



**SUN-SNO-GUIDENANO Sustainable
Nanotechnology Conference 2015
Monday, Mar. 9 – Wednesday, Mar. 11
Venice, Italy**

Nanomaterials and Sustainability in the fields of Architecture and Preservation of Cultural Heritage

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“Ricercatore Esperto di Nanotecnologie e Nanomateriali per i Beni Culturali”
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www.masternanotecbc.it

APPLICATIONS FOR BUILDING CONSTRUCTION



SUSTAINABILITY



**Reduce the environmental footprint of
the building environment**

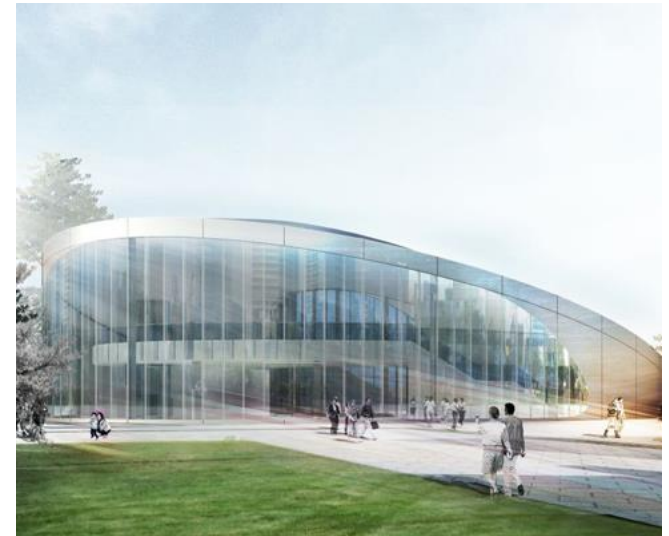
**MORE SUSTAINABLE
BUILDING MATERIALS**

**EFFICIENT USE
OF ENERGY AND RESOURCES**

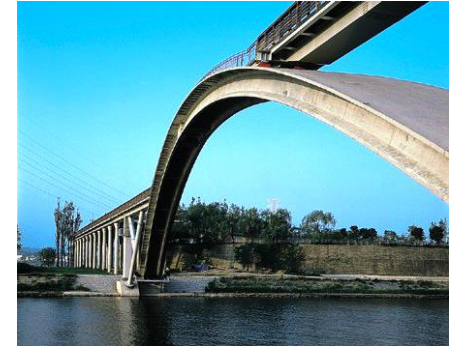
NANOMATERIALS FOR ARCHITECTURE

- Improving the **performance** of building materials
- Increase **durability** and **reliability** of the building elements
- Improving **energy efficiency** and **safety** of the buildings
- Reducing the environmental impact through **sustainable materials**
- Simplifying and **reducing maintenance works**
- Providing **greater comfort** of life inside the rooms

STRUCTURE



SURFACES



NANO ADDITIVES

- Metal nanoparticles
- Nano-silica fumes
- Carbon nanotubes
- Carbon nanofibers



NEW PROPERTIES

- Higher mechanical strength
- Increased durability
- Self-cleaning
- De-polluting/purifying properties
- Increased fire resistance
- Faster curing process

GLASS AND SMART WINDOWS



- **THIN FILM COATINGS**
- **THERMOCHROMIC TECHNOLOGIES**
- **PHOTO-CHROMIC TECHNOLOGIES**
- **ELECTRO-CHROMIC COATINGS**

