BUSINESS PLAN

CEN/TC 386
PHOTOCATALYSIS

EXECUTIVE SUMMARY

Business Environnement

Europe represents actually near 20% of photocatalysis application of the world market.

CEN/TC 386 as horizontal CEN/TC, aims at producing general standards to be applied to different elements and building constructions.
As a matter of consequence, stakeholders are manifold, including practitioners, scientists, authorities around Europe and professional bodies, government departments, architects, contractors, designers, construction companies and building materials producers, insulation manufacturers, laboratories.

Intervenors (non exhaustive list which may be completed so that all the other interested stakeholders can receive the information at the start of the project.)

- Media producers
- Lamp manufacturers/distributors
- Reactor and purifier constructors
- Analysis laboratories
- Industrialists, End-users
- Research and Test laboratories, Technical centres, Research centres

Benefits

The standardization of the photocatalytic processes will allow the rise of this new technology while reassuring the market on reliable apparatuses and of quality.
As all the new technologies, the setting of new standards (especially dedicated to the qualification of the performance) is necessary in order to prove to the consumer the efficiency of the products.

A first set of 6 European standards is already being prepared since the creation in 2008 of this Technical Committee CEN/TC 386, but it is only the beginning.

Priorities

In order to follow the market, the CEN TC 386 has been divided into five specific working groups (WGs) (one more is dedicated to the terminology). Three of them are really very active as products are already sold:

- WG2 Air purification
- WG4 Self-cleaning applications
- WG6 Light sources

In these fields, the priorities are to make European standards available related to:
- Performance of photocatalytic devices
- Confidence of consumers

1 BUSINESS ENVIRONMENT OF THE CEN/TC

1.1 Description of the Business Environment

The following political, economic, technical, regulatory, legal, societal and/or international dynamics describe the business environment of the industry sector, products, materials, disciplines or practices related to the scope of this CEN/TC, and they may significantly influence how the relevant standards development processes are conducted and the content of the resulting standards:

The Scope of the CEN/TC 386 is defined as follows:

Photocatalysis is based on absorption of light and consequent production of oxidizing and reducing species both on the semiconductor and in the surrounding medium capable of partly or wholly mineralising the majority of organic compounds.
The oxidation state of inorganic coupounds could be changed as well. Its principle is based on the simultaneous action of photons and of a catalytic layer which allows to destroy the molecules. The most commonly used photocatalyst is titanium dioxide (TiO_2), which is thermodynamically stable, non toxic and economical. It can be used in powder form in water or deposited on a substrate (glass fibre, fabrics, plates/sheets…).

Photocatalysis applications in the following sectors:

Air purification
Water purification
Self cleaning application (surfaces: glass, metals, concretes, cements, plastics, ceramics, textils, paints and varnishes, etc...)
Medical application
Light sources (UV A, B, C, visible…)

The objective is to introduce performance standards for photocatalytic effects (including photo induced effects).

The EN standards will mainly concern test and analysis methods.

1.2 Quantitative Indicators of the Business Environment

The following list of quantitative indicators describes the business environment in order to provide adequate information to support actions of the CEN /TC:

Photocatalysis is a natural phenomenon by which UV radiation, activating a catalyst, induces an oxidation-reduction chemical reaction of pollutants, which are thus eliminated. The most commonly used photocatalyst is titanium dioxide (TiO2) in anatase form, which can be used in diverse forms (powder, sol-gel, solution).

In particular:

- In powder form in water (destruction of pollutants, pesticides, dyes) with both separation and recycling at the end of treatment;
- In layers deposited on a substrate (glass, fabrics, cement-based materials, ceramics and diverse surfaces …);
- In powder form, in mass (gypsum, concrete, hydraulic lime or other inorganic building materials).

Currently, there is an increasing number of industrial applications, above all in the building sector:

- Anti-bacterial ceramic tiles;
- Self-cleaning glass (windows, automobile side mirrors);
- Concrete and other cement-based materials;
- Film coating for several application fields;
- Fabrics and tissues;
- Organic paints;
- Air conditioning systems for indoor air cleaning.

Such general picture of applications shows a value chain offering different business opportunities based on the photocatalysis. Thus an increase of market demand of the photocatalysis has to be expected. The market analysis points out Business to Business sectors including the R&D of raw materials identified as the photocatalyst and their integration with semi-finished products sold to the companies producing and commercializing finished products. Other systems of offer can be identified looking at the Businesses to Consumer sectors.

