INSTITUTO UNIVERSITARIO
CEAM
CENTRO DE ESTUDIOS AMBIENTALES DEL MEDITERRÁNEO
UNIVERSITAS Miguel Hernández

TO WHOM IT MAY CONCERN:

The Instituto Universitario Centro de Estudios Ambientales del Mediterráneo CEAM - UMH has produced a report entitled:

"NITROGEN-OXIDES REDUCTION POTENTIAL OF BIONICTILE® IMPREGNATED WITH THE PHOTOACTIVE MATERIAL OFFNOX®: A STUDY UNDER CONTROLLED CONDITIONS AT THE EUPHORE SIMULATION CHAMBER"

dated 4 June 2010. It analyses the efficiency and photocatalytic capacity of the ceramic tile called **BIONICTILE®** which is manufactured by **CERACASA S.A**, and contains the photoactive ingredient **OFFNOX®** developed by **FMC Foret S.A**.

This report presents the results of a pilot project developed and carried out in one of the EUPHORE simulation chambers **under typical winter conditions in Valencia**, i.e., an **anticyclonic meteorological situation with representative levels of nitrogen oxides and humidity for this city at this time of the year** (paragraphs I.1 and II.1.3 of the report). The experiment was performed in three phases; a blank experiment simulating only the NOx and relative humidity conditions but without the tiles, and two 24-hour cycle experiments simulating the same conditions as before but including the **BIONICTILE®-OFFNOX®** tiles inside the reactor (Cycles 1 and 2).

The conclusions of the report were as follow:

1. **Under the experimental conditions used, a decrease in the level of nitric acid (HNO_3)** was observed when using the **BIONICTILE®-OFFNOX®** tiles inside the chamber. Especially significant are the 74.44% decrease during Cycle 1 and the 57.65 % decrease during Cycle 2, with respect to the blank experiment
2. **Decrease in the levels of HO_2 radicals** in the presence of **BIONICTILE®-OFFNOX®** tiles. This means that the chemical reaction mechanism that takes place is shifted to the formation of OH radical which, together with the methane (CH_4) always present in the EUPHORE chambers, produces formaldehyde (HCHO), as was detected by FTIR (see Fig, IV.5 of the report).
3. **Formation of formic acid (HCOOH),** which is the next step in the oxidation of formaldehyde. This indicates that there is photochemical activity inside the chamber due to the presence of the tiles.
4. **Average concentration of 9.71 mg/m^2 of nitrates (NO_3^-) and 0.014 mg/m^2 of nitrites (NO_2^-)** in the **BIONICTILE®-OFFNOX®** washing water.
5. **In relation to the spatial orientation of the tiles, no differences were observed**, arriving at any conclusion on this aspect would require longer experiments with several dark-light cycles and intermediate washing cycles.
6. It is confirmed that **the nitrate analyzed comes from the photocatalytic activity of the BIONICTILE®-OFFNOX®** tiles and is not a product of its direct deposition on the

tiles because the level of particles measured was under the detection limit of the instrumentation used.

7. **The overall nitrogen balance showed** that **9.21% of the total nitrogen introduced in the chamber was captured** by the BIONICTILE®-OFFNOX® tiles **as nitrate (NO_3^-), and 0.02% was captured as nitrite (NO_2^-).**

8. Using nitrogen as a tracer species, **it is estimated that the amount of NO_x recovered by the BIONICTILE®-OFFNOX®** tiles as nitrates and nitrites is **equivalent to 5.96 mg NO_x/m^2.** However, when the number of hours the tiles were exposed to solar radiation during the experiment and the constant environmental conditions (simulation conditions at EUPHORE chamber described in Chapter II of the report) are taken into account, and the experiment **is extrapolated to the total number of hours of sun during November and January in Valencia, then the total amount of NOx recovered by the tiles is estimated to be equivalent to 132 mg NO_x/m^2.**

TCHNICAL CONDITIONS:

- Experimental period at EUPHORE chambers: from 01/02/2010 to 05/02/2010.
- 10 samples of **BIONICTILE®-OFFNOX®** tiles measuring 49.1x98.2 cm, located on to the four cardinal points and the cover.
- Instrumentation:
  - FTIR (IR) to detect HNO_3, HONO and chamber dilution.
  - DOAS (UV-Vis) for NO_2 measurements.
  - LIF (Laser) for OH and HO_2 radical detection.
  - SMPS TSI 3081 for aerosol determination.
  - NO_x Eco Physics ALppt 77312 monitor with photolytic converter PLC 760 for NO and NO_2 measurement.
  - Monitor Labs 9810 O_3 monitor for ozone determination.
  - Waltz Hygrometer for relative humidity measurement
  - Barometers for absolute pressure monitoring.
  - Radiometer for JNO_2 measurement.

To this effect, I undersign this letter at Paterna, October 6th 2010.

Dr. Millán Millán Muñoz
Executive Director

CEAM
FUNDACIÓN CENTRO DE ESTUDIOS AMBIENTALES DEL MEDITERRANEO

FUNDACIÓN DE LA COMUNIDAD VALENCIANA
CENTRO DE ESTUDIOS AMBIENTALES DEL MEDITERRÁNEO
PARQUE TECNOLÓGICO • C/ CHARLES R. DARWIN, 14 • 46980 PATERNA - VALENCIA (ESPAÑA)
TEL. (34) 96 131 82 27 • FAX (34) 96 131 81 90 • http://www.gva.es/ceam
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AENOR Asociación Española de Normalización y Certificación

VALIDACIÓN DEL ANÁLISIS DEL CICLO DE VIDA (ACV)

ACV-Nº 01/10

La Asociación Española de Normalización y Certificación (AENOR) valida que el Análisis del Ciclo de Vida (ACV) de la empresa:

CERACASA, S.A.

Titulado:

Análisis del Ciclo de Vida del Producto BIONICTILE®

Y resultado:

> "En la fase de uso en fachadas exteriores de edificios, BionicTile by Ceracasa® reduce el POTENCIAL DE FORMACIÓN DE OZONO FOTOQUÍMICO y POTENCIAL DE ACIDIFICACIÓN." / "Throughout the use phase on external facades of buildings BionicTile by Ceracasa® reduces the PHOTOCHEMICAL OZONE FORMATION POTENTIAL and the ACIDIFICATION POTENTIAL"

De fecha: 2010-09-08

Es conforme con la metodología descrita por las Normas **UNE-EN-ISO 14040: 2006** y **UNE-EN-ISO 14044: 2006**, sobre **Análisis de Ciclo de Vida**.

La validación se ha realizado con fecha 20 de septiembre de 2010, en referencia al Informe de Revisión Crítica IRC-Nº 01/07 de fecha 2010-09-08, que se incluye en el citado ACV, no considerando cualquier circunstancia acontecida con posterioridad.

Fecha de emisión: 20 de septiembre de 2010

AENOR

El Director General de AENOR