INSULATING



- Aerogel
- Vacuum insulation panel
- Thermal Wrap
- Energy efficiency
paintings



COATINGS FOR INTERIOR APPLICATIONS



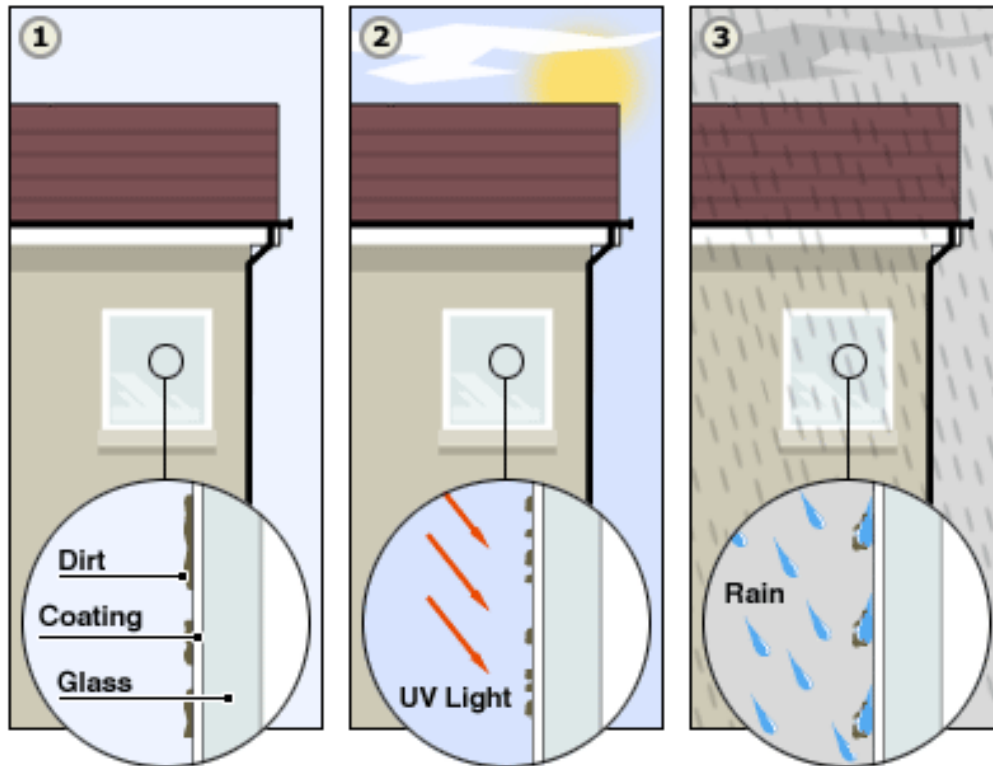
- Self-cleaning and / or anti-pollution
- Sanitizing and antibacterial activity
- Scratch resistance
- Anticorrosion for iron
- Fire retardant for wood

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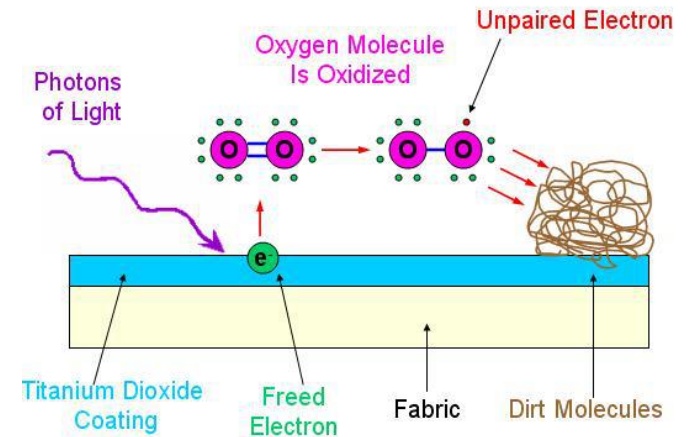
COATINGS FOR EXTERNAL