These sectors extend the buy process to the customers and users who can profit all the benefits coming from the photocatalytic products.

The present situation in the European markets shows a certain suspicion about the benefits produced with the photocatalytic applications, so that the market demand is discontinuous and the market value is slight and not significant yet to forecast a rise at short terms. The main reason is the wide spread opinion that the positive effects of the photocatalysis don’t produce economic performances when they are measured on field.

The FAQ touch many objections regarding the mode of action of the photocatalytic applications, the control of the duration of activity and their interactions with external agents. There are not yet reliable instruments and standards method that could help the proposal of photocatalytic applications to quantify the costs reduction of maintenance, the improvement of the air and water quality, the reduction of the chemicals consumption, the safe energy and water sources.

For that reason the scopes and the objectives of the photocatalytic technologies are open to different interpretations, so that the incorrect evaluations of the performances rule because of the deficiency of standards methods.

The technical and economic assessments of photocatalytic applications have to be aligned to the market expectations. Therefore the market needs of the prospect involve the performances measurement, both quality life effects and economic benefits.

For information, the progress of photocatalysis (market size in 2005) is presented in Figure 1.

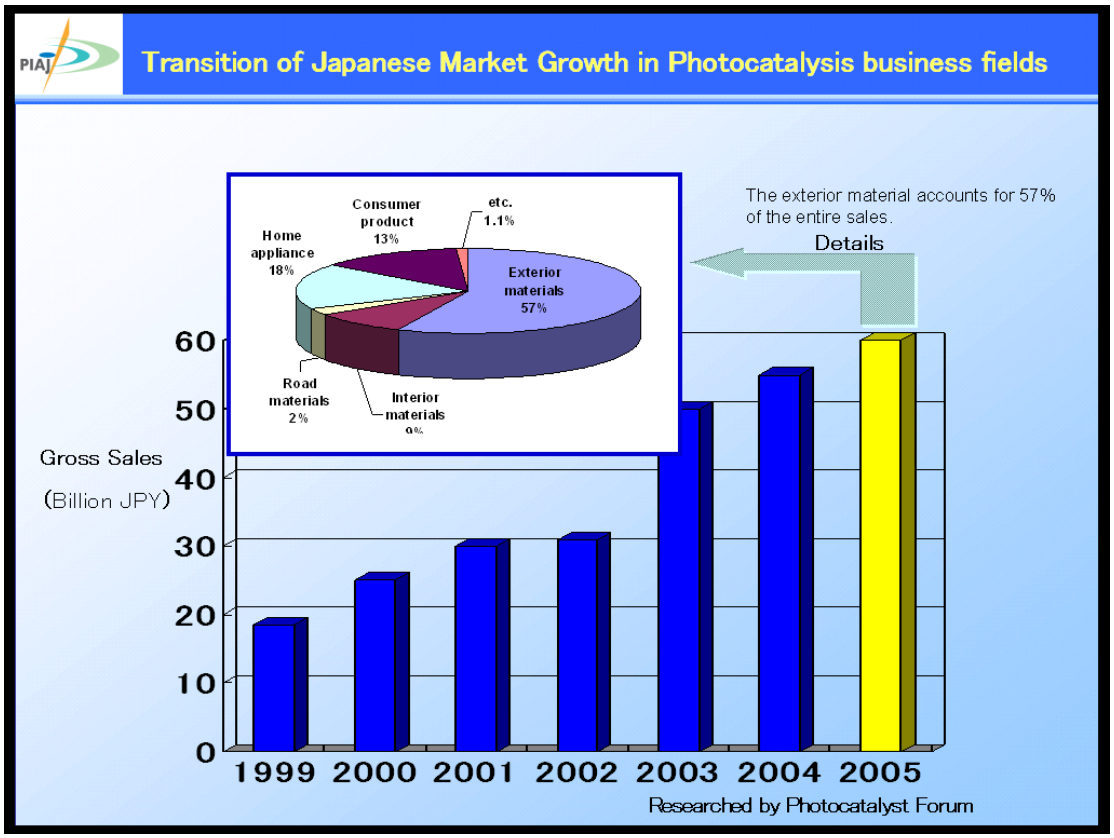

Figure 1 : Progress of photocatalysis (market size in 2005)

In 2005, the exterior materials accounts for 57% of entire sales, in Japan. Other market segments are: home appliance (18%), consumer products (13%), interior materials (6%) road materials (2%) and other products (1,1%).

