Nanocellulose and new developments in the consolidation of painting canvases

Alexandra Bridarolli[1*], Oleksandr Nechyporchuk[2], Marianne Odlyha[3], Nadine Boehme[4], Romain Bordes[2], Manfred Anders[4], Aurélia Chevalier[5], Krister Holmberg[2], Laurent Bozec[1]

University College London[1]*(London, UK), Chalmers University of Technology (Gothenburg, Sweden)[2], Birkbeck College[3] (London, UK), Zentrum fuer Bucherhaltung (Leipzig, Germany)[4], Atelier Aurélia Chevalier (Paris, France)[5].

* Alexandra.Bridarolli.15@ucl.ac.uk

UCL

ABSTRACT: Nanocellulose, a renewable biomaterial made of nanoparticles of cellulose, has found in the last 20 years an application in a number of fields thanks to its remarkable mechanical, optical and barrier properties [1][2]. These have now raised the interest of the conservation community [3] and might present an efficient alternative to current paintings consolidation practices. The nanocellulose treatment was assessed following a nano- to macroscale strategy. Treatments deposition (FEG-SEM), canvas mechanical reinforcement (DMA-RH, AFM), treatments adhesion (AFM) and canvas response to moisture uptake (DEA-RH) were investigated on untreated and treated canvases. The results establish **procedures for the first assessment of canvas/nanocellulose interaction** and give a first assessment on the **treatment efficiency for canvas reinforcement.**

METHODOLOGY

NANOSCALE

MACROSCALE

Sample preparation

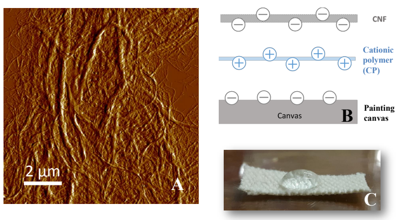


Fig. 1: Canvas samples and nanocellulose used for the tests: AFM image of a Nanocellulose fibrils (CNF) (A), reinforcement treatment strategy with order of application (B) and nanocellulose solution at 1%w/w on canvas sample (C).

DMA-RH (Dynamic Mechanical Analysis at controlled Relative Humidity)

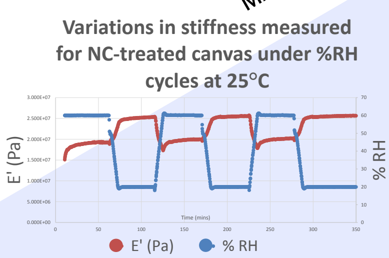


Fig. 2: Changes in storage modulus (E') shown for a non-treated cotton canvas subjected to RH variations (20-60-20%RH cycles, change at 4%RH min).

DMA allows mechanical testing at controlled %RH and T°C. Canvas in uncontrolled environments is usually subjected to RH and T variations in its life-time.

FEG-SEM imaging

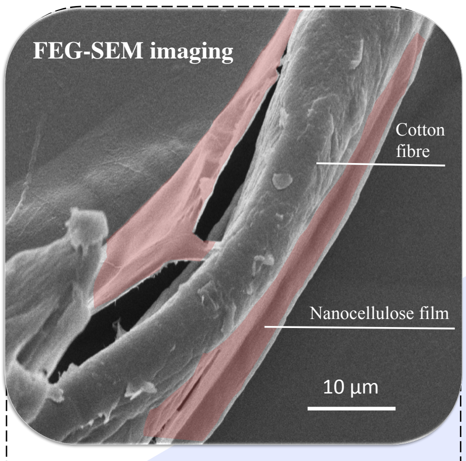


Fig. 3: Nanocellulose film observed on a cotton canvas fibre after treatment (SEM image, x2500)

DEA (Dielectric Analysis) with controlled RH

The frequency dependence of the dielectric constant ε', and the loss factor for the sample were measured over a frequency range 0.3,1,3,10 and 30Hz. The manner in which ε'' varies with frequency indicates whether conductivity (ε''cond) or dipole relaxation (ε''dipole) processes dominate, and the former were found to do so. Differences in conductivity values for samples treated with different NC consolidation formulations then indicate whether treatment resulted in more hydrophilic or hydrophobic behaviour.

AFM (Atomic Force Microscopy)

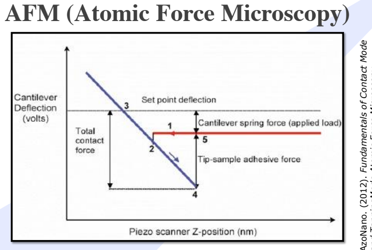
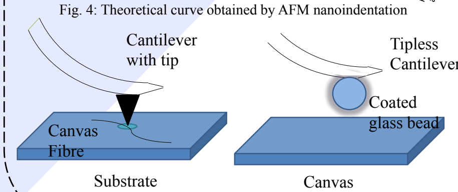


Fig. 4: Theoretical curve obtained by AFM nanoindentation



CHALLENGES:

Selection of nanocellulose functionalization, solvent, concentration in solution and application strategy.

Assessment of the nanocellulose **depth of penetration** and the **mechanical reinforcement** achieved after treatment from fibre to fabric level.

Evaluation of the **long-term behaviour** of Nanocellulose-treated canvases

CONCLUSIONS:

The various analyses carried out have raised the complexity of the study of canvas properties study and its characterisation. The need for testing procedures integrating the physico-chemical properties of canvas is crucial for an exact and meaningful assessment of canvas consolidation using Nanocellulose and its functionalized forms.

The evaluation of the immediate and long-term effect of these formulations on canvases reinforcement will provide a solid foundation for future "in context" studies of nanocellulose-treated canvases.

Aknowledgement:

This research was supported by a co-funding from the Engineering and Physical Sciences Research Council (EPSRC) through the Centre for Doctoral Training and the newly awarded H2020 European Project – NanoRestart.

The authors are grateful to Aurelia Chevalier (Aurelia Chevalier SME, Paris, France) for samples provision and to ZFB (Leipzig, Germany) for the production of the NC formulations.

Literature:

[1] Nair, S., Zhu, S., Deng, J., & Ragauskas, Y. (2014). High performance green barriers based on nanocellulose. Sustainable Chemical Processes, 2(1), 1-7.

[2] Dufresne, A. (2013). Nanocellulose: A new ageless bionanomaterial. Materials Today, 16(6), 220-227.

[3] Cataldi, A., Berglund, L., Deflorian, F., & Pegoretti, A. (2015). A comparison between micro-and nanocellulose-filled composite adhesives for oil paintings restoration. Nanocomposites, (0), 1-9.

UCL eastman DENTAL INSTITUTE CHALMERS Aurélia CHEVALIER ZFB ZENTRUM FÜR BUCHERHALTUNG NanoRestART