48M report-Appendix 1: February 2012 - January 2016

FP7-NMP-2011-SMALL-5- Collaborative Project
Grant Agreement No: 280519

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Project acronym: NANOSELECT

Project title: Functional membranes/ filters with anti/low-fouling surfaces for water purification through selective adsorption on biobased nanocrystals and fibrils

Funding Scheme: Collaborative project: FP7-NMP-2011-SMALL-5

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Grant Agreement No: 280519

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Univ-University, RO-Research Organization, SME-Small or Medium Sized Enterprise, IND-Industry

Figures and Tables

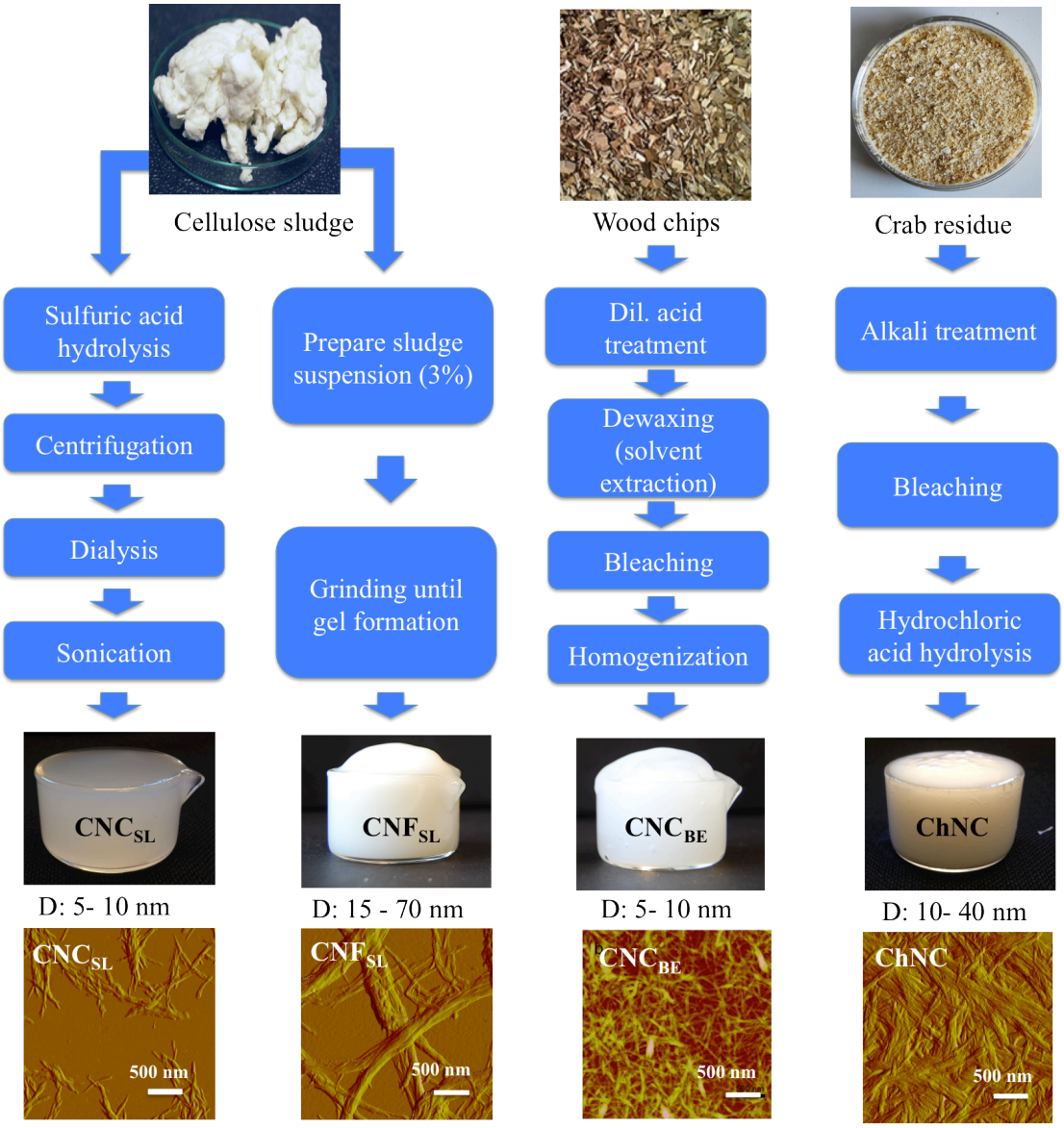


Figure 1. Procedures for isolations of nanocellulose and nanochitin

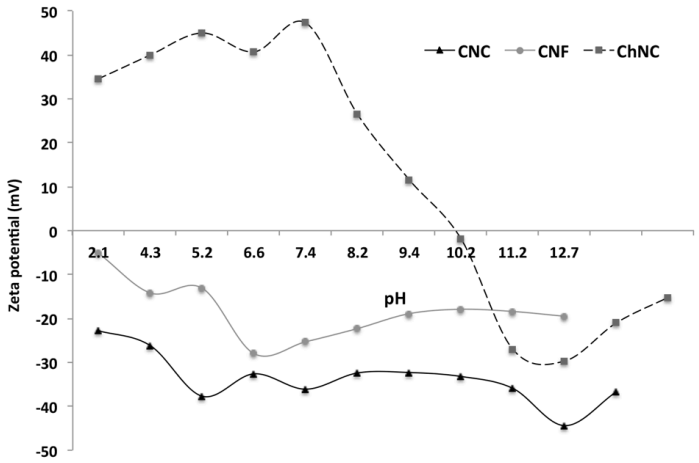
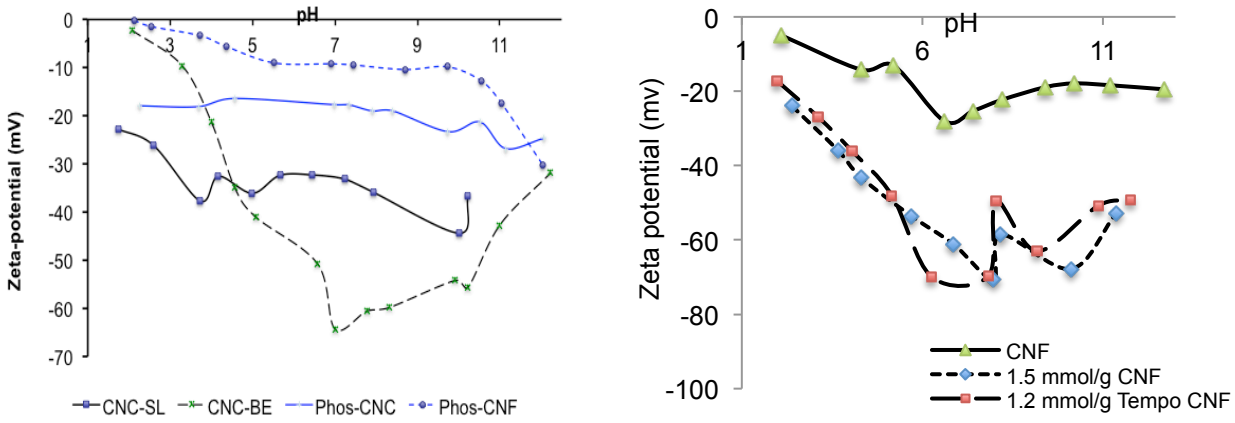


Figure 2. Zeta potential as a function of pH



a ***b***

Figure 3*: Zeta potentials a) of bioethanol CNC, CNC (sludge), phosphorylated CNC and phosphorylated CNF b) CNF and Tempo oxidised CNF with different carboxylic group contents at different pH*