In these more recent years, is particularly increasing the sector of cement-based materials (which has the highest potential market). The current applications in this field are here summarized:

Horizontal applications
- Concrete pavements
- Paving blocks and paving plates
- Other coating systems for pavements and roads (whitetopping, self-levelling mortars, ...)
- Roofing tiles
- Roofing panels
- Cement-based tiles

Vertical applications
- Indoor and outdoor paints
- Finishing coatings, plasters and other final rendering cement-based materials
- Covering precast panels
- Permanent formworks
- Masonry blocks
- Sound-absorbent elements for buildings and roads applications
- Traffic divider elements
- Street furniture
- Retaining fair-faced elements

Tunnels
- Paints and renderings
- Concrete panels
- Concrete pavements
- Ultra-thin whitetopping

A reliable estimation of photocatalytic surfaces produced with cement-based materials, within the 2007 year in Europe is approximately 1.000.000 m^2. The total surface referred only to the horizontal applications (paving blocks, industrial pavements, whitetopping ...) is approximately 50%.

However, the lack of specific standard tests for the photocatalytic characterization has limited a wider diffusion of these materials and products, so that the market is still potential but not yet mature.

It is also worth noting that the COST 540, set up by the Brussels Research Commission « New photocatalysts and Coatings » gathers together forty or so research workers and industrialists hailing from twelve European countries on the topic « New nano-architectures for photocatalysis in Europe ».

The studies have highlighted the need to define measurement standards relative to the performances of photocatalytic processes.

For additional information about the market of photocatalysis, see also Figure 2 which is a presentation of a market survey report made by BCC Research (formerly known as Business Communications Company).

