

**Nanotechnologies and nanomaterials for cultural heritage:
research and education as drivers for the technology transfer**



MASTER UNIVERSITARIO
RICERCATORE ESPERTO DI
NANOTECNOLOGIE E
NANOMATERIALI
PER I **BENI CULTURALI**

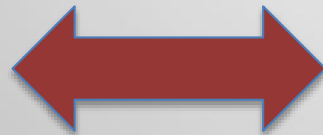


**UNIVERSITÀ
DEGLI STUDI
DI PALERMO**

“young researchers becoming the links between industries and research, contributing to the establishment of solid cooperation, turning it also into job opportunities”



Roberta Basile
Lorenzo Sambo





Giovanni Predieri⁽¹⁾, Laura Bergamonti⁽¹⁾, Claudia Graiff⁽¹⁾, Clelia Isca⁽¹⁾, Ilaria Alfieri⁽¹⁾, Andrea Lorenzi⁽¹⁾, Pier Paolo Lottici⁽²⁾

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Nanostructured Materials for Preservation and Conservation *of stone and lignocellulosic materials*

Methods and materials

- Sol-gel process involving alkoxysilanes
- Hybrid inorganic-organic materials (e.g. SiO_x-polyamidoamines)
- Sol-gel process involving non-silicate materials: titanium dioxide
- CNC: crystalline nano-cellulose

Objectives

- Cleaning, consolidation, coating of stone materials
- Application of nanosols on wood: protection against biotic decay
- Application of nanosols on paper: protection and deacidification



High Materials Innovation is a Parma University Spin-off company working in the development, production and commercialization of superficial treatments and innovative materials.

The company has been founded in 2015 by eleven professors and researchers of the Chemistry Department.



High Materials Innovation

www.highmaterialsinnovation.com

c/o Dipartimento di Chimica – Università di Parma
Parco Area delle Scienze 17/A – 43124 Parma, Italy

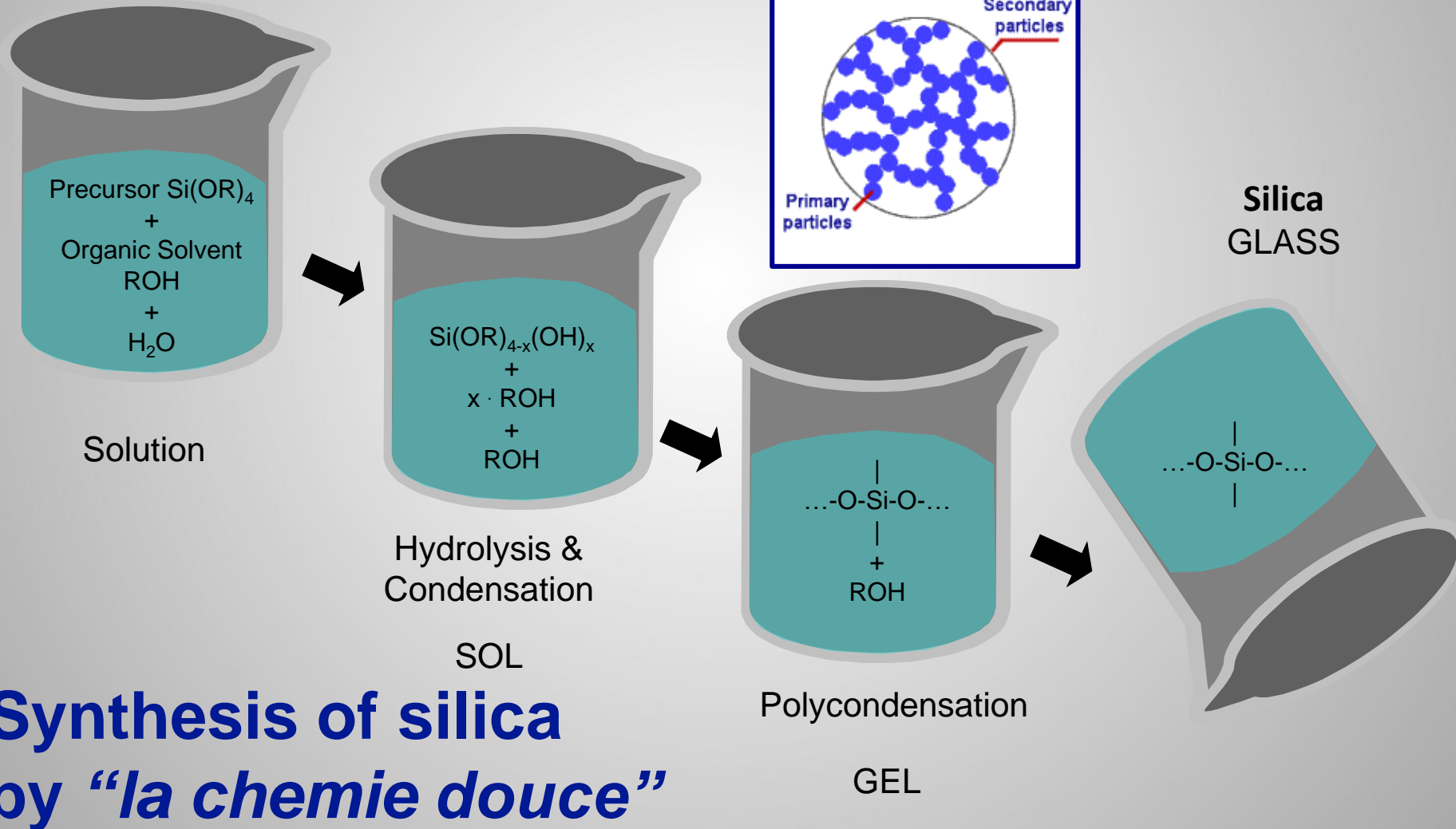
- **Hydrophobic treatments**
- **Food contact materials analysis**
- **Photocatalytic treatments**
- **Antimicrobial products (for packaging and for domestic surfaces)**
- **Cultural heritage protection**
- **Oxygen barrier coatings**
- **Metal protection (silver and aluminium)**