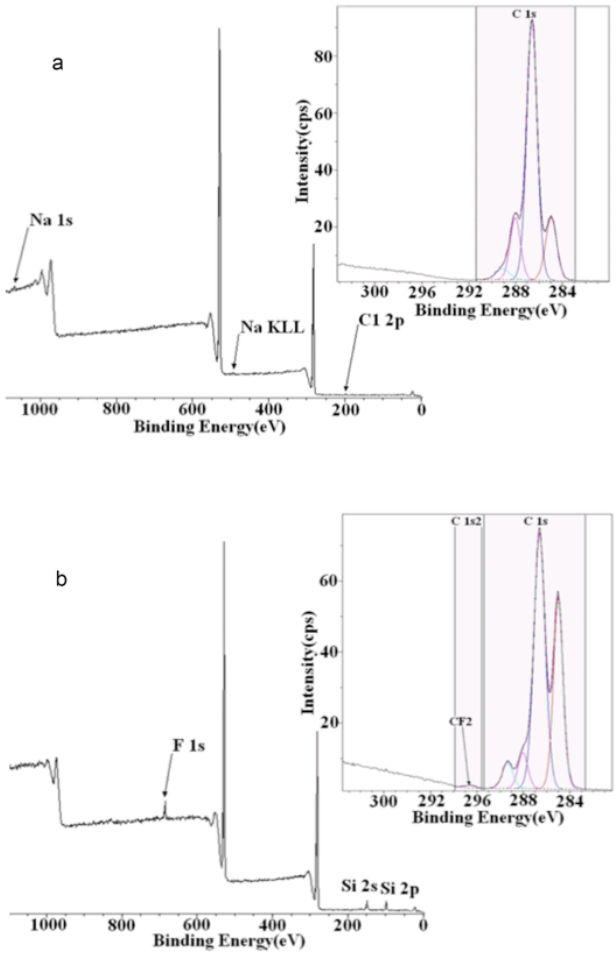


Figure 4. *Survey spectra of a) CNC_{BE} and b) CNC_{H2SO4} and the respective C 1s photoemission spectra (inset)*

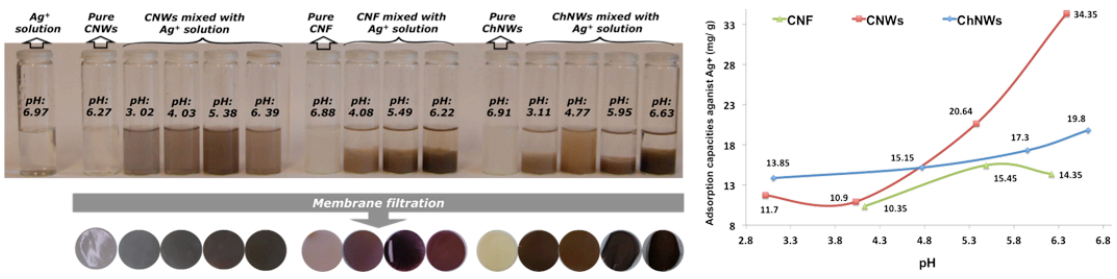


Figure 5 Photograph showing a Ag^{+} solution, pure nanomaterial suspensions and suspensions of nanomatrials mixed with silver ions at different pH after 12 hrs magnetic stirring

Figure 6: Masuko MKZA 10-20J, installed at LTU

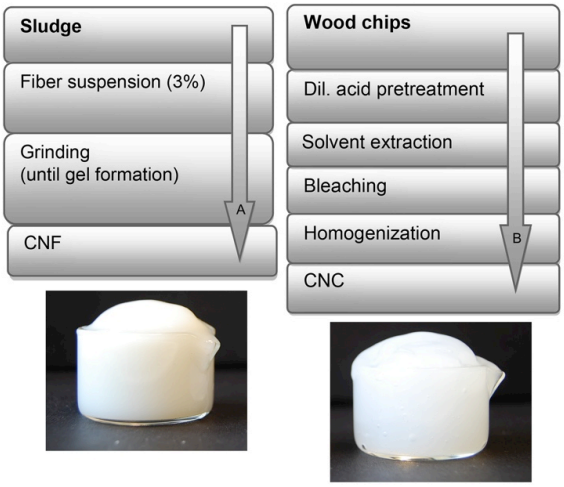


Figure 7: Schematic representation of scaled up processing of CNF and CNC, at LTU

