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Nanocellulose based materials for Cultural Heritage: Wood and textile applications

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INTRODUCTION:

Cellulose-based materials, such as paper, wood and canvases, constitute a large part of the global patrimony of humankind. For this reason nanocellulose, and in particular CNC (cellulose nanocrystals), are very important for recovery and conservation of Cultural Heritage; they give better results respect synthetic products, and moreover they don't alter the visual aspect of artistic surfaces. Nanocellulose is non-toxic, biodegradable, stable and low cost. In this work, nanocellulose is used for deacidification and consolidation of strongly degraded historical papers, for recovery and consolidation of decayed wood and finally for structural reinforcement for canvases degraded by aging.

Grafted nanocellulose and alkaline nanoparticles for the strengthening and deacidification of cellulosic artworks[1].

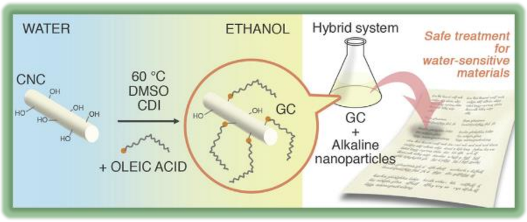

Fig.1 Graphical abstract.

Materials:

- Oleic acid-grafted cellulose nanocrystals (GC);
- Ethanol;
- Calcium hydroxide (OH3) and calcium carbonate (CO3) nanoparticles;

Tests:

- Evaluation of pH;
- Ultimate Tensile Strength measurements (UTS);
- Three-interval thixotropy tests (3ITT).

Results and Conclusions:

- Acidity neutralized by GC-CO3 and GC-OH3;
- Increase in UTS only due to nanocellulose;
- Thixotropic dispersions;
- No alterations in the visual aspect.

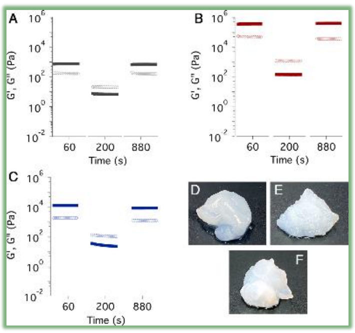

Fig.2 3ITT of GC (A), GC-OH3 (B) and GC-CO3 (C); the visual aspect of the samples: GC (D), GC-OH3 (E) and GC-CO3 (F).

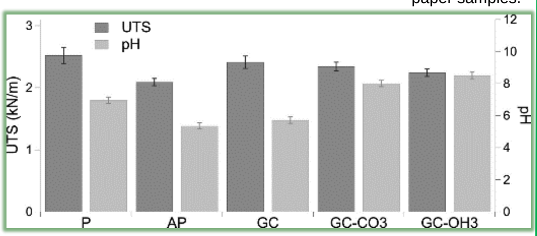

Fig.3 UTS (dark bars), and pH (light bars) of paper samples.

Bio-inspired consolidants derived from crystalline nanocellulose for decayed wood[2].

Materials:

- Composite sol of CNC and PDMS-NH (CP);
- Composite sol of CNC and lignin sol (CL);
- Composite sol of CNC and PDMS-lignin (CPL);
- Wood samples from old beams of Norway spruce.

Tests:

- Dynamic mechanical analysis (DMA);
- Static contact angle (CA) measurements.

Results and Conclusions:

- Increasing number of impregnation cycles→consolidant penetrated increases;
- Storage module E' increases more for CNC;
- CNC increase wettability.

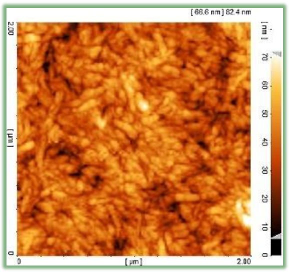

Fig.4 AFM image of CNC sol.

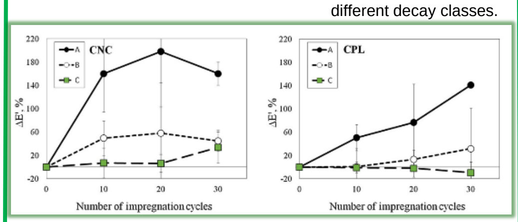

Fig.5 ΔE' vs. number of impregnation cycles for the two consolidants CNC and CPL on wood samples of different decay classes.

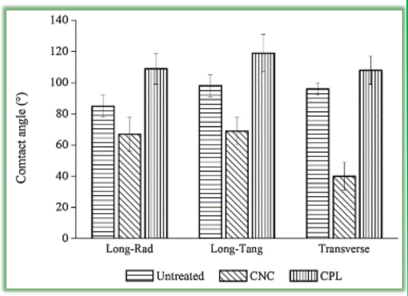

Fig.6 CA of water measured on surfaces of treated and untreated wood samples.

On the potential of using nanocellulose for consolidation of painting canvases[3].

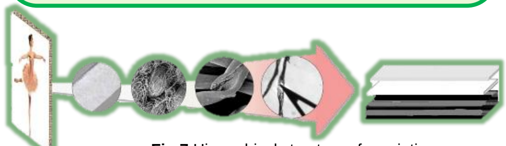

Fig.7 Hierarchical structure of a painting canvas.

Materials:

- Mechanically isolated cellulose nanofibrils (CNF);
- Carboxymethylated cellulose nanofibrils (CCNF);
- Cellulose nanocrystals (CNC);
- Conventional consolidants;
- Samples: new painting canvases and aged real painting canvas.

Tests:

- Mechanical test according to ASTM method;
- Controlled relative humidity Dynamic mechanical analysis (DMA-RH).

Results and Conclusions:

- Nanocelluloses form a film on the canvas surface→reversible;
- No alterations in the visual aspect;
- CNC showed the highest level of consolidation.

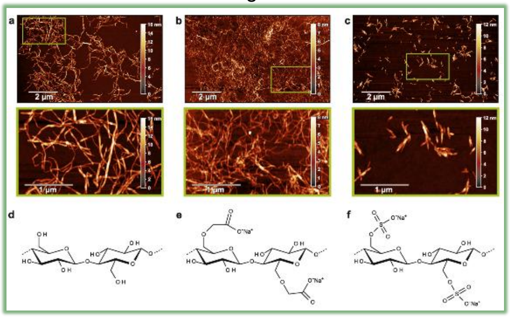

Fig.8 AFM images of: (a)(CNF); (b)(CCNF); (c)(CNC), and the corresponding simplified surface chemistries (d–f).

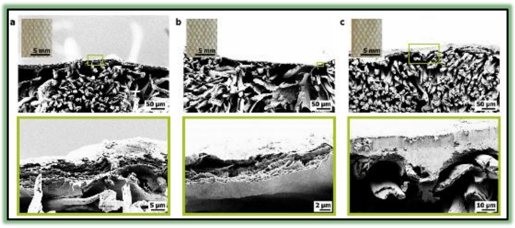

Fig.9 SEM images of aged cotton canvases coated 3 times with: (a) CNF; (b) CCNF and (c) CNC, with OM images as insets (left top).

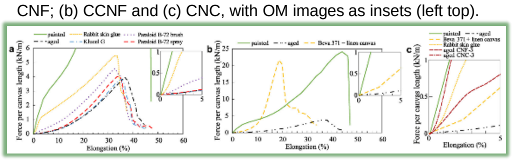

Fig.10 Mechanical properties of aged canvases after various consolidation treatments.

Bibliography:

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