Dottorato Nazionale in Heritage Science-
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Studies of nanotechnological tools for ancient wood conservation

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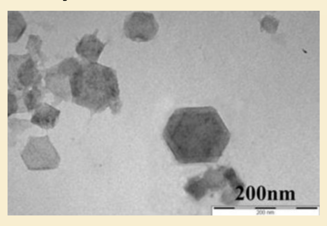
Introduction

The major problem of wood's artifacts is the great degradation that acts on these material due to different factors. This is particularly evident in the ancient wooden ships. Of the two main components of wood, cellulose and lignin, only cellulose is degraded by bacteria, algae and fungi, while lignin, which preserving the wood's internal structure, leads to a high fragility of the wreck. For this reasons, wooden artifacts recovered from submerged or underground environments, are treated with a poly-ethylene-glycol (PEG) solution, which penetrates in wooden fibers and give a support to the lignin structure [1]. Moreover, there are iron's residues in areas of wood where nails as well as decorations were present. These residues could react with sulphur, which is introduced by the metabolism of anaerobic bacteria, to originate compounds such as pyrite. These products represent not only a risk till anoxic environments persist, but, in the presence of oxygen or in particular conditions of temperature and humidity, they can be oxidized and thus form sulphuric acid, which causes an irreversible and visible degradation of the wood. We focused on the use of Calcium Hydroxide NanoParticles (CH-NPs) which have basic characteristics. Their deacidification power was verified by conducting studies on small samples of wreck wood. The very promising results suggest that the CH-NPs treatment is able, in a single step, to stop the acidification and to create a stock of NPs which prevents further degradations [2-3-4].

Aim

- Verify the curative end preventive effectiveness of NPs on wood deacidification
- Apply NPs with different methods and in different conditions and study the depth reached by theme through wood fibers
- Identify the species of wood and the bacteria population

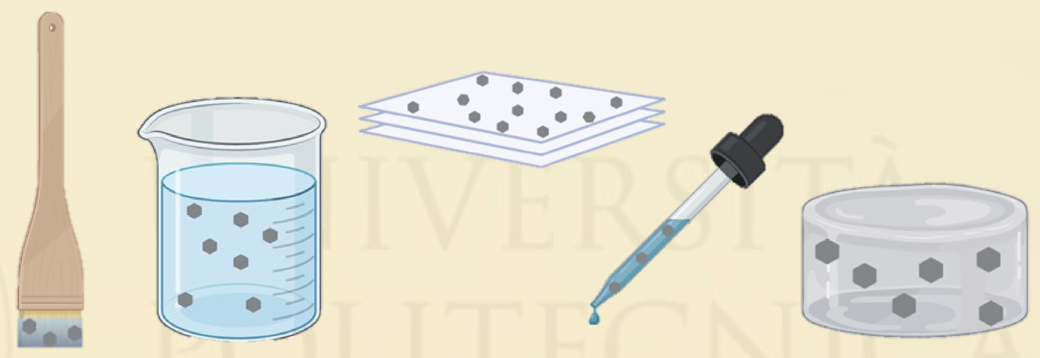


Materials

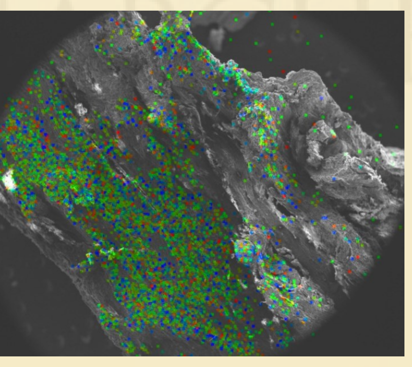
- Wood from a shipwreck
- Dated ~2000 years ago
- Founded in France

Experimental plan

- Sample acidification with treatment at 80C° and 100% humidity
- Application of NPs with different methods