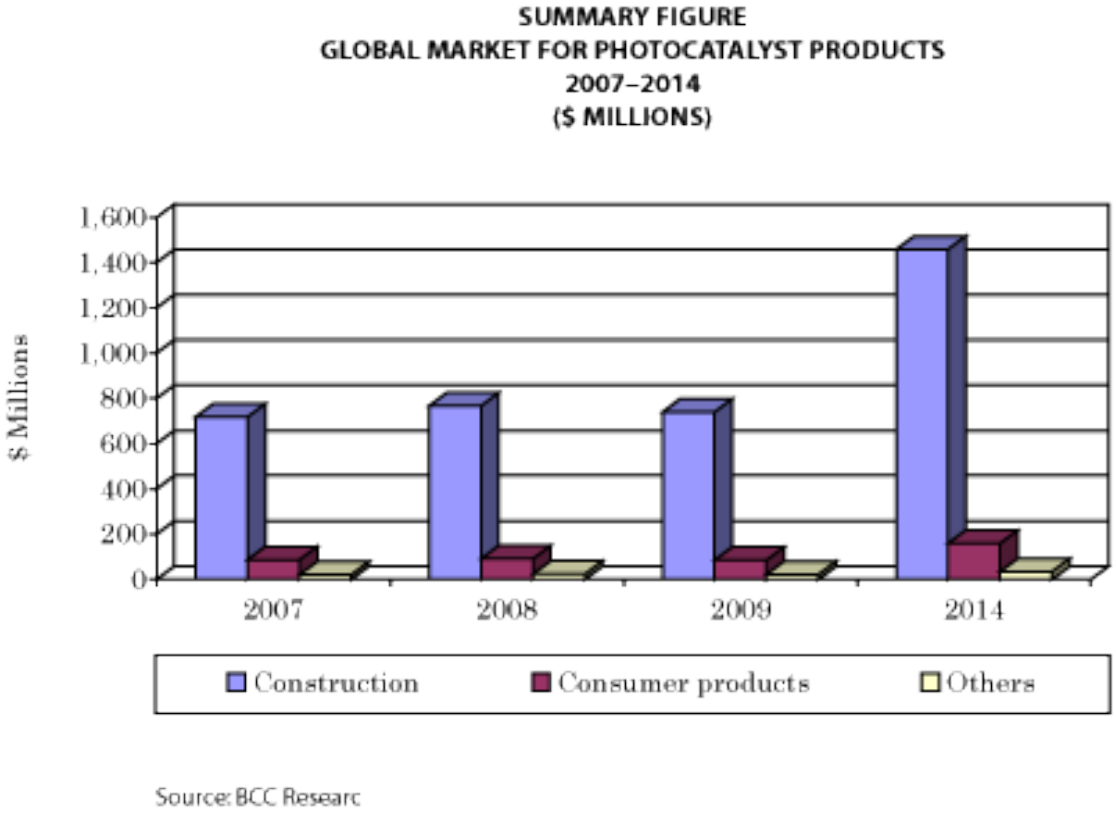

Figure 2: Global market for photocatalysis (2007 to 2014)

Moreover, photocatalytic filters can be included in air cleaning devices.
A recent study (april 2014) from “PM research study” about “China’s Home Air Purifiers Market” give the information from 1,8 millions of units to 11,2 millions units in 2016 and 51,7 millions of units in 2020 (for a medium growth scenario)
As about 23% of the sold air cleaners are included catalytic process and taking a medium price of 200 € for a system, it corresponds at a maximum potential of 515 millions € in 2016 and 2 378 millions € in 2020 for the China market of air purifier.

