

# Nanotechnology in Construction (250709)

## General information

<b>School:</b>	ETSECCPB
<b>Departments:</b>	Departament d'Enginyeria Civil i Ambiental (DECA)
<b>Credits:</b>	5.0 ECTS
<b>Programs:</b>	MÀSTER UNIVERSITARI EN ENGINYERIA ESTRUCTURAL I DE LA CONSTRUCCIÓ, pla 2015 - (codi pla 1140)
<b>Course:</b>	2015/2016
<b>Course language:</b>	Castellano

## Faculty

Responsible faculty: Ignacio Casanova Hormaechea

Teacher: Ignacio Casanova Hormaechea

## Generic objectives

Subject to identify the main nanotechnology applications in the construction sector

Identification capability nanotechnologies major application in the field of construction and use techniques of nanometric

Study techniques at the nanoscale level. Nanotechnology of Cement. Nanotechnology of Additives. Nanotechnology of mineral additions. Nanotechnology of mortars and concretes . Nanotechnology of Asphalt Mixture. Energy efficiency and environmental applications. Economic impact of nanotechnology in the construction sector.

Knowledge: Scales under construction. Critical evaluation of tests. The time factor. Development study and planning criteria. Knowledge: cement hydration; the CSH as nanostructured material Understanding the molecular level structure of hydrated cement and its influence on the macroscopic behavior. Interaction between polymer molecules and mineral surfaces and cement hydrates. Nanoscale understanding of the different actions of the additives in concrete (air-entraining agents, superplasticizers, adhesives, curing ...). Action differences between micro-additions i the nanoadiciones. Ability to decide on when to use micro and nano. Rating macroscopic effects of the use of nanomaterials and the use of their properties in the manufacture of multifunctional mortars and concretes. Nanoadditions effect on the performance of asphalt mixtures: comparative study of technological procedures. Embedded sensors, intelligent materials, ultra-high performance, energy efficiency. Development of a small study of technology prospective. Identification of the most relevant nanotechnology and development of a coordinated establishing a material / structure model study.

## Skills

### *Specific skills*

To conceive and design civil and building structures that are safe, durable, functional and integrated into its surroundings.

Designing and building using traditional materials (reinforced concrete, prestressed concrete, structural steel, masonry, wood) and new materials (composites, stainless steel, aluminum, shape memory alloys?).

To evaluate, maintain, repair and strengthen existing structures, including the historic and artistic heritage.

Mathematically modelling structural engineering problems.

To apply methods and advanced design software and structural calculations, based on knowledge and understanding of forces and their application to the structural types of civil engineering.

### *Generic skills of subject*

To conceive, design, analyze and manage structures or structural elements of civil engineering or building, encouraging innovation and the advance of knowledge.

To develop, improve and use conventional materials and new construction techniques to ensure the safety requirements, functionality, durability and sustainability.

## ECTS credits: total hours of student work

		Dedication	
		Hours	Percent
Supervised Learning	Theory	27.00	60.0%
	Assignments	15.00	33.3%
	Laboratory	3.00	6.7%
	Supervised activities	15.00	33.3%
Self-Learning		80.00	

## Contents

### *Introductory concepts*

#### *Dedication*

9.0h. Theory + 3.0h. Assignments + 3.0h. Laboratory

#### *Description*

Scale factors in construction

Introduction to Nanotechnology

Microscopy electronics, interferometry and atomic force. X-ray diffraction synchrotron radiation. Synthesis techniques. Surface chemistry studies: photoelectron spectroscopy X-ray characterization mechanics: nanoindentation

Exercises of nanomaterials characterization

Guided tour of the laboratories of the Center for Research in Nano-Engineering of the UPC

### **Nanomaterials**

#### ***Dedication***

15.0h. Theory

#### ***Description***

Nanotechnology of Cement

Nanotechnology of Admixtures

Nanotechnology of Mineral Additions

Nanotechnology of mortars and concretes

Nanotechnology of asphalt mixes

### **Energy, environment and economy**

#### ***Dedication***

3.0h. Theory + 12.0h. Assignments

#### ***Description***

Energy efficiency and environmental applications: case study

Economic impact of nanotechnology in the construction sector

Case analysis

### **Activities**

#### ***Final course report***

#### ***Dedication***

15.0 h. Supervised activities

#### ***Description***

Research work on one of the topics discussed during the course

### **Grading rules (\*)**

**(\*) The evaluation calendar and grading rules will be approved before the start of the course.**

The mark of the course is obtained from the ratings of continuous assessment and their corresponding laboratories and/or classroom computers.

Continuous assessment consist in several activities, both individually and in group, of additive and training characteristics, carried out during the year (both in and out of the classroom).

The teachings of the laboratory grade is the average in such activities.

The evaluation tests consist of a part with questions about concepts associated with the learning objectives of the course with regard to knowledge or understanding, and a part with a set of application exercises.

### **Test rules**

Failure to perform a laboratory or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.

### **Teaching methodology**

The course consists of 3 hours per week of classroom sessions in a classroom (large group).

They are dedicated to lectures 1.5 hours in a large group on I that teachers exposed the basic concepts and materials of matter, presents examples and exercising.

The rest of weekly hours dedicated to tutorials and individual monitoring of the work commissioned.

Support material is used in the form of detailed teaching plan using the virtual campus ATENEA: content, programming and evaluation activities directed learning and literature.

### **Office hours**

Monday and Friday from 9:00 to 11:00

### **Basic bibliography**

- F. Pacheco-Torgal, S. Jalali. **Nanotechnology: Advantages and drawbacks in the field of construction and building materials**. Constr. Build. Mater. 25 . 2011.
- A. Porro, J.S. Dolado, J.J. Gaitero, H. Manzano. **Nanotechnology and Concrete Concepts and Approach**,. Transp. Res. Rec. . 2010.
- W. Zhu, P.J.M. Bartos, A. Porro. **Application of nanotechnology in construction - Summary of a state-of-the-art report**. Mater. Struct. 37 . 2004.
- T. Brockmann, P. Fontana, B. Meng, U. Mueller. **Nanotechnology in construction engineering**. Beton- Und Stahlbetonbau. 103. 2008.

### **Complementary bibliography**

- Y. Yang, X. Liu, H. Jia, B. Xu. **How do vapor grown carbon nanofibers nucleate and grow from deoiled asphalt?** . Mater. Chem. Phys. 126 . 2011.
- C. Rodriguez-Navarro, E. Ruiz-Agudo, M. Ortega-Huertas, E. Hansen. **Nanostructure and irreversible colloidal behavior of Ca(OH)(2): Implications in cultural heritage conservation.** Langmuir. 21 . 2005.