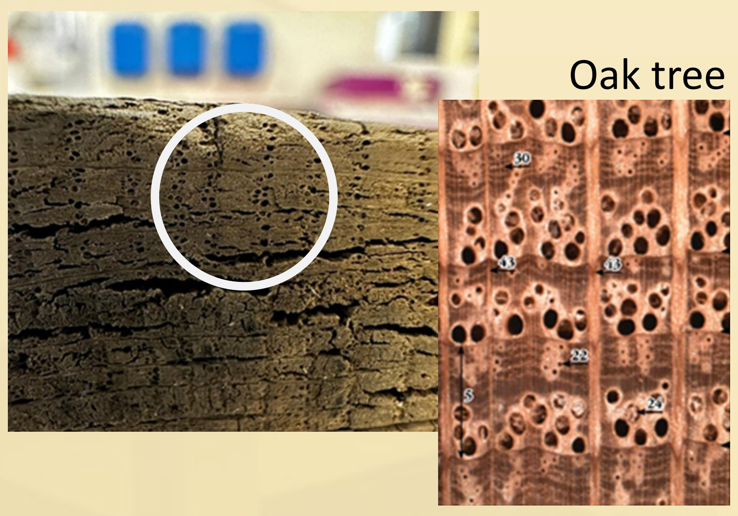


- Checking the presence of NPs up to 5 mm depth in wood with SEM-EDX analysis

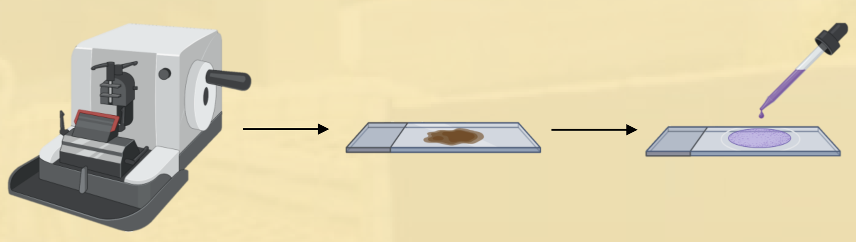


Wood identification

Macroscopic observation

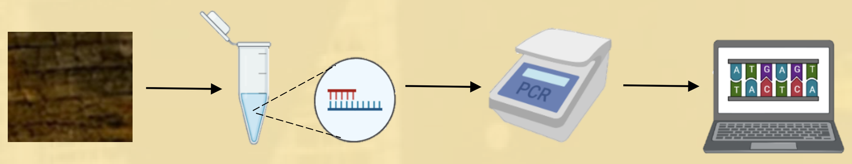


Microscopic observation

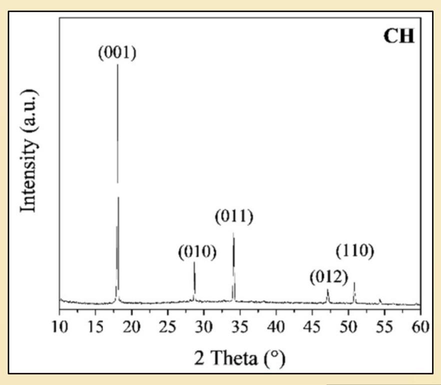


- Histological staining to distinguish lignin and cellulose

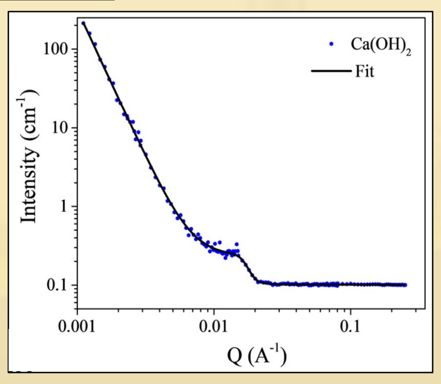
Ancient DNA extraction



NPs characterization

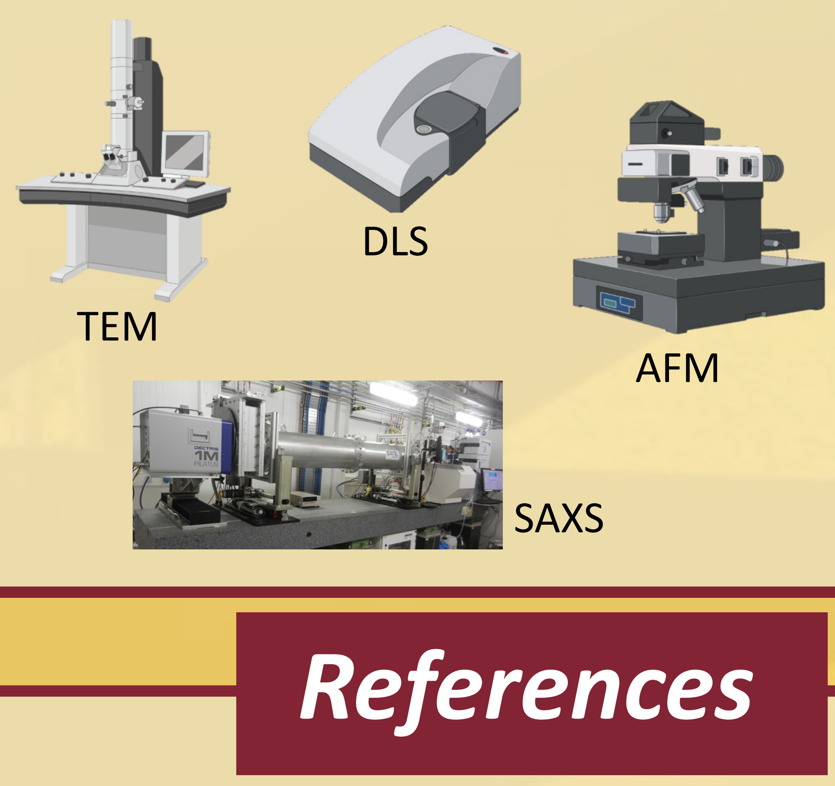


XRD analysis on Calcium Hydroxide NPs



SANS analysis on Calcium Hydroxide NPs

Next steps



Future perspectives

Other treatment

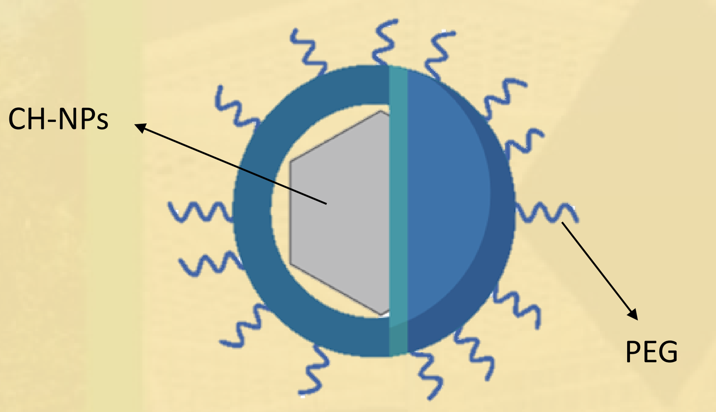
- Treatment with Calcium Carbonate ($CaCO_3$) NPs by immersion on non-acidificated wood