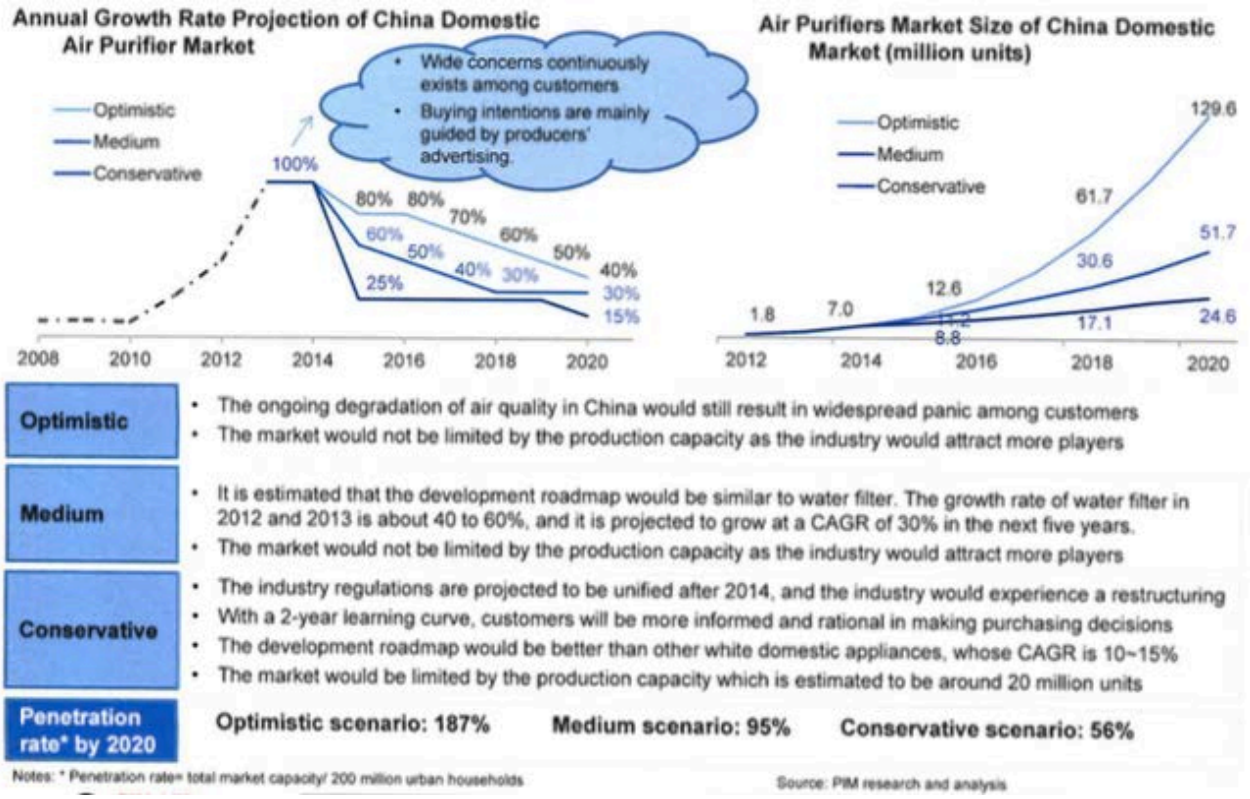

Figure 3: Three scenarios for China’s domestic household air purifiers market

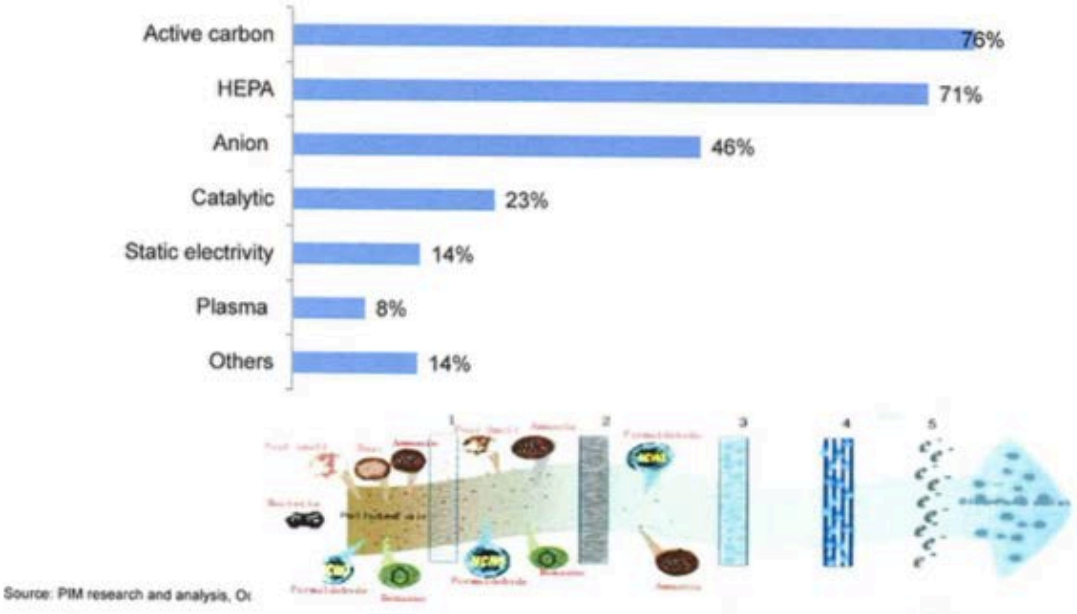

Figure 4: Different types of included air cleaning technologies (in %) for air purifiers in the market

2 BENEFITS EXPECTED FROM THE WORK OF THE CEN/TC

In order to respond to the expressed need, a large number of industrialists have proposed to create at European level a « Photocatalysis » Technical Committee responsible for drawing up performance standards in this field with a view to obtain an industrial tool in order to increase competitiveness in global market and to protect consumer (providing more information; removal of poor quality products).

As always happens in case of innovative products launched into the market, there is the need to define standard methods which can be used for the evaluation of the initial photocatalytic activity, and for the assessment of its endurance along the whole service life.

3 PARTICIPATION IN THE CEN/TC

All the CEN national members are entitled to nominate delegates to CEN Technical Committees and experts to Working Groups, ensuring a balance of all interested parties. Participation as observers of recognized European or international organizations is also possible under certain conditions. To participate in the activities of this CEN/TC, please contact the national standards organization in your country.

4 OBJECTIVES OF THE CEN/TC AND STRATEGIES FOR THEIR ACHIEVEMENT

4.1 Defined objectives of the CEN/TC

A CEN technical committee has been created (CEN/TC386) with a view to elaborate EN standards in the field of photocatalysis, including laboratory methods, expression of results and accuracy.

Standardization of the test and analysis methods used in all fields of application of photocatalysis which are namely air, water, self cleaning (concretes, cements, paints, glass/glazing, ceramics, textiles…) and medical applications and parameters influencing the photocatalysis like light sources.

The problem of by-products generation will be discussed.

Within reason, on-field tests could be developed.

4.2 Identified strategies to achieve the CEN/TC.s defined objectives.

Six Working Groups have been set up but the prioritization was given for the moment on work concerning air purification, self cleaning applications and light sources.