TiO₂ PHOTOCATALYTIC ACTION



- Self-cleaning
- Anti-bacterial
- De-pollutant
- Reduction of maintenance

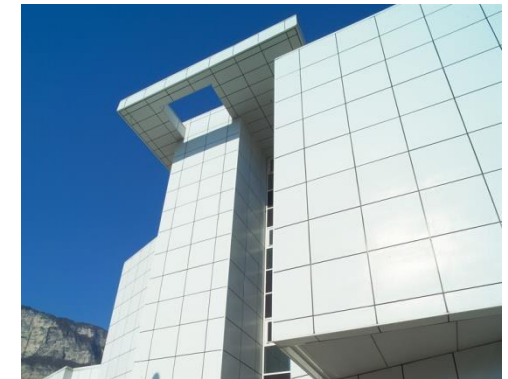


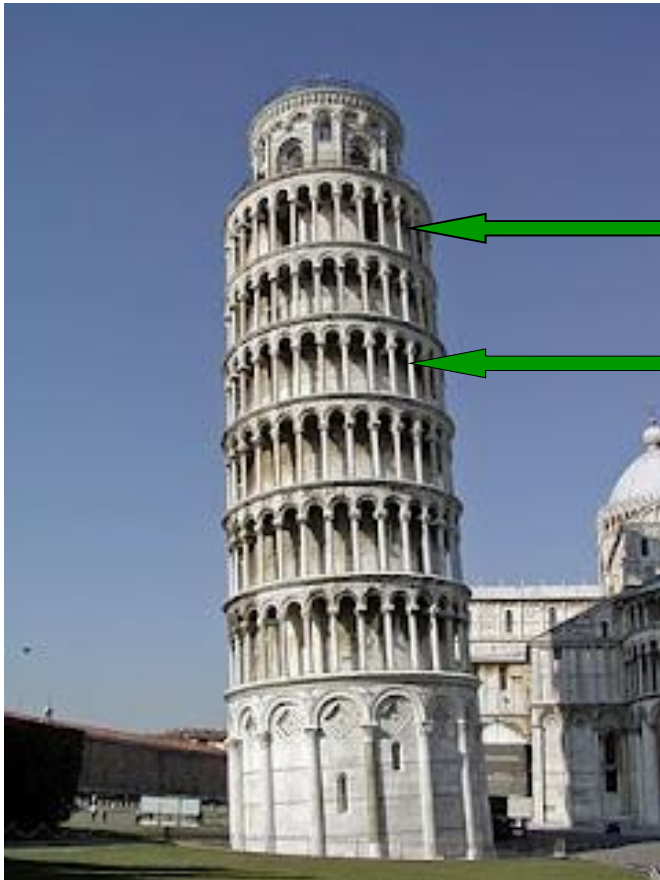
TiO₂ PHOTOCATALYTIC ACTION



- ☐ Transparency in the visible region
- ☐ High surface affinity
- ☐ Ensures the breathability of the support