- SEM-EDX analysis to check the dissociation of acid precursors given by these NPs

Test on pyrite

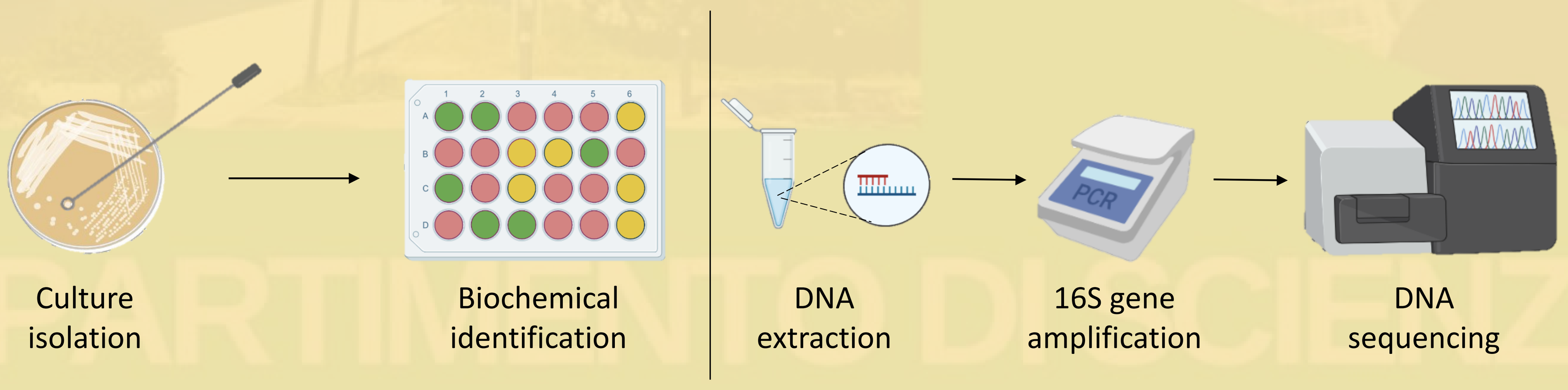
- Chemical analysis on pure pyrite to understand the efficiency of nanoparticles
- Test using different NPs with addition of CO_2 and H_2O_2

Synthesis and charaterization of NPs

- Development of new NPs
- Characterization through TEM, EDX, AFM, DLS, SANS and SAXS analysis



Study of bacteria population



References

1. Stramm, J A. Forest Product Research Society, 5, 201-204 (1956).
2. Giorgi, R et al. Langmuir 21, 10743-10748 (2005).
3. Taglieri, G et al. Nanomaterials 10, 1744-1753 (2020).
4. Volpe, R et al. Europen Patent, EP2880101, 2016.