



# **COST Action 540**

## **»PHONASUM«**



### **PHOTOCATALYTIC TECHNOLOGIES AND NOVEL NANOSURFACES MATERIALS – CRITICAL ISSUES**

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## **SCIENTIFIC REPORT**

### **3rd Meeting of Working Group 2 CNI-TNK Nanotechnology – Photocatalytic Technologies**

#### **Photocatalytic Applications, Standardization and Verification Methods**

**Meeting room of the Czech Normalization Institute (CNI), Prague, Czech  
Republic, 6 June 2008**

Following Scientific Report from the 3rd WG2 meeting was written by Dr. Petr Lukes (Nanopin). Full presentations given at the meeting are available through authorized access on the website of COST Action 540 ([www.cost540.com](http://www.cost540.com)). Dr. Zdenka Buresova from the Czech Normalization Institute officially opened the meeting. During the meeting representatives and experts from COST Action 540 European countries gave brief survey about actual situation regarding photocatalytic applications and testing towards industrial applications in their countries. There were also invited experts in the field of photocatalysis and ISO methods from Japan (Dr. Koji Takeuchi, Mr. Tatsuya Imura, Mr. Shigekazu Kato)..

Dr. Frantisek Peterka  
Chair of COST540

- 1) 9:00-9:30: Dr. Peterka started technical program of the meeting, briefly presented aims of the action COST540 and gave introduction about situation of testing and standardization in the photocatalytic application field in Europe.
- 2) 9:30-10:00: Dr. Takeuchi summarized current status of standardization of testing methods in the photocatalytic field in Japan and in the frame of ISO/TC 206. He informed about problems and actual situation in Asia. Asian countries are facing problems related with import/export of fake products, invasion by cheaper but useless products that cause losing consumers' reliance. Since any single country alone cannot control international trade there is need of collaboration among countries and measures in harmonized manner. As a result "Committee of Asian Standardization for Photocatalytic Materials and Products" was established in Tokyo in December 2007 with members from China, (India), Indonesia, Japan, Korea, Malaysia,

(Philippines), Taiwan, Thailand, Vietnam. Current work is focused on survey of testing capability in participating countries for round-robin test, encouraging to join ISO/TC 206 and finding possibilities for new joint proposals to ISO. The final goal is to establish certification marks common to Asian countries and to create a system to find and remove fake products through the network among countries.

- 3) 10:00-10:30: Dr. Kaluzny presented CEN standardization status of photocatalytic applications. He reminded that as a result of previous COST540 meeting in Prague in November 2007 AFNOR has proposed the creation of a European TC on photocatalytic applications. A proposal has been sent in March 2008 and currently any European countries can answer until the 9th of June 2008. He introduced possible next steps, which should follow out after establishing of European TC: meeting in Paris in October 2008, proposal of possible structure of established TC (plan about 5 WGs) and possible links with activities of existing technical committees within ISO and CEN.
- 4) 11:00-11:30: Dr. Cameron presented research on photocatalytic materials and some of the results performed in Advanced Surface Technology Research Laboratory (ASTRaL). He showed details of test of photocatalytic performance of TiO<sub>2</sub> materials made with methylene blue and summarized problems of this method that limit comparison with other results. He concluded that there is need of common testing procedure to be agreed among researchers as “reference standard” material that will allow comparisons between different methods since in his opinion the level of efficiency is not as important as consistency. He suggested circulation of samples around laboratories in order to develop own “relative” standards as possible initial step.
- 5) 11:30-12:00: Dr. Dillert informed about current status of photocatalysis in Germany. He summarized industrial companies working in the photocatalytic applications and successful products in Germany. Currently, the only successful application is based on easy to clean superhydrophilic surfaces. The others (air purification, bactericidal surfaces and water treatment) are not successful yet, partly because customers require clear proof of performance – i.e., there is need of certified testing methods. He presented status of standardization of test methods to determine the activity of photocatalytic materials in Germany, which are made in the frame of DIN Working Committee: Normausschuss Materialprüfung NMP293 „Photokatalyse“ and he gave details of DIN test method 52980: Photocatalytic activity of surfaces: Determination of photocatalytic activity in aqueous medium by degradation of methylene blue. This method is now under discussion and it is expected that will be accepted as standard method next year.
- 6) 12:00-12:20: Dr. Pimpinelli informed about development of photocatalytic active commercial product TX Active made by Italcementi. Currently, about 50 customers used their product (mainly for manufacturing of paving blocks, covering panels and plasters with production about 500 t/year), however, successful commercialization of their product was significantly affected and delayed by lack of standards. As a result, Italcementi introduced 4 standards of testing methods of photocatalytic concrete and ceramic materials that were published as Italian UNI standards in 2007 and 2008. He presented examples of successful commercial applications of their photocatalytic products and he concluded that it is always very important to inform

customers about exact function of their products to avoid sometimes too high expectations that are beyond limits of photocatalysis.