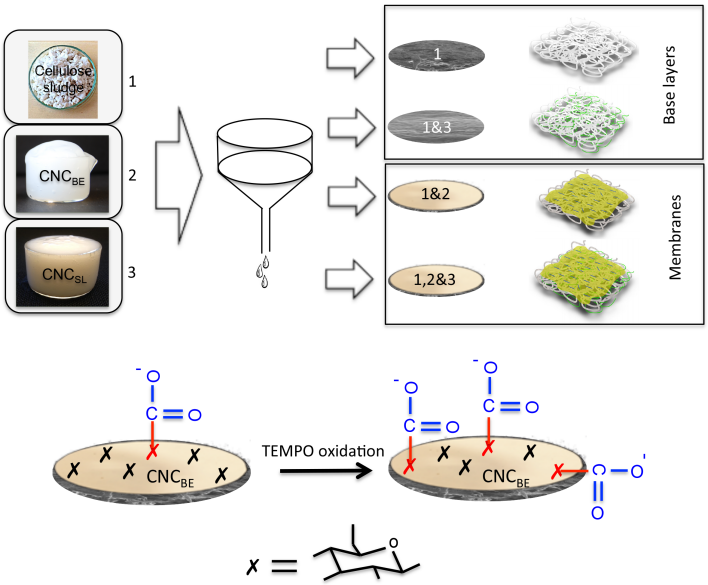


Figure. 8: In situ functionalization of top layer was performed as shown in image. The symbol x represent a monomer of cellulose.

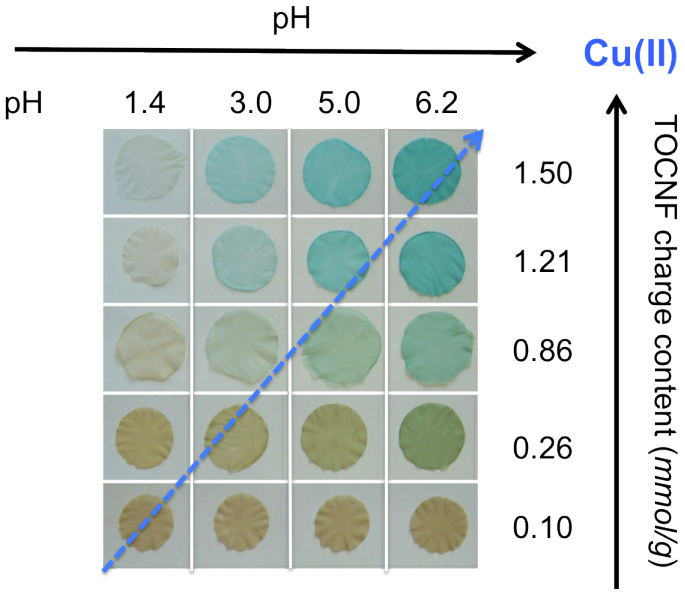


Figure 9. Photograph of nanofiber filter cakes after Cu(II) adsorption for different pH with different surface charge

