Institute for Construction Science "Eduardo Torroja" (IETcc) - CSIC

The State Agency for National Research Council (CSIC) is the largest public institution dedicated to research in Spain and the third in Europe. The Eduardo Torroja Institute for Construction Science, IETcc, belongs to the CSIC Area of Materials Science and Technologies. IETcc basic function is to conduct scientific research and technological developments in the field of construction and materials. The Research Group that present this project is "Interaction of the Construction Materials with the Environment (ISCMA)" whose overall objective is the excellence in the generation of knowledge and technology that allows to minimize the negative impacts of the construction.

Sustainability of photocatalytic technologies on urban pavements: From laboratory tests to in field compliance criteria / LIFE-PHOTOSCALING

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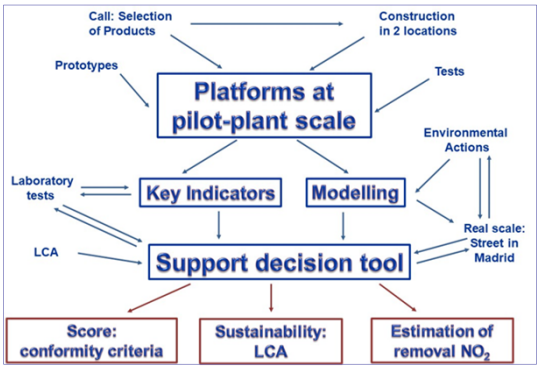
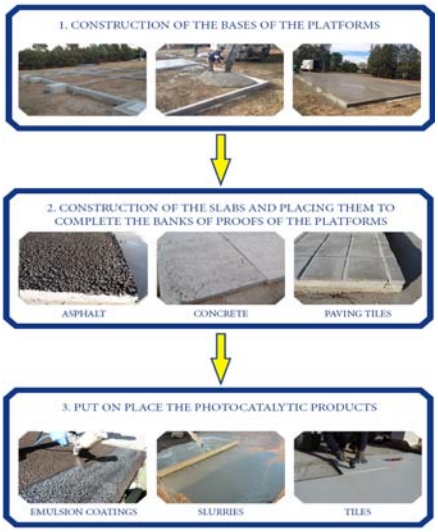
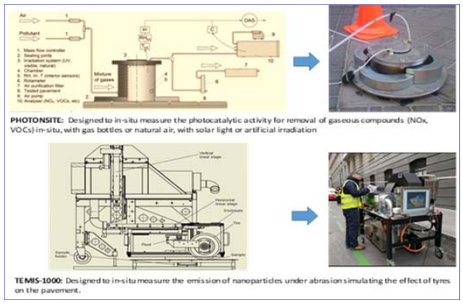
Air pollution causes 800,000 extra deaths a year in Europe and 8.8 million worldwide. Thus, reduction of the levels of contamination in the air is a priority in Europe. Photocatalytic construction materials represents a promising technology for the efficient removal of chemical contaminants. Photocatalysis is a technology that really works having been probed that most harmful contaminants can be mineralised by photocatalytic materials. Furthermore, this technology has been already applied at a real scale in some projects and specific emblematic buildings, mainly promoted by the manufacturers of the materials or by local public authorities. However, **important problems associated with monitoring the efficiency of the system from a global point of view have been faced when applying the photocatalytic construction materials at real scale. There were not any conformity criteria for the products** to be installed in the streets and just the initial activity was evaluated. This promoted **a lack of confidence in the products** that supposed a barrier that discouraged public authorities and most architects to promote their use, as they were not confident on the balance between the benefits and possible problems that their massive use could bring. In this context, **LIFE-PHOTOSCALING was born to fill in these gaps with the objective** to demonstrate the validity of the photocatalytic technology in urban agglomerations by establishing the instruments to scaling up from laboratory measurements to application in our cities, **by developing a Decision Support Tool, implemented as an app to assess the sustainability of each particular solution in each particular environment.**