Based on some international or national standards (see enclosed), European standandards on method of testing and analysis have been developed first to determine the photocatalytic efficiency, the photocatalytic degradation of organic micropollutants in air, the self-cleaning performance and the photocatalytic activity of hydraulic binders.

The expected deliverables are EN (European Standard) except for 5 draft standards on light sources where it was decided to publish CEN/TS (Technical Specification) in order to use an experimental period of three years.

Future work will be undertaken on terminology, water purification, new technologies and other important issues.

Draft international standards (prepared by ISO/TC206/WG37 "Test methods for photocatalytic materials"):

☞ ***Published standards***

ISO 10676:2010 Fine ceramics (advanced ceramics, advanced technical ceramics) -- Test method for water purification performance of semiconducting photocatalytic materials by measurement of forming ability of active oxygen

ISO 10677:2011 Fine ceramics (advanced ceramics, advanced technical ceramics) -- Ultraviolet light source for testing semiconducting photocatalytic materials

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

ISO 11894-1:2013 Fine ceramics (advanced ceramics, advanced technical ceramics) -- Test method for conductivity measurement of ion-conductive fine ceramics -- Part 1: Oxide-ion-conducting solid electrolytes

ISO 14605:2013 Fine ceramics (advanced ceramics, advanced technical ceramics) -- Light source for testing semiconducting photocatalytic materials used under indoor lighting environment

ISO 17094:2014 Fine ceramics (advanced ceramics, advanced technical ceramics) -- Test method for antibacterial activity of semiconducting photocatalytic materials under indoor lighting environment

ISO 18061:2014 Fine Ceramics (Advanced Ceramics, Advanced Technical Ceramics) --

Determination of antiviral activity of semiconducting photocatalytic materials -- Test method using bacteriophage Q-beta

ISO 18560-1:2014 Fine ceramics (advanced ceramics, advanced technical ceramics) -- Test method for air-purification performance of semiconducting photocatalytic materials by test chamber method under indoor lighting environment -- Part 1: Removal of formaldehyde

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

ISO 22197-2: 2011 Fine ceramics (advanced technical ceramics) — Test method for air-purification performance of semiconducting photocatalytic materials - Part 2: Removal of acetaldehyde

ISO 22197-3: 2011 Fine ceramics (advanced technical ceramics) — Test method for air-purification performance of semiconducting photocatalytic materials - Part 3: Removal of toluene

ISO 22197-4: 2013 Fine ceramics (advanced technical ceramics) — Test method for air-purification performance of semiconducting photocatalytic materials - Part 4: Removal of formaldehyde

ISO 22197-5: 2013 Fine ceramics (advanced technical ceramics) — Test method for air-purification performance of semiconducting photocatalytic materials - Part 5: Removal of methyl mercaptan

ISO 27447: 2009 Fine ceramics (advanced ceramics, advanced technical ceramics) – Test method for antibacterial activity of semiconducting photocatalytic materials

ISO 27448: 2009 Fine ceramics (advanced ceramics, advanced technical ceramics) – Test method for self-cleaning performance of semiconducting photocatalytic materials - Measurement of water contact angle

☞ ***Draft International Standards***

ISO/DIS 18071 Fine Ceramics (Advanced Ceramics, Advanced Technical Ceramics) -- Determination of antiviral activity of semiconducting photocatalytic materials under indoor lighting environment -- Test method using bacteriophage Q-beta

ISO/DIS 19635 Fine ceramics (advanced ceramics, advanced technical ceramics) -- Test method for antialgal activity of semiconducting photocatalytic materials

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

☞ ***Committee Drafts***

ISO/CD 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/CD 17168-2 Fine ceramics (advanced ceramics, advanced technical ceramics) -- Test method

for air-purification performance of semiconducting photocatalytic materials under indoor lighting environment -- Part 2: Removal of acetaldehyde

ISO/CD 17168-3 Fine ceramics (advanced ceramics, advanced technical ceramics) -- Test method for air-purification performance of semiconducting photocatalytic materials under indoor lighting environment -- Part 3: Removal of toluene

ISO/CD 17168-4 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

ISO/CD 17168-5 Fine ceramics (advanced ceramics, advanced technical ceramics) -- Test method for air-purification performance of semiconducting photocatalytic materials under indoor lighting environment -- Part 5: Removal of methyl mercaptan