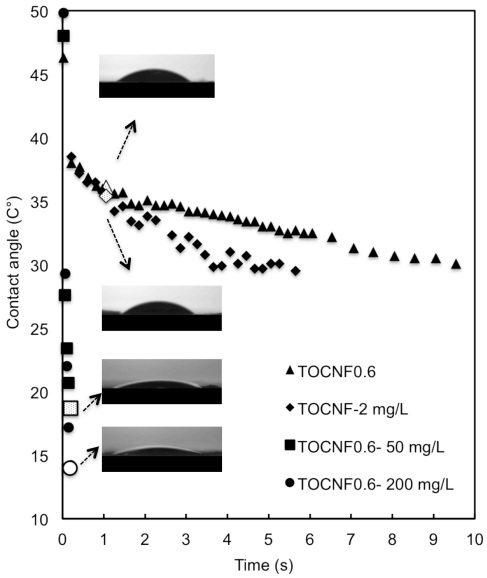


Figure. 10 Contact angle variation with Cu(II) adsorption on TOCNF

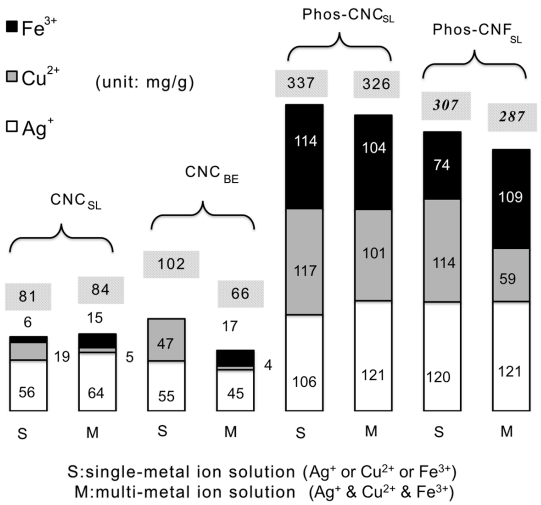


Figure.11 Effect of single ions vs multiple ions in the water on the adsorption selectivity of Ag^{+}, Cu^{2+}, Fe^{3+} on the nanocelluloses at pH 3.5–4.5.

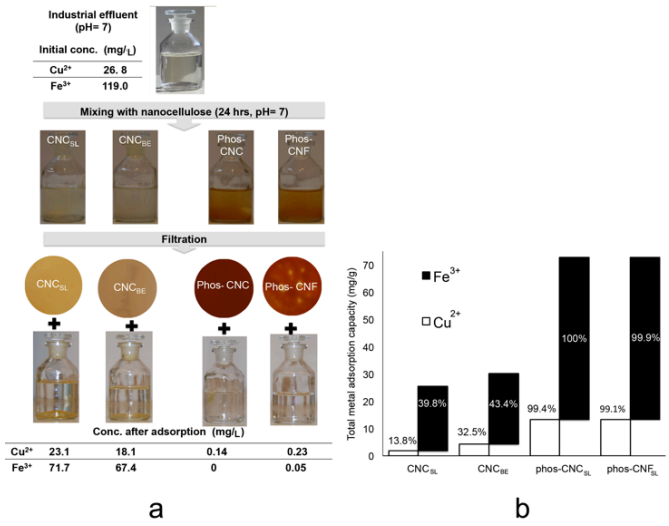


Figure 12. Scheme showing the industrial effluent and the effect of treatment with nanocelluloses on the ion concentration

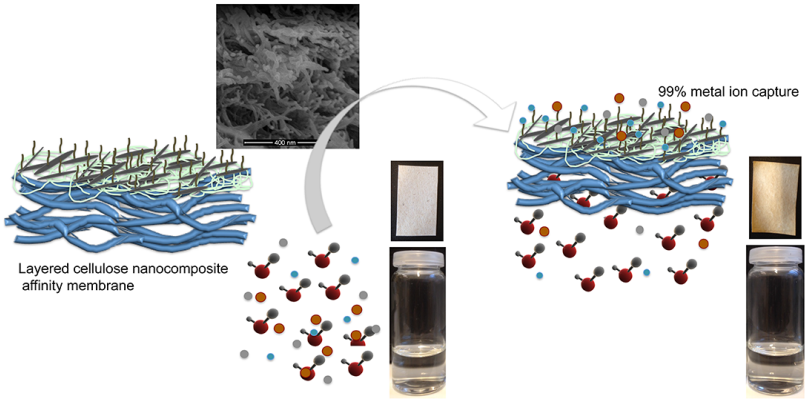


Figure 13. Scheme showing the bilayered membarnes and the metal ion removal process

Selected dyes	Surface charges	λ_{max} (nm)
Methyl Violet 2B (MV 2B)	+	581
Rhodamine 6G (R 6G)	+	526
Victoria Blue 2B (VB 2B)	+	616

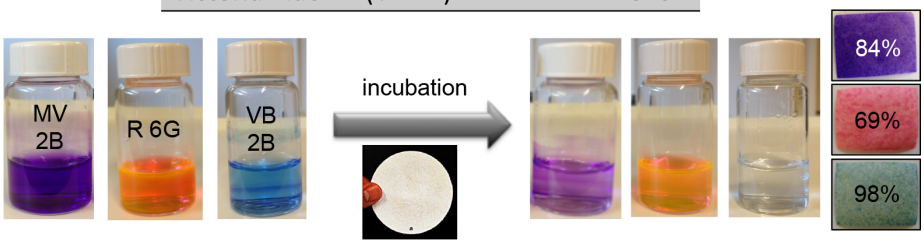


Figure 14: Three dyes as mentioned in table were selected for the removal experiment. Adsorption experiment was conducted in static mode.