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Tutela e conservazione del patrimonio

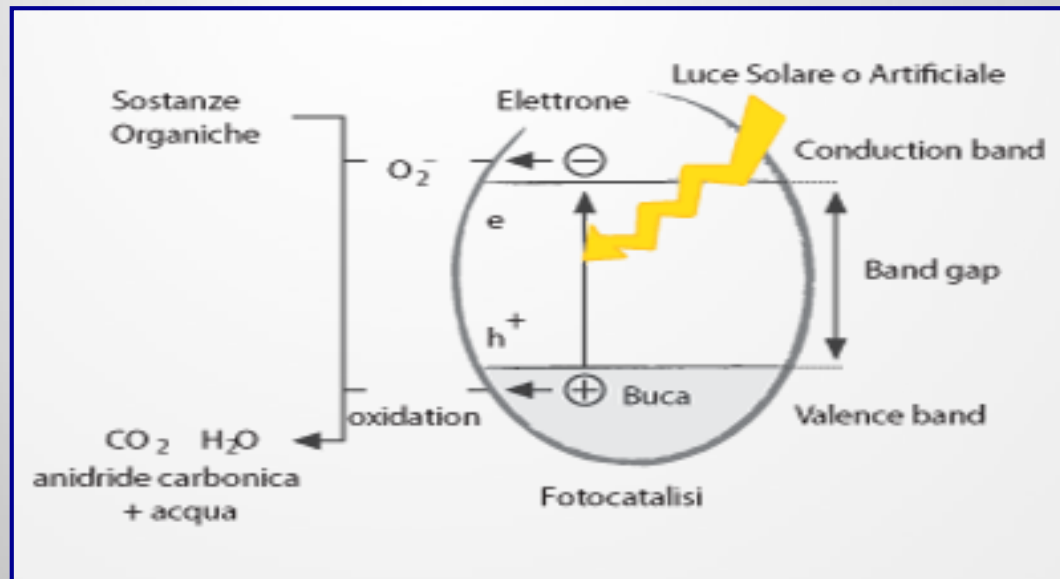
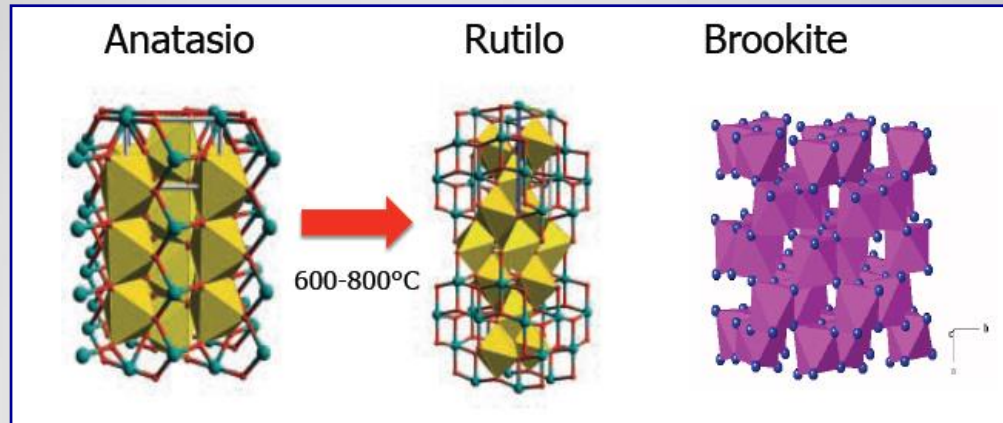