- 7) 12:20-12:40: Dr. Cernigoj presented results of standardization efforts of determination of photocatalytic properties of TiO<sub>2</sub> coatings in liquid and gaseous phase made in University of Nova Gorica, Slovenia. He presented results on measurements of photocatalytic activity of titania paints made by UV-VIS spectrophotometrical determination of photocatalytic decolorization of plasmocorinth B dye in aqueous solution and by FT-IR spectrometrical determination of decomposition of isopropanol and toluene in the gas medium. He showed results on determination of quantum yield of photochemical conversion of coumarin by measuring the fluorescence of its product 7-hydroxycoumarin.
- 8) 12:40-13:00: Dr. Buyle introduced research areas of Centexbel and its activities in the development of testing procedures for use in determination of photocatalytic properties on the textile. He mentioned that lot of companies use their own methods to prove the function of their products, however, these are often not compatible with others. He expressed the interest of Centexbel to collaborate with COST540 in the standardization efforts.
- 9) 14:30-15:00: Dr. Kato introduced activity of Photocatalysis Industry Association of Japan (PIAJ), successful commercial applications of photocatalysis in Japan and progress in the standardization process in Japan. He noted that recent insufficient photocatalytic properties of some products in the market called the necessity on the creditability and urgent standardization to provide correct understanding on the proper photocatalyst products and to satisfy customer's expectations. He introduced basic determining criteria that should be realized by standards and where should be focused (low criteria: remove confusion with fakes, high criteria: brings screening off the proper goods). He presented the role of PIAJ in standardization process and how PIAJ can cooperate with Europe. Dr. Kato proposed that PIAJ could assist Europe in establishing one association through out European countries and industries and in cooperation arrangements (e.g., in establishing evaluation protocol, to assist criteria determination under the standard, to dispatch the technical support team from PIAJ).
- 10) 15:00-15:30: Dr. Beeldens presented results from the research project on the use of photocatalytic TiO<sub>2</sub> doped concrete pavement blocks for purification of air pollution from car traffic made by Belgian Road Research Centre. 10.000 m<sup>2</sup> photocatalytic pavement blocks as pilot project on the parking lanes of a main axe in Antwerp were constructed in 2004-2005. Durability of the air purification properties was investigated in situ and in laboratory by measurements of photocatalytic removal of nitric oxide in the air according to standard method ISO 22197-1. It was determined that photocatalytic efficiency of the pavement blocks stays over time, even after three year exposure to traffic and environmental conditions. Efficiency is influenced by relative humidity. Dr. Beeldens concluded that translation from laboratory to site is not easy, surface covered has to be chosen very carefully and has to be in good line with pollution. New trial sections will be started and followed up.
- 11) 15:30-16:00: Dr. Imura presented details and application of test methods for self-cleaning performance of semiconducting photocatalytic materials proposed by Japan as ISO standard methods. Three performance tests were developed and examined in light of data collated from environmental exposure programmes in the field. Test 1 involved measurement of change of

water contact angle with UV-irradiation time. Test 2 involved evaluating the degradation of oleic acid on the surface on the photocatalytic test piece under specified irradiation. Test 3 involved adaptation of German proposal of DIN method based on determination of photocatalytic activity of surfaces by degradation of dye molecule methylene blue in aqueous medium using UV-light illumination. Based on these test two JIS standard were established in 2007: JISR1703-1 Measurement water contact angle, JISR1703-2 Decomposition of wet methylene blue. Concerning adoption of JIS standards to proposal of ISO methods Dr. Imura emphasized that PIAJ is open and hope to discuss the standardization with Europe and COST540.

- 12) 16:00-16:30: Dr. Navratil introduced the System for surface energy evaluation based on measurement of contact angle (SEE system) developed at Masaryk university Brno and Advex Instruments, Czech Republic. SEE is cost-effective device that allows accurate and rapid determination of surface-free-energy through contact-angle measurements. The development of the software was aimed at the self-cleaning performance evaluation according to the ISO standard ISO TC 206/SC. Dr. Navratil presented procedure of evaluation of contact angle dependence on irradiation time using SEE device and details about method of calculation of surface free energy.
- 13) 16:30-17:00: Dr. Kartheuser critically evaluated limitations of existing ISO methods available to asses performance of photocatalytic air purification devices. Currently there are within ISO available three air purification test methods based on measurement of removal of nitric oxide (ISO 22197-1), acetaldehyde (ISO/CD 22197-2) and toluene (ISO/CD 22197-3). However, these methods are not adapted for air purifier devices since they are limited to small materials samples, low flow (0.03-0.2 m/s) in comparison with commercial air purifiers (around 1 m/s), they also do not look after by-products. Based on this Dr. Kartheuser identified needs to assess air purifier performance and introduced new standard test method for evaluation photocatalytic air purification devices. Test is performed in testing chamber of one cubic meter, working gas is a mixture of compounds family representative of indoor air pollution (aldehyde, acetone, alcane, aromatic) and on-line analyses of compounds removal, by-products formation (light VOC, ozone) and CO<sub>2</sub> production are made.