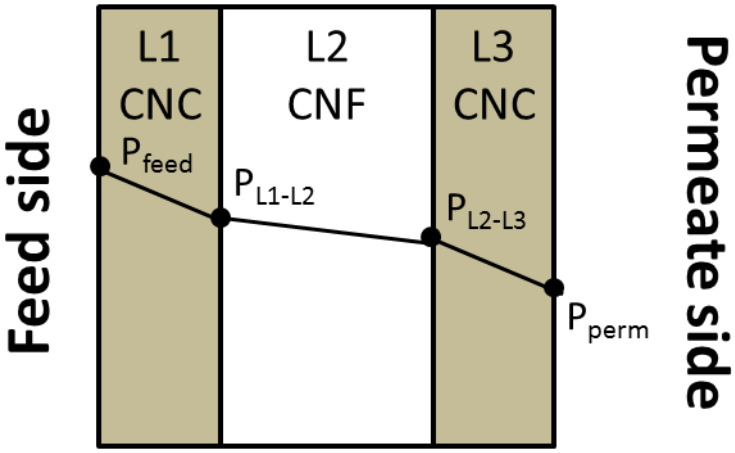


Figure 15: Schematic figure of layered membrane structure and pressure profile.

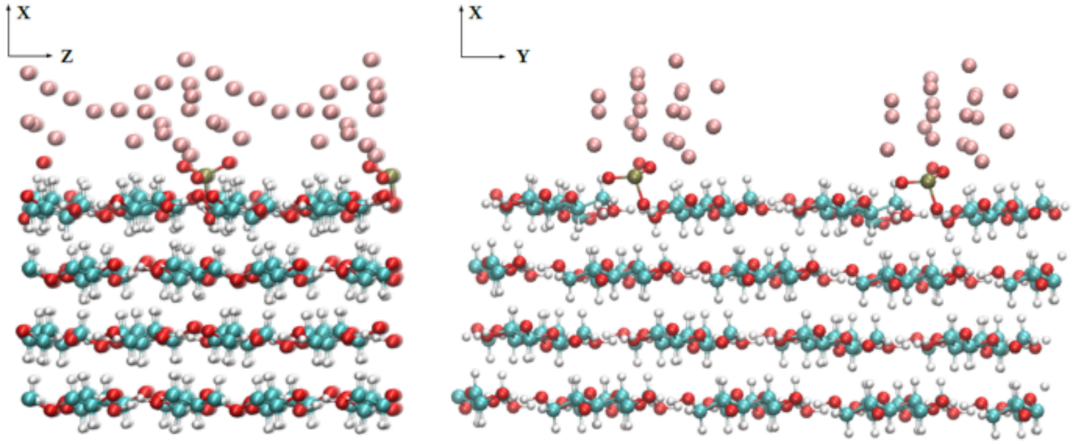


Figure 16. DFT model for the cluster formation of Ag on celulose surfaces with phosphoryl groups.