**Synthesis of silica
by “la chimie douce”**

Titania nanosols

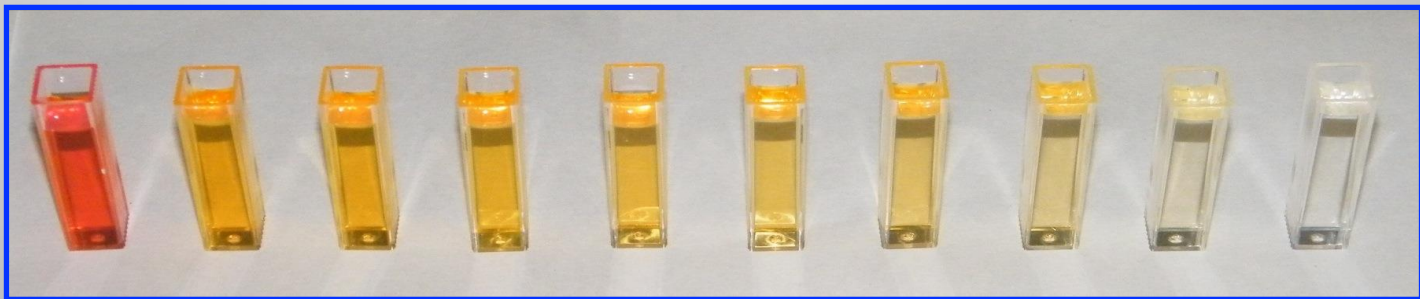
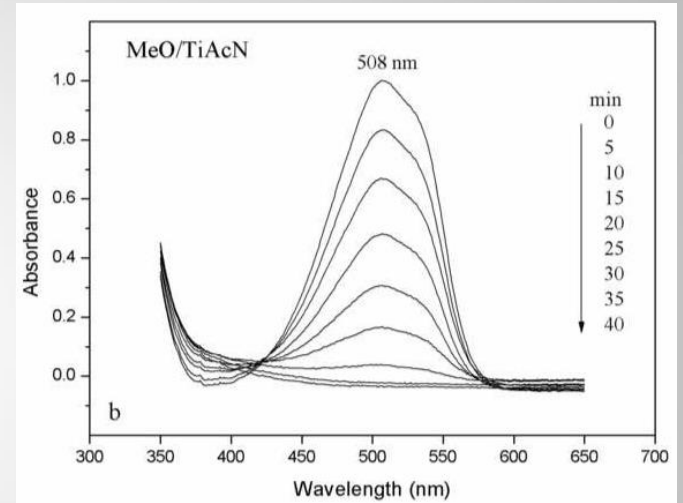
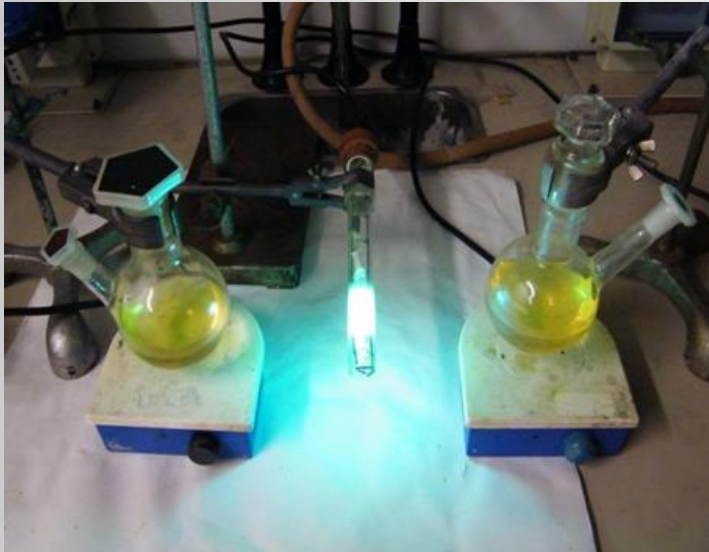


