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Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for determination of photocatalytic activity on semiconducting photocatalytic materials by dissolved oxygen consumption

Céramiques techniques — Méthode d'essai relative à la détermination de l'activité photocatalytique sur matériaux photocatalytiques semiconducteurs par la consommation d'oxygène dissous

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

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Introduction

International Standards covering test methods for determination of photocatalytic activity have been published. A wide variety of photocatalytic functions, such as water and air purification, antibacterial effect, and self-cleaning, require different evaluation methods. However, much easier methods to evaluate a common semiconducting photocatalytic activity are strongly demanded, in particular in research and development activities for testing of performance of semiconducting photocatalyst and photocatalytic materials under development.

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Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for determination of photocatalytic activity on semiconducting photocatalytic materials by dissolved oxygen consumption

1 Scope

This document specifies the test method for determination of concentration of dissolved oxygen consumed due to photocatalytic oxidation of phenol in aqueous phase by semiconducting photocatalytic substances. The method is applicable to powder test sample or film test piece of semiconducting photocatalystic material targeting water contaminants. This test method is not applicable for evaluating the materials conjugated with other base material, such as organic binder which can also be decomposed by the photocatalytic activity.

This document is applicable to the test method for the activity of powder test sample or film test piece of semiconducting photocatalystic material targeting water contaminants.

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 5814, *Water quality — Determination of dissolved oxygen — Electrochemical probe method*

ISO 10677, *Fine ceramics (advanced ceramics, advanced technical ceramics) — Ultraviolet light source for testing semiconducting photocatalytic materials*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20507 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
semiconducting photocatalyst
substance that displays photocatalytic action based on its electronic band structure

Note 1 to entry: This applies to metal oxides like titanium dioxide and sulfides. Photocatalysts which are not semiconducting includes metal complexes.

3.2
photocatalytic materials
material in which or on which the photocatalyst is added by coating, impregnation, mixing, etc.

Note 1 to entry: Materials include ceramic, metal, plastic, cloth, etc. for general purpose.

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3.3
DO
dissolved molecular oxygen in aqueous phase

3.4
DO analyser
measuring instrument for continuous measurement of *DO* (3.3) in aqueous using *DO electrode* (3.5)

3.5
DO electrode
electrode to measure *DO* (3.3) in aqueous phase

3.6
photocatalytic oxygen demand
POD
quantity of molecular oxygen in aqueous phase consumed in photocatalysis

3.7
blank POD(%)
percentage of concentration of *DO* (3.3) consumed under a test condition without phenol addition

4 Symbols

Designation	Symbol	Unit
room temperature	R.T.	°C
water temperature	W.T.	°C
concentration	c	mol/l
concentration of DO	c_{DO}	mg/l
photocatalytic oxygen demand	POD	mg/l
c_{DO} before UV light irradiation in the dark	c_{iDO}	mg/l
c_{DO} after UV light irradiation in the dark	c_{fDO}	mg/l
volume of test solution	V	ml
wavelength	λ	nm
UV light irradiation intensity	I	mW/cm^2

5 Principle

Photocatalysis in pure water generally produces molecular oxygen(O_2) from water molecule (H_2O) oxidation[3]. In the water polluted by some of the organic compounds, major photocatalysis oxidizes the organic compounds[4]. Photocatalyst needs O_2 to oxidize organic compounds to CO_2 and water in the environment[4]. Then the quantity of O_2 that photocatalysis needs is much larger than O_2 production from H_2O oxidation because the organic compound is photocatalytically oxidized much easier than water molecule. O_2 then has major three functions in semiconducting photocatalyst. The first function is to improve charge separation by accepting conduction band electron. The second one is to produce active oxygen species that have the ability to oxidize organic compounds. The final one is oxidation. O_2 combines with organic radicals (intermediates) produced by semiconducting photocatalytic oxidation; O_2 is an indispensable species in the semiconducting photocatalysis[4]. Therefore, the photocatalysis to oxidize organic compound means O_2 consumption. In the photocatalysis to oxidize and mineralize the organic compounds, partially oxygenated by-products are produced. Under the progress in the continuous oxidation of partially oxygenated by-products, the photocatalysis consume O_2 to mineralisation. On the basis of the photocatalytic mineralization and functions of O_2, the semiconducting photocatalytic activity can be evaluated by determining O_2 consumption. This test method is especially effective in the photocatalysis in aqueous phase. Target photocatalytic materials are either powder test samples or a film test pieces.

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