- ☐ Chemical inertness
- ☐ Low cost and easy to produce

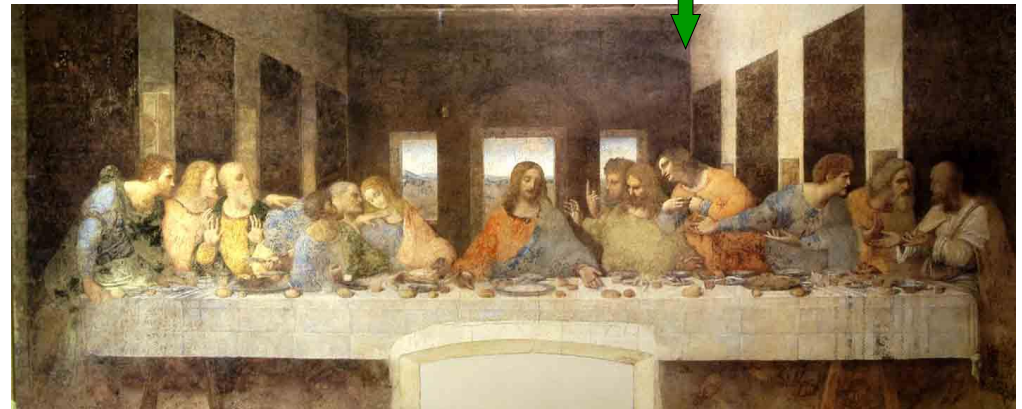




Titanium dioxide
nanoparticles

Nanosilica

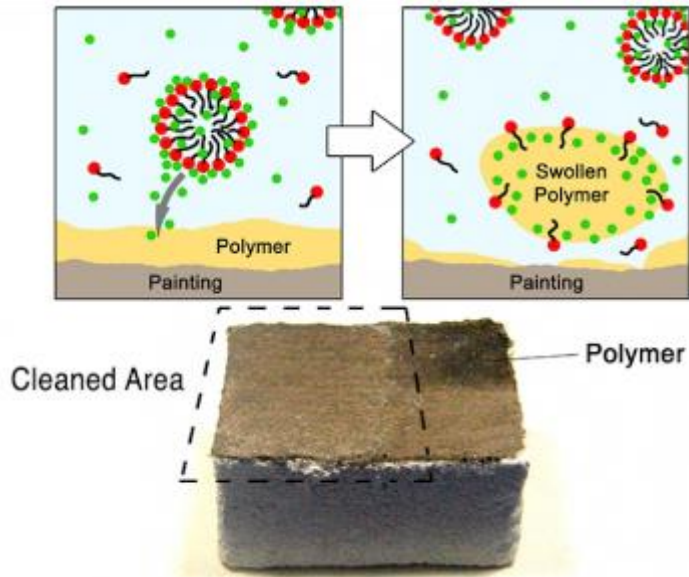
Calcium
hydroxide
nanoparticles



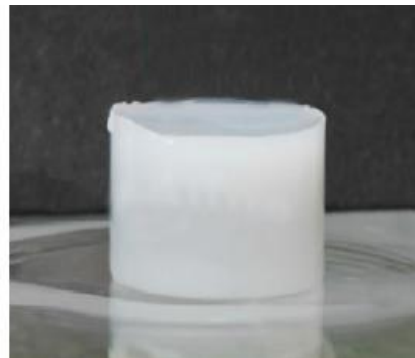
- **CLEANING**
Nanostructured cleaning systems
- **CONSOLIDATION**
Calcium hydroxide nanoparticles
Silica nanoparticles
- **PROTECTION**
Water repellency
Self-cleaning
Anti-bacterial
Depolluting
Controlled-release biocides
- **MONITORING**
Mininvasive advanced sensors
Non-destructive diagnostics



CLEANING SYSTEMS



- Micellar solutions and microemulsions for the removal of degraded synthetic resins
- High retention chemical gels for selective cleaning of surfaces sensitive to water and to polar solvents
- Dispersions of magnesium and calcium nanoparticles for the deacidification of paper items

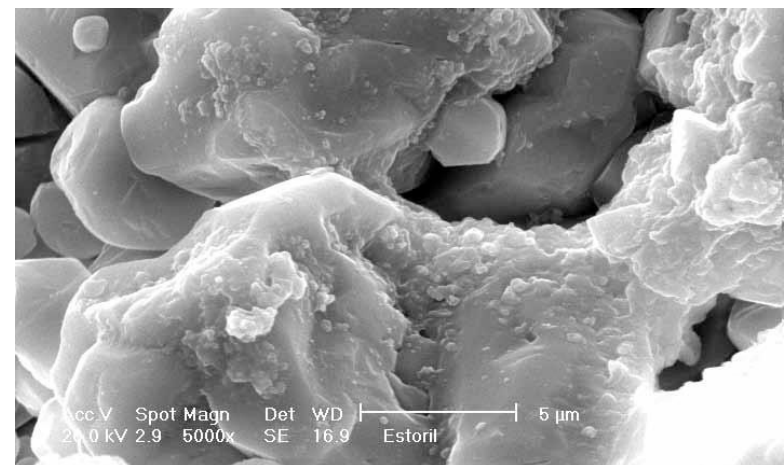


(Fonte: Carretti E, Giorgi R., 2007)

CONSOLIDATION: CO₂ NANOPARTICLES

Calcium hydroxide nanoparticles in isopropyl alcohol:

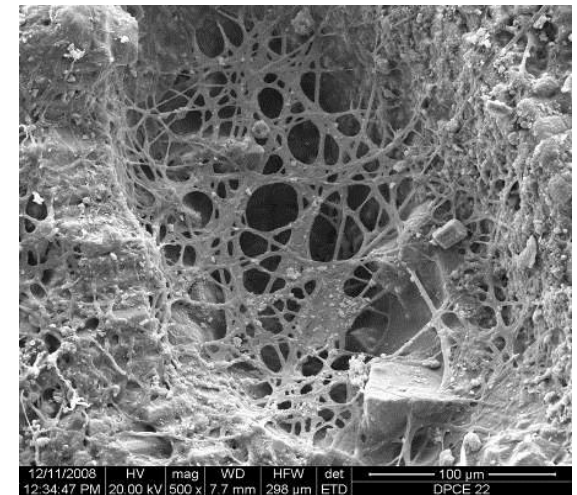
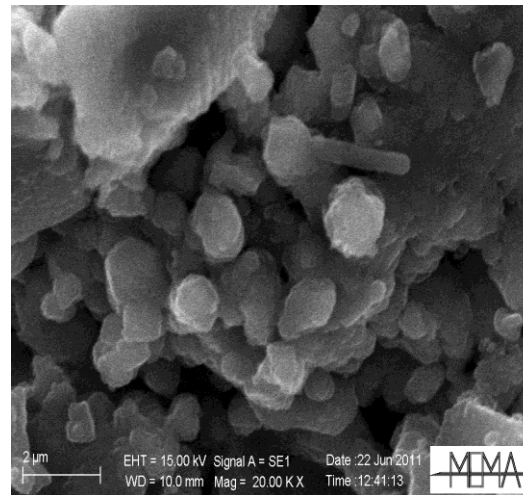
- compatible
- greater penetration
- delayed time of carbonation