titanium
dioxide



Photocatalytic activity

by colorimetric tests

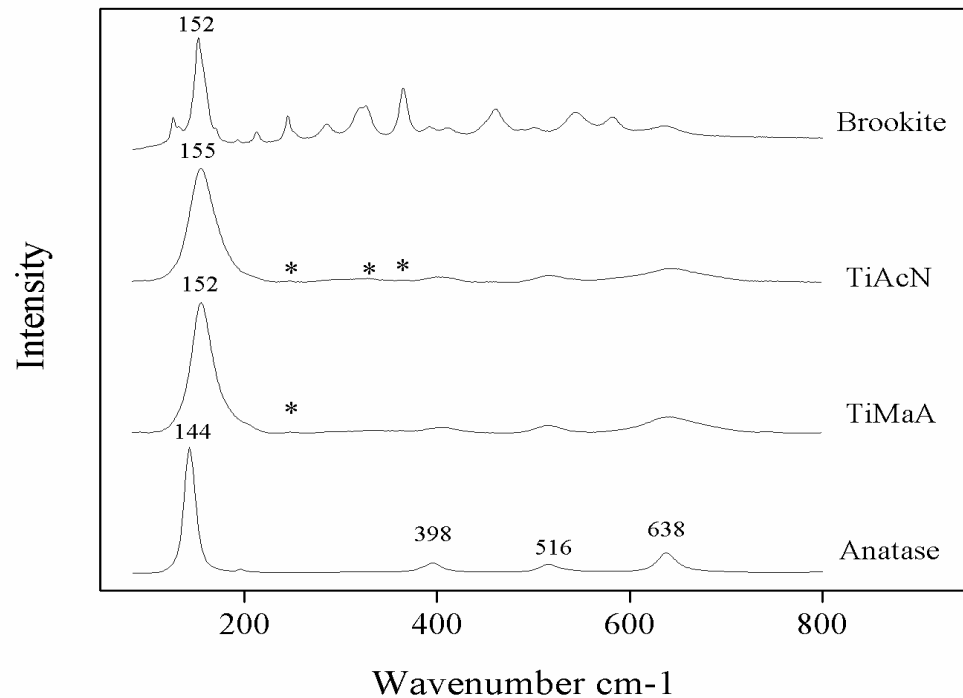
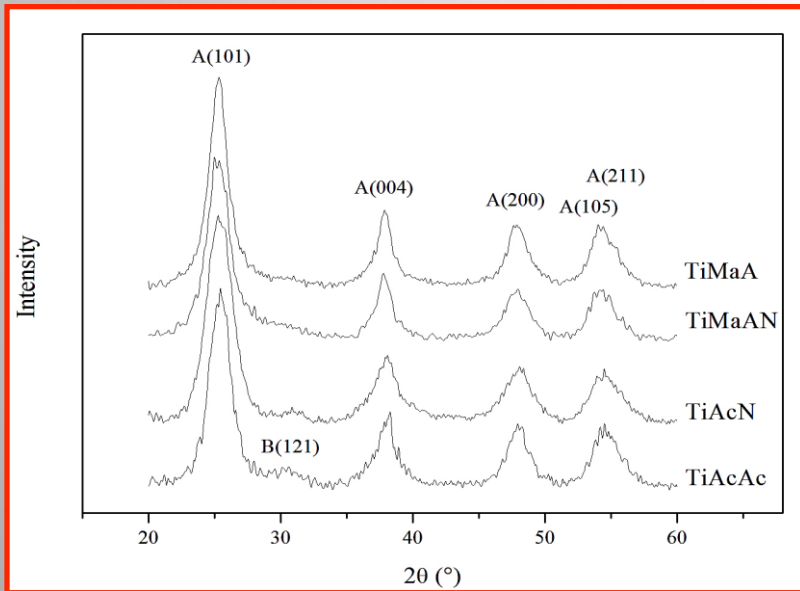
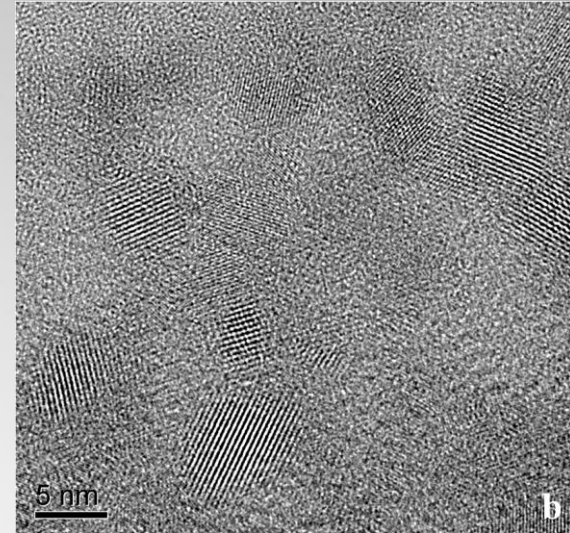




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XRD, Raman and TEM Characterization of the nanosols



The Baroque monuments of Modica (Eastern Sicily)

Assessment of causes of chromatic alteration of stone building materials



Fig. 1 (a) The main façade of the Cathedral of San Pietro; (b) a detail of the sampling sites

Nanocrystalline TiO_2 by sol-gel: characterization and photocatalytic activity on Modica and Comiso stones

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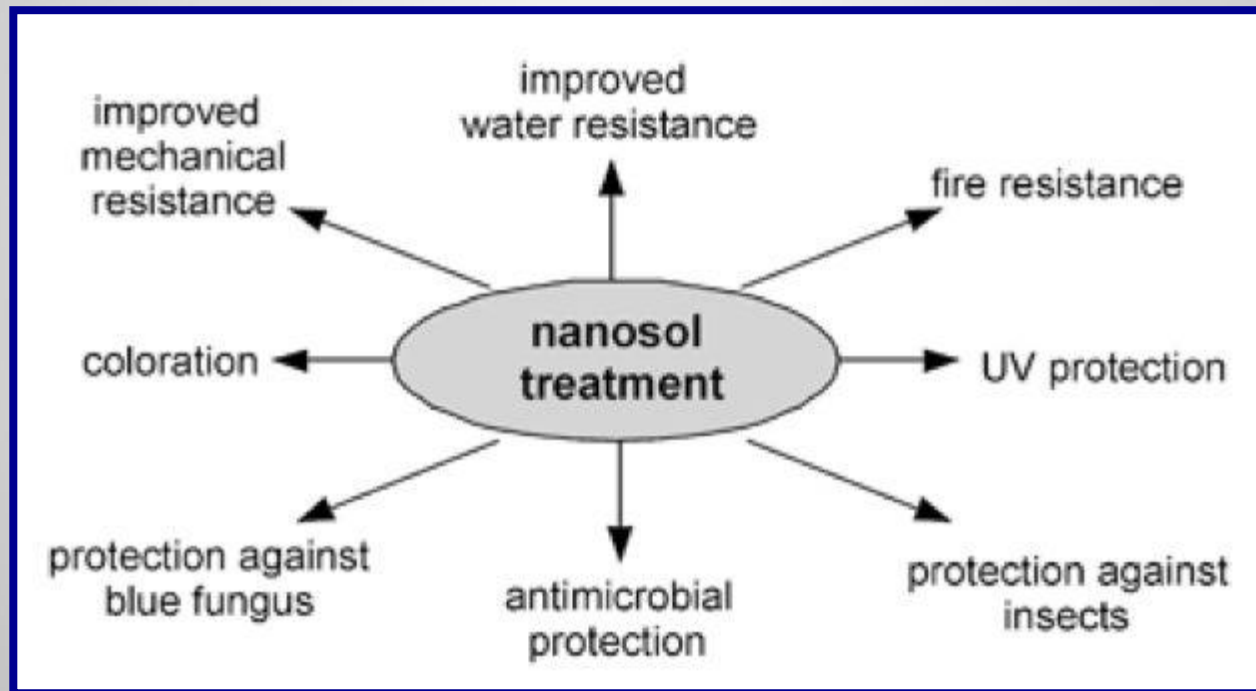