Construction of the platforms

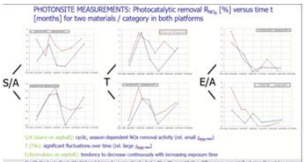


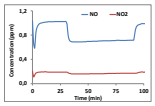
Development of prototypes

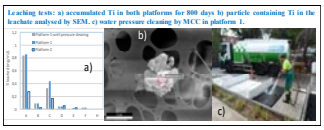


Accelerated ageing: Tests

PROPERTIES		IN SITU	LAB
Intrinsic Performance	Mechanical strength measured ultrasonic pulses	24	
	Slippery	14	
	Freeze-thaw resistance		84
	Water absorption		14
Photocatalytic Performance Efficiency	Absorption range of light, band gap		14
	Decontamination of NOx (PHOTONSITE- PROTOTYPE 1 / ISO 22197-1:2007)	182	107
	Self-cleaning properties (leakages and graffiti)	325	
	Self-cleaning properties (Rhodamine B degradation test)		14
	Photocatalytic activity indicator probe/inks	6	28
	Decontamination of VOCs, continuous monitoring (PID)	CONTINUOUSLY	
	Decontamination of NO and NO_2, continuous monitoring (AQ MESH)	CONTINUOUSLY	
	Carbonation		42
	Adherence		14
Undesired Secondary Effects	Nitrate selectivity (%)	*NOx tests	
	pH, and conductivity of runoff water		249
	Ti leaching		122
	Nitrates leaching		285
	Nanoparticles emission: Min-Tribo test rig and (TEMIS 1000- PROTOTYPE 2)	14	38
Other tests/ Characteristics	XRD		14
	SEM-BSE (3, 9 and 19 months)		42
	Mercury Intrusion Porosity		14
	Colour variation by product application		14
	Total number of tests	565	1095





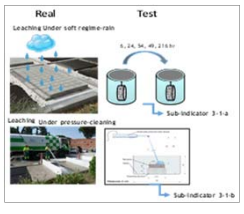


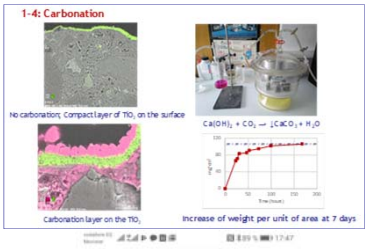
Indicators/sub-indicators → associated tests

1: Photocatalytic Performance Efficiency (PPE)
- o 1-1: Band gap (eV)
- o 1-2: Initial efficiency, R_{NOx} (%)
- o 1-3: Adherence to the substrate
- o 1.4: Carbonation

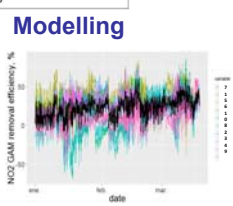
2: Intrinsic performance (IP)
- o 2-1: Slippery:

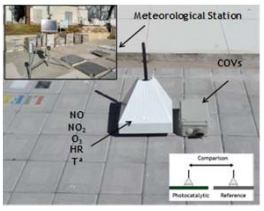
3: Undesired Secondary Effects (USE)
- o 3-1: Leaching of Ti (2 methods)
- o 3-2: Nanoparticles emission as airborne
- o 3-3: Selectivity to NO_3^-





Modelling

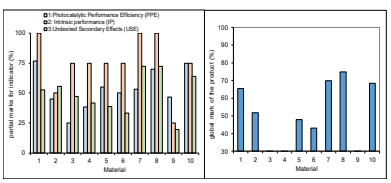




Ranges and scoring

Indicators		Sub-indicators		Scoring 1 point	2 points	3 points	4 points	0 points
1	Photocatalytic Performance Efficiency (PPE)	1-1	Band gap (eV)	eV>3.26	3.26≥eV≥2.75	2.75>eV≥2.5	eV<2.5	
		1-2	Initial Efficiency	1>R_{NOx}≥10	10>Rd≥20	20>R_{NOx}≥30	R_{NOx}≥30	≤3%
		1-3	Adherence	mg>30	30≥ mg>10	10≥ mg	NA*	
		1-4	Carbonation	mg/cm²≥150	20>mg/cm²< 150	20≥mg/cm²	NA*	
2	Intrinsic performance (IP)	2-1	Slip Resistance	15<Rd≤45	45<Rd≤70	70<Rd≤100	Rd>100	≤15
3	Undesired Secondary Effects (USE)	3-1-a	Leaching Ti-rain	10>mg/m²≥5	5>mg/m²≥1	mg/m²<1	0	> 10
		3-1-b	Leaching Ti pressure	15>mg/m²≥7	7>mg/m²≥1	mg/m²<1	0	> 15
		3-2	Nanoparticles emission a) Open asphalt b) Tiles	30<1<80 1.4<1<1.8	8<1≤30 0.7<1≤1.4	0<1≤8 0<1≤0.7	1≤0 1≤0	>80 >1.8
		3-3	Selectivity to NO_3	0.7<S_{NO_3}<0.8	0.8< S_{NO_3} ≤0.9	0.9< S_{NO_3} ≤0.95	S_{NO_3} >0.95	≤ 0.7

Marks for the products



Validation in a street in Madrid

PhotoScaling Decision Maker

https://www.life-photoscaling.eu/decisionmaker/