ISO/CD 19810 Fine ceramics (advanced ceramics, advanced technical ceramics) -- Test method for self-cleaning performance of semiconducting photocatalytic materials under indoor lighting environment -- Measurement of water contact angle

☞ ***New projects***

ISO/NP 27447 Fine ceramics (advanced ceramics, advanced technical ceramics) -- Test method for antibacterial activity of semiconducting photocatalytic materials

National standards:

☞ **British standard :**

BS ISO 22197-1 Fine ceramics (advanced ceramics, advanced technical ceramics) - Test method for air-purification performance of semiconducting photocatalytic materials - Removal of nitric oxide

☞ **French standard :**

XP CEN/TS 16599 Photocatalyse - détermination des conditions d'irradiation pour tester les propriétés photocatalytiques des matériaux semiconducteurs

NF B44-200 Épurateurs d'air autonomes pour applications tertiaires et résidentielles - Méthode d'essais - Performances intrinsèques

☞ **German standard :**

DIN 52980 Photocatalytic activity of surfaces – Determination of the photocatalytic activity by degradation of methylene

☞ **Italian standards :**

UNI 11238-1 Determination of the catalytic degradation of organic micropollutants in air – Part 1: Photocatalytic cementitious materials for use in construction

UNI 11238-2 Determination of the catalytic degradation of organic micropollutants in air – Part 2: Photocatalytic ceramic materials for use in construction

UNI 11247 Determination of the catalytic degradation of nitrogen oxides in air by photocatalytic

inorganic materials

UNI 11259 Determination of the photocatalytic activity of hydraulic binders - Rodammina test method".

☞ **Japanese standards:**

JIS R 1701-1:2004 Fine ceramics (advanced ceramics, advanced technical ceramics) -- Test method for air purification performance of photocatalytic materials -- Part 1: Removal of nitric oxide

JIS R 1702:2006 Fine ceramics (advanced ceramics, advanced technical ceramics) -- Test method for antibacterial activity of photocatalytic products under photoirradiation and efficacy

Liaisons:

Cooperation and liaisons with other CEN, ISO committees or organisations will be established for the following aspect:

☞ Test methods
- ISO/TC 206/WG 9 «Photocatalyse»

☞ Workplace air quality:
- ISO/TC 146/SC 2 “Air quality – Workplace atmosphere”
- CEN/TC 137 “Assessment of workplace exposure”

☞ Indoor air quality:
- ISO/TC 146/SC 6 “Air quality – Indoor Air”
- CEN/TC 264/WG 2 “Air quality – Odours”

☞ Water quality:
- CEN/TC 164 «Water supply»

☞ Coatings quality
- CEN/TC 129/WG 6 “Glass in building”
- CEN/TC 139 "Paints and varnishes"

☞ Nanotechnology
- CEN/TC 352 « Nanotechnology »

☞ European organisations
- European Commission, Joint Research Centre (JRC)
- European Photocatalysis Federation

4.3 Environmental aspects

The fields of application are related on the protection and the depollution of the environment (air purification; treatment of the odors; decomposition of the bacteria, organic matters and polluting gas) and to the improvement of quality of life.

As a matter of fact, within the space of few years, indoor air quality has become of growing concern for many people. As a result, residential air cleaners has become a buoyant market: various air cleaners can now be found in the shops, either as stand-alone portable devices or as part of air-conditioning terminal units. Real technical advances have also been made. The first

residential air cleaners to be sold were addressing specific IAQ problems such as odours or tobacco smoking. Now, most of the commercially-available devices are made up of various advanced filtering techniques (especially photocatalysis for VOCs and bio-contaminants), and thus can be considered as global solutions for IAQ improvement.

5 FACTORS AFFECTING COMPLETION AND IMPLEMENTATION OF THE CEN/TC WORK PROGRAMME

- Some factors may slow the progression of the CEN/TC 386 Programme of work:
  - the complexity of phenomenon (photocatalysis remains a rather new technology)
  - The lack of resources available to work on the projects (lack of expertise). This is emphazised by the relative small sizes of manucfacturers.
  - The validation of test methods are dependent upon funding being available to undertake the necessary pre/co-normative research
  - The overlaps with other CEN/TCs may occur (TCs which develop application standards)