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Protecting wood by nanosol application





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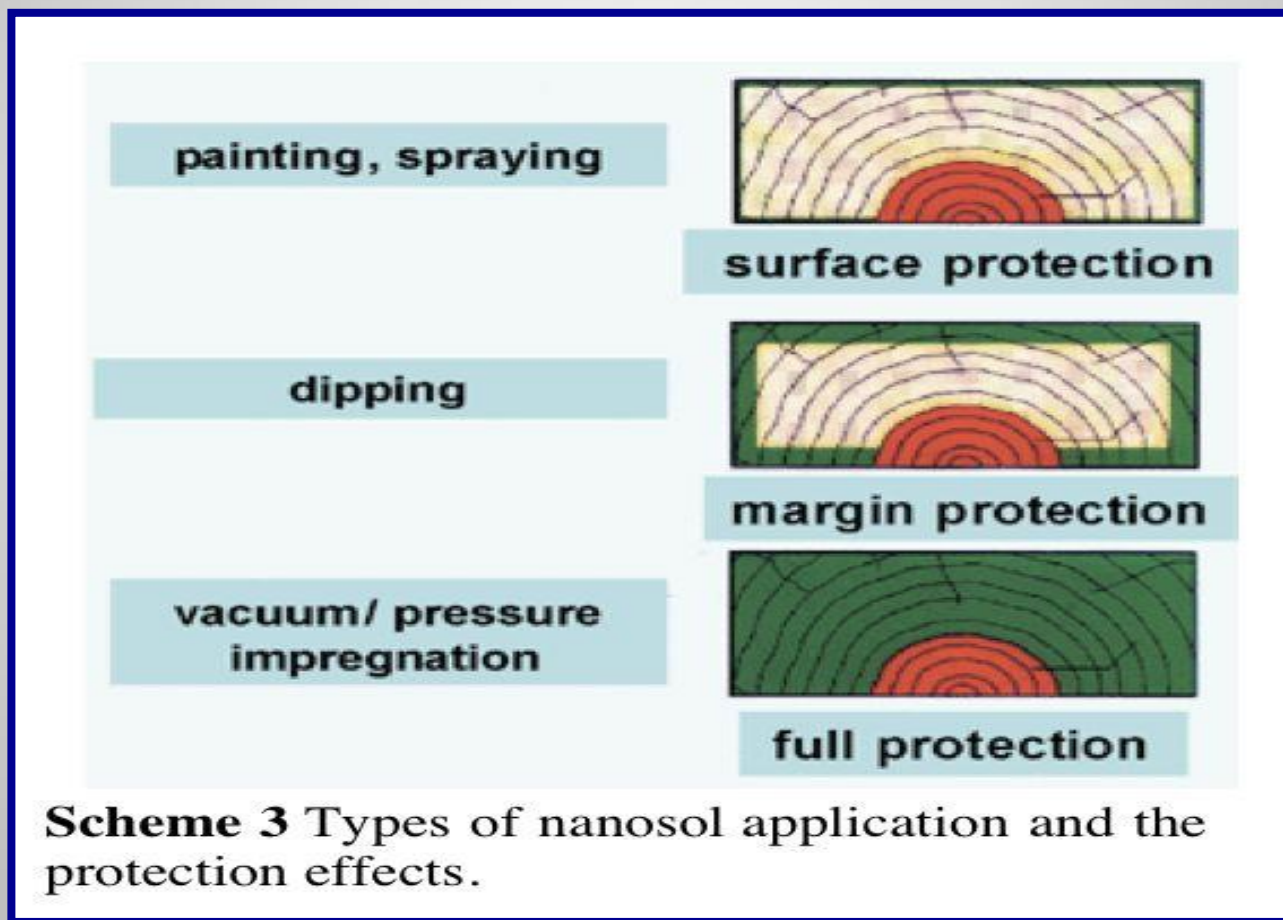
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Types of nanosol application