CONSOLIDATION: SILICA NANOPARTICLES



- Silica nanoparticles in aqueous solution:
- compatible
 - treatment works in presence of moisture
 - shorter access times (3-4 days)



PROTECTIVE TREATMENTS



Surface treatments for stone, wood, plaster, ceramics that confer characteristics of:

- Hydro-oil repellency
- Self-cleaning against smog and biodeteriogens

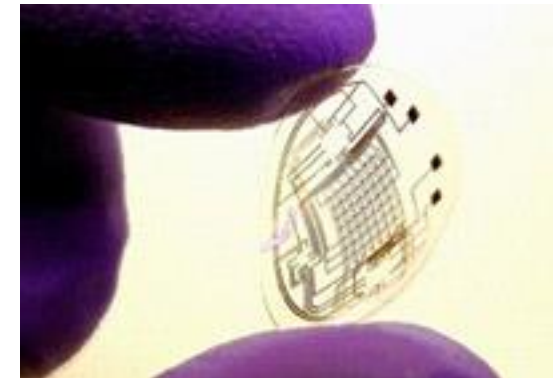
while maintaining color characteristics and water vapor permeability of the treated materials



DIAGNOSTIC AND MONITORING



- Diagnostics for non-destructive analysis of the decay
- Imaging and advanced instruments for microstructural characterization of materials
- Development of sensors for real-time monitoring
- Remote control and safety of assets



The application of nanotechnology makes a concrete contribution in the field the construction industry and cultural heritage preservation to the following areas:

- Optimization of existing products
- Damage protection
- Reduction in weight and/or volume
- Reduction in the number of production stages
- A more efficient use of materials
- Reduced need for maintenance (easy to clean, longer cleaning intervals) and/or operational upkeep

**NANOPARTICLES CAN BE ACCIDENTALLY
RELEASED INTO THE ENVIRONMENT AT
DIFFERENT STAGES OF THEIR LIFE CYCLE**

No adequate informations about the **toxicity** and
the **nature** of the nanoparticles used in their
products

How they **transform** the environment?

What might happen in case of increase
in the **concentration** in the atmosphere?

What might happen in case of **release**?

Develop a profile of full exposure of the **entire lifecycle** of nanomaterials, to assess the possible effects on **human health** and the **ecosystem**

Specific actions are necessary to overcome these issues, i.e.:

- **Eurocodes**: development of new codes supporting the use of emerging materials and technologies in the construction sector
- **Environmental impact** of construction materials

CONCLUSIONS

EVEN IF NANOMATERIALS ARE CONTRIBUTING TO A SIGNIFICANT CHANGE IN BOTH SECTORS WE MUST ENSURE THAT THE POTENTIAL RISKS ARE IDENTIFIED AND CONTROLLED, THROUGH DEVELOPING NEW APPROPRIATE STANDARDS AND CODES FOR THEIR APPLICATION

A STRONG INTERDISCIPLINARY COOPERATION IS NEEDED TO PERFORM ALL THE NECESSARY ASSESMENTS OF THE ENTIRE LIFE CYCLE OF THE NEW PRODUCTS TO ENSURE THEIR PROPER SUSTAINABILITY IN TERMS OF POTENTIAL TOXICITY AND HEALTH RISKS

THANKS FOR YOUR ATTENTION

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