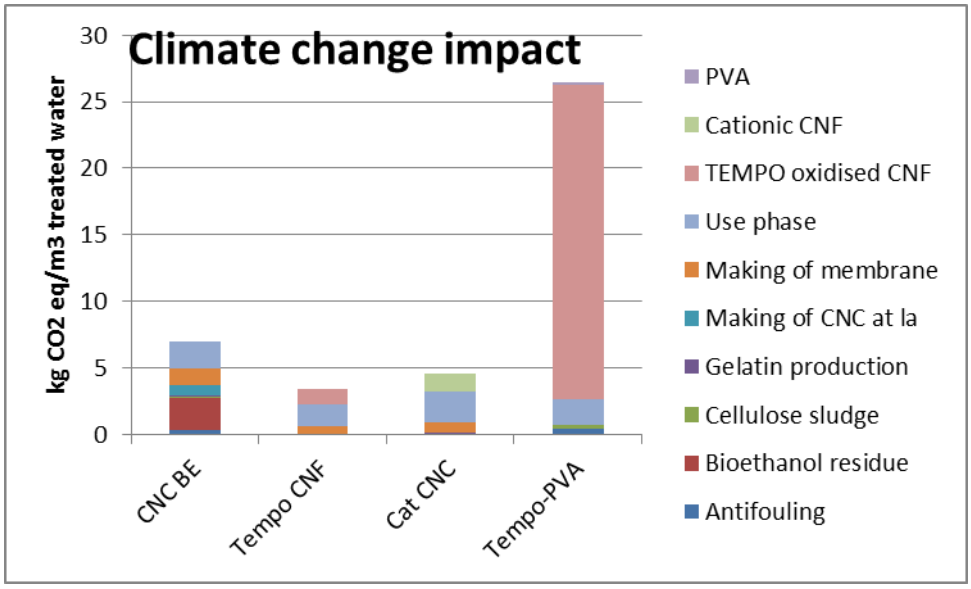


Figure 17: Effect of Nanoselect technology on climate change

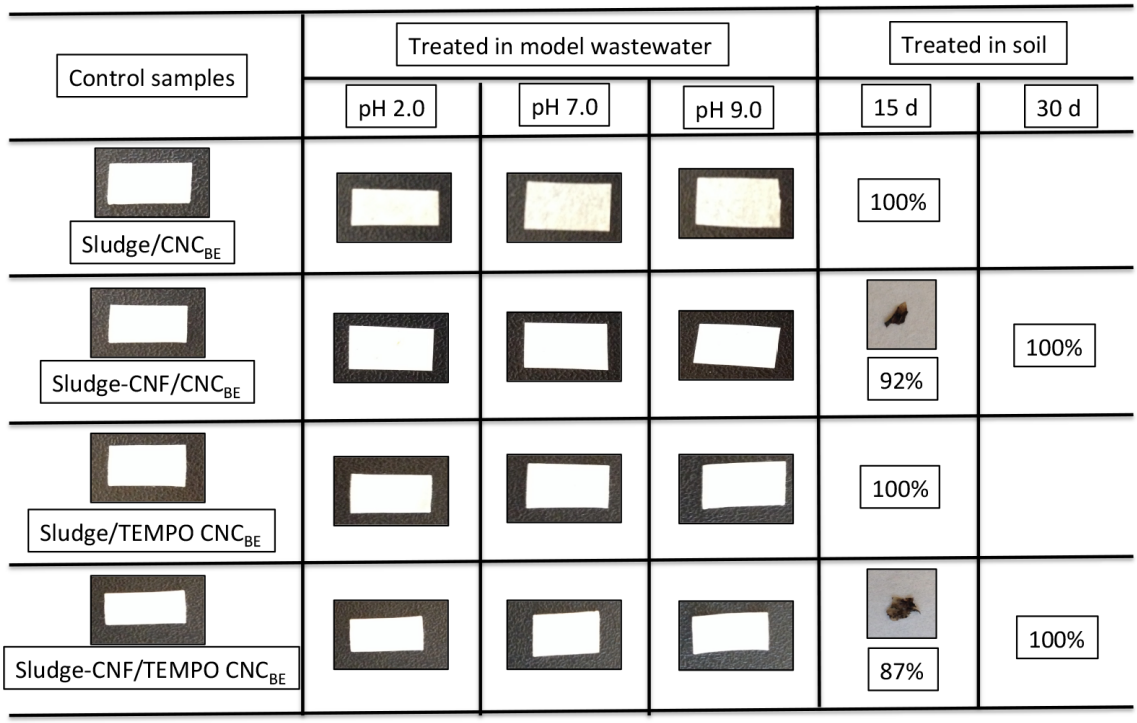


Figure 18: Biodegradability study of fabricated nanopapers in water (a) and in soil (b).