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Wood fossilization

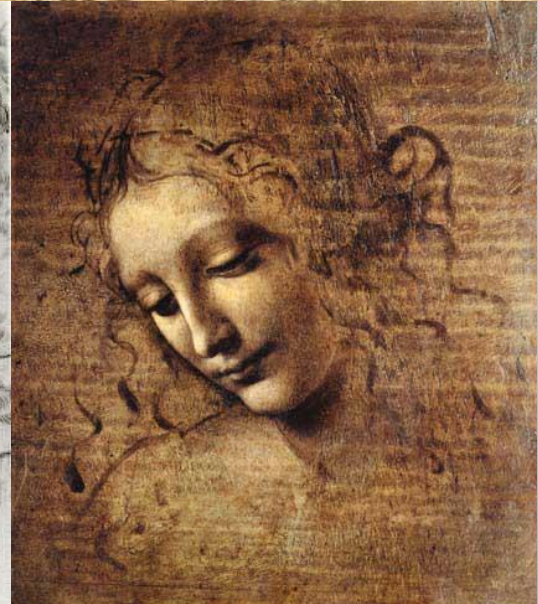
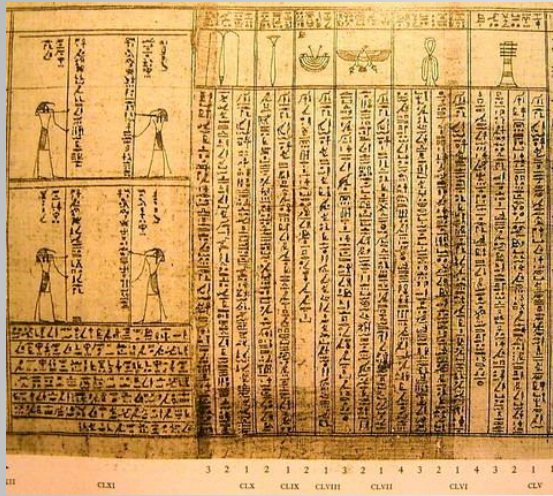




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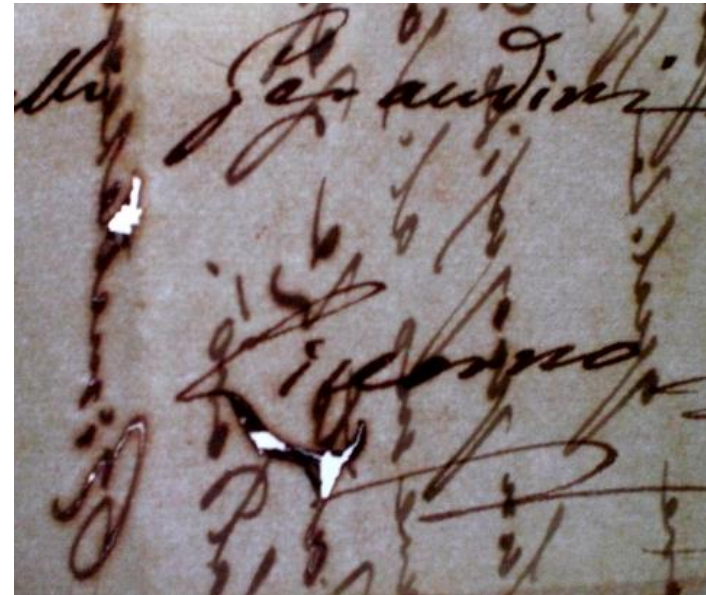
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Principali processi responsabili del deterioramento della carta (degrado strutturale)

- **Idrolisi***
- **Ossidazione**
- **Fotodeterioramento**
- **Biodeterioramento**

