testing cylinders fixed on the sample surface by a suitable glue, or two testing cells, each consisting of a vessel with a sample holder (for a schematic diagram of a suitable measuring device, see Annex B).

5.3 Glass pane, to cover the measuring cell exhibiting minimal absorbance within the spectral emission region of the UV-radiation light source (5.4).

5.4 UV-radiation light source, i.e. a narrow-band emitter in the wavelength range between $\lambda = 320$ nm and $\lambda = 400$ nm (UV-A) with a UV-radiation intensity of $E = (10 \pm 0{,}5)$ W/m^2, measured at the height of the sample underneath the covering glass pane.

5.5 UV radiometer (sensor), to measure the UV-radiation intensity, calibrated to closely match the characteristic of the UV-radiation light source.

5.6 UV/vis-spectrophotometer, calibrated in the measuring range between $\lambda = 600$ nm and $\lambda = 700$ nm, for the determination of methylene blue concentration.

5.7 Measurement cells, for the spectrophotometer made of glass or plastics, with an optical length of 10 mm and a transmittance > 80 % (600 nm to 700 nm).

6 Calibration

The apparatus according to 5.5 and 5.6, as well as the balances used, shall be calibrated following the instructions for equipment monitoring.

7 Measuring and conditioning solution

Aqueous methylene blue solutions shall be used for both the measurement and the conditioning. The methylene blue solutions shall be prepared freshly from stock solutions stored in the dark using distilled water in the absence of any other additives. The initial MB concentration c_0 for the test solution shall be $c_0 = (10 \pm 0{,}5)$ µmol/L. The conditioning solution shall be prepared at a concentration of $c = (20 \pm 1)$ µmol/L. The absorbance, A_λ, of the solutions shall be calculated using Equation (1):

$$A_\lambda = \varepsilon \times c \times d \qquad (1)$$

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