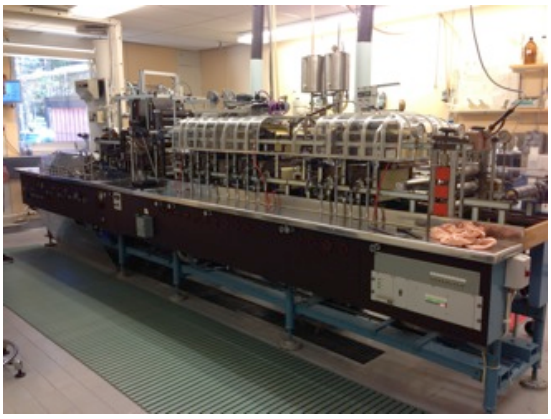


Figure 19. Experimental paper machine (XPM) at MoRe Research

Figure 20: Photograph of the generation 1 prototype for point-of- use water treatment.

TABLE 1. Physiochemical characteristics of CNF, CNC and ChNC

Material	Source of nanoparticle	Preparation method	Crystallinity (%)	Onset Degradation Temp (°C)	Func Group	Negative charges (mmol/g)
CNF	Sludge	Grinding	64	258	-OH	100
CNC	Sludge	Sulfuric acid hydrolysis	72	209	HSO_3-, OH-	148
ChNC	Crab-shell powder	Hydrochloric acid hydrolysis	87	243	-NH2, COO-	320
CNC_{BE}	Bioethanol	Mechanical grinding	77	240	COO-	150

Table 2: ICE-OPS analysis of metal ions removal

Types of membranes	pH	C_o (mg/L)	C_i (mg/L)	Sorption capacity		Removal rate (%)
				Membrane (mg/g)	**CNCs (mg/g)**	
Cu(II)						
S-G/CNC_{SL}	2.3	330.2	290.2	8	11	12%
S-G/CNC_{BE}			220.5	22	64	33%
S-G/$PCNC_{SL}$			3.0	66	233	99%
Fe(II)/Fe(III)						
S-G/CNC_{SL}	2.3	550.5	480.0	14	20	12%
S-G/CNC_{BE}			380.0	34	100	30%
S-G/$PCNC_{SL}$			1.5	109	391	99%
Ag(I)						
S-G/CNC_{SL}	9.1	1.48	0.00	0.29	0.42	100%
S-G/CNC_{BE}			0.00	0.29	0.87	100%
S-G/$PCNC_{SL}$			0.00	0.29	1.0	100%

Table 3. Cost of Pilot scale processing of membranes

	CNC_{BE} hybrid membranes	TOCNF hybrid membranes	TOCNF coated membranes

Production cost of nanoparticles	19 €/kg	205 €/kg	205 €/kg
XPM operation cost	2.7 €/m^2 of membrane	2.7 €/m^2 of membrane	2.7 €/m^2 of membrane
Nanoparticle cost/m^2	0.38 €/m^2 (20gms)	4.1 €/m^2 (20gms)	0.41 €/m^2 (2gms)
Total cost	**1.026 €/m^2**	**11.07 €/m^2**	**1.107 €/m^2**

Table 4. Cost of the modules

Components	CNC_{BE} hybrid membranes	TOCNF hybrid membranes	TOCNF coated membranes
Membrane	0.86	9.30	0.93
Spacers	0.29	0.29	0.29
Glue (Envelop)	0.57	0.57	0.54
Glue (End caps)	2.68	2.68	2.68
Tape	0.03	0.03	0.03
Filter core	6.34	6.34	6.34
End caps	2.61	2.61	2.61
Total cost	**€ 13.37**	**€ 21.80**	**€ 13.41**

Each module consists of 4 m x 0.21 m of nanopaper membrane.

Table 5. The comparison of Nanoselect modules with current market solutions

Contaminant	Existing market solution and price	Nanoselect solution
Suspended solids	9 ¾" PP filter 5 µm **10,5 €**	€ 13.37- 21.80
Dyes	9 ¾" PP filter 5 µm + Activated carbon **22.5 €**	€ 13.37
Nitrates	9 ¾" PP filter 5 µm + Dinitrification resin **33,84 €**	Not known (expected to be in the same range as TEMPO CNF based filters , € 21.80)

Videos

Demonstration
https://www.youtube.com/watch?v=RNV0fccdMHs