**soprattutto dovuta all'acidità
intrinseca ed estrinseca*



**Acidità indotta dagli
inchiostri ferrogallici**



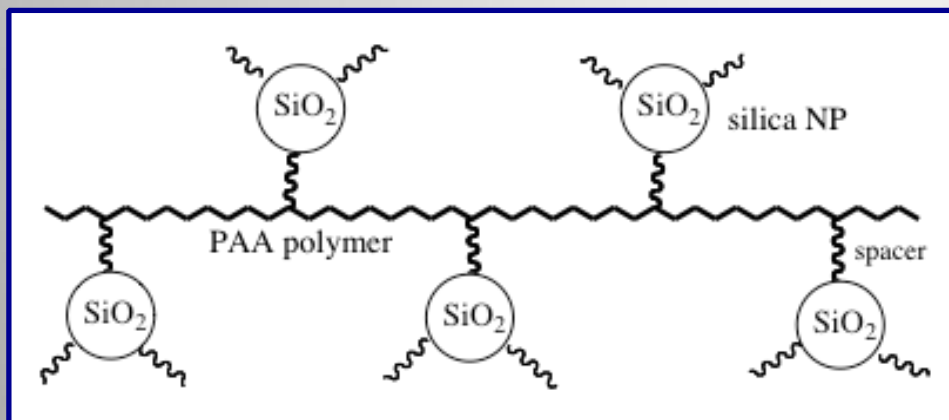
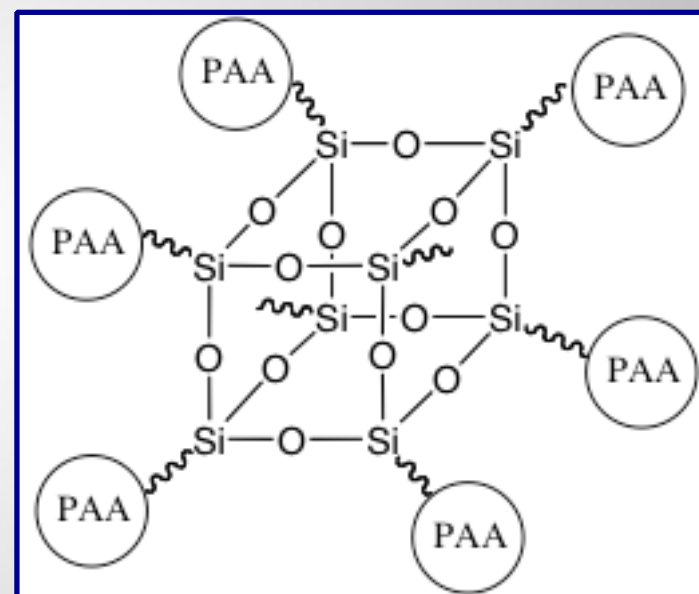
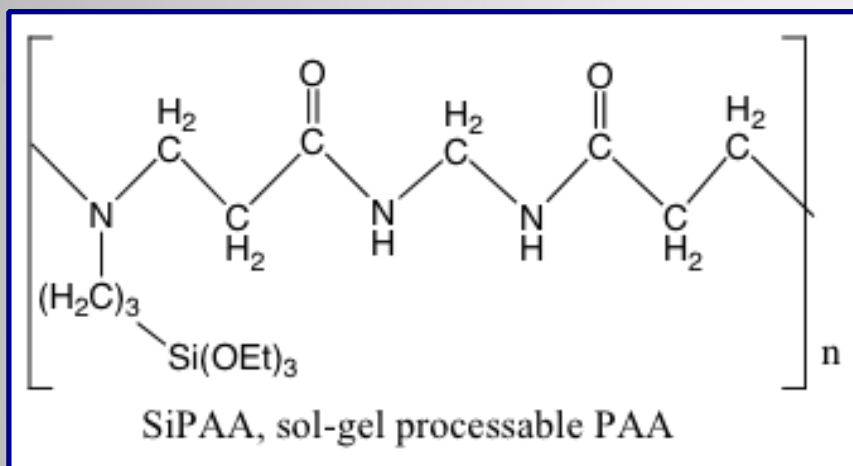
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Poliammidoammine



POSS cage
Polyhedral
Oligomeric
SilSesquioxanes

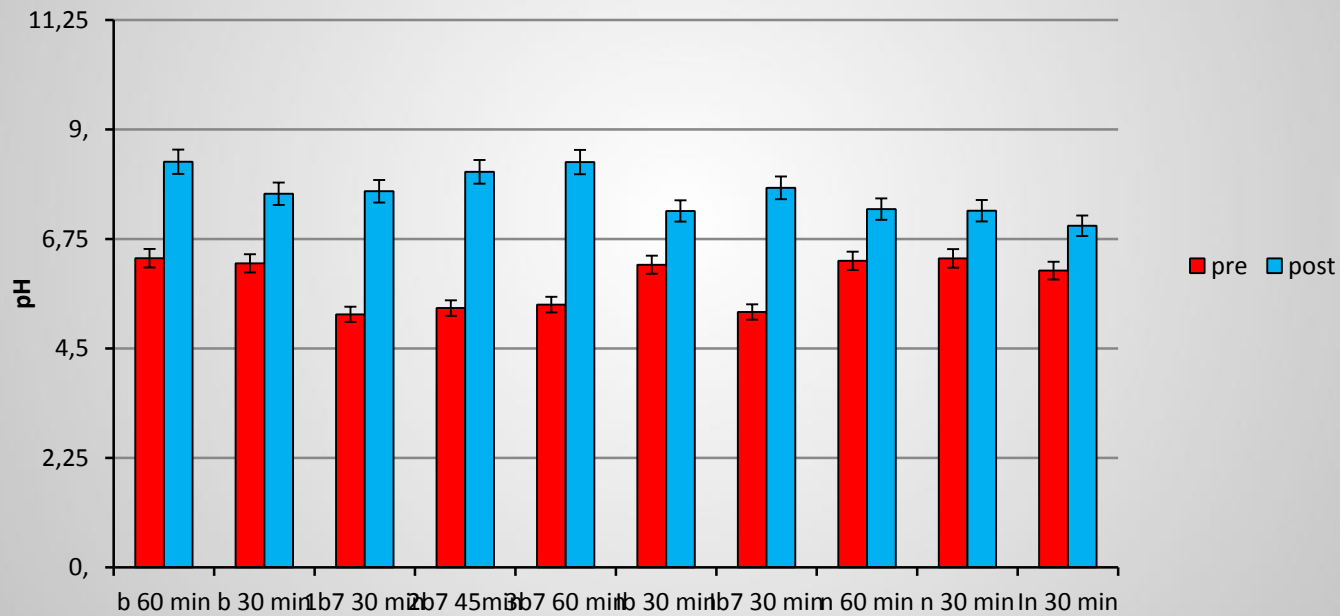


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pH values of paper before and after treatments



AGAR+PAA
On filter paper

AGAR+PAA
On XVIII century
paper

IMMERSION IN
PAA
filter paper

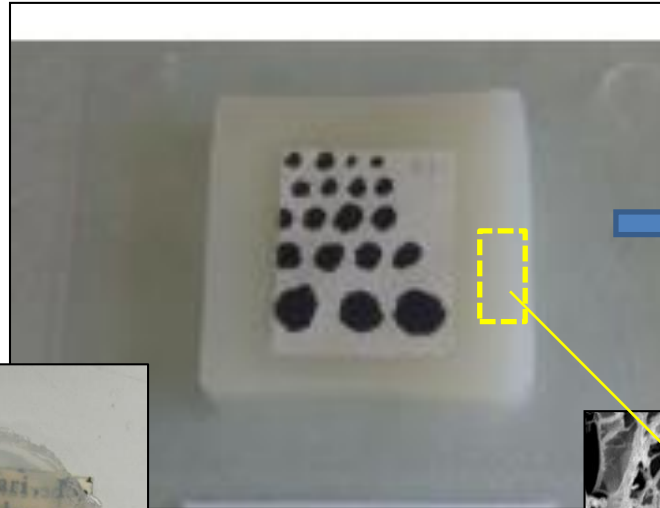
IMMERSION IN
PAA
XVIII paper

AGAR+PAA+ boric
ac.
filter paper

Nanomaterials for the protection of paper: deacidification, protection from biotic decay, consolidation

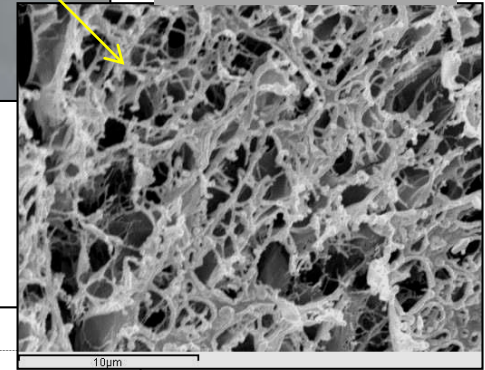
- Polyamidoamines (PAA) in hydrogels
- CNC

BEFORE

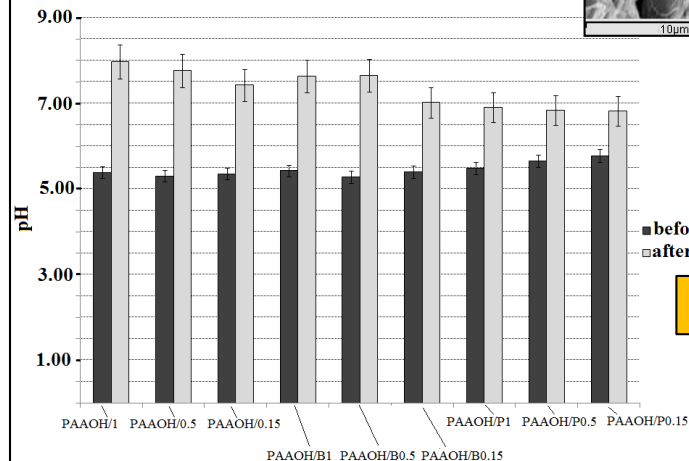


AFTER

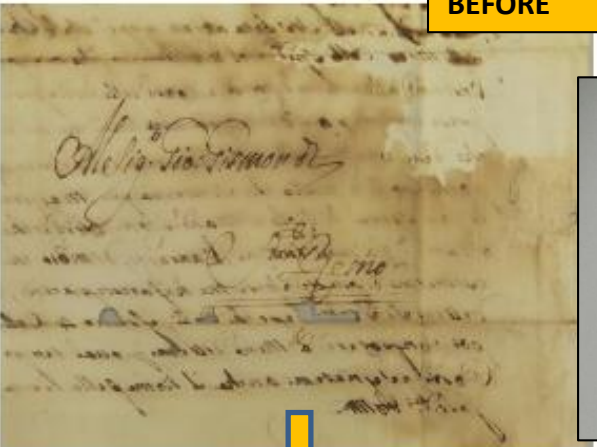
TREATMENTS



AFTER



INCREMENT IN pH



CNC (crystal nanocellulose) for the preservation of lignocellulosic materials

(functionalization with metal cations organic groups, inorganic NP, hybrid siloxanes)

