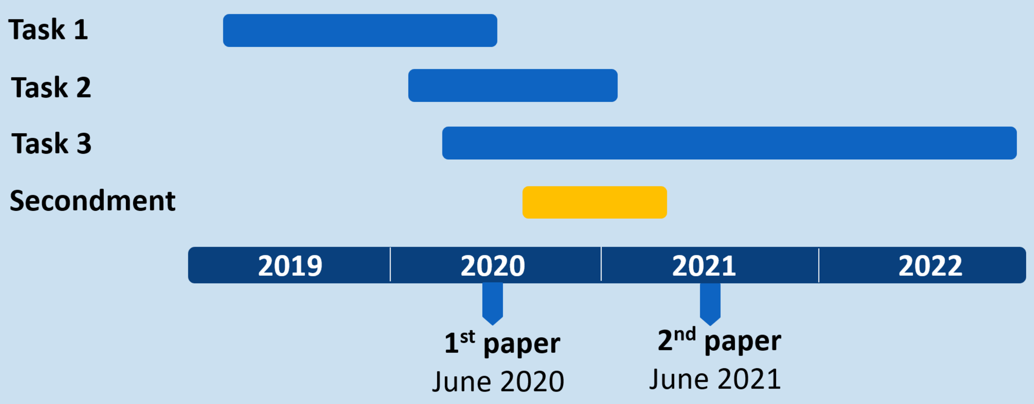
European Training Network for the Remediation and Reprocessing of Sulfidic Mining Waste Sites

MSCA-ETN SULTAN

Synthesis of new bio-based mining chemicals for froth flotation

Fiber and Particle Engineering research unit, University of Oulu

Feliciana Ludovici, Ossi Laitinen and Henrikki Liimatainen



Task 1: Fabrication of cellulose nanofibers (CNF) and cellulose nanocrystals (CNC).

Task 2: Characterization of functionalized CNFs and CNCs.

Task3 : Improvement of froth flotation system.

Objectives

- Modification of bio-based (cellulose, nanocellulose) chemicals through new environmentally friendly reactions;
- Determine the selectivity of the new green nanoparticle with selected mine tailings;
- Improve froth flotation parameters.

Milestone

- Design selective and effective flotation chemical for mining industry. Flotation recovery of >70% of the selected metals (Cu, Zn and Pb) from selected Cu-Zn, Zn-Pb and Cu-Zn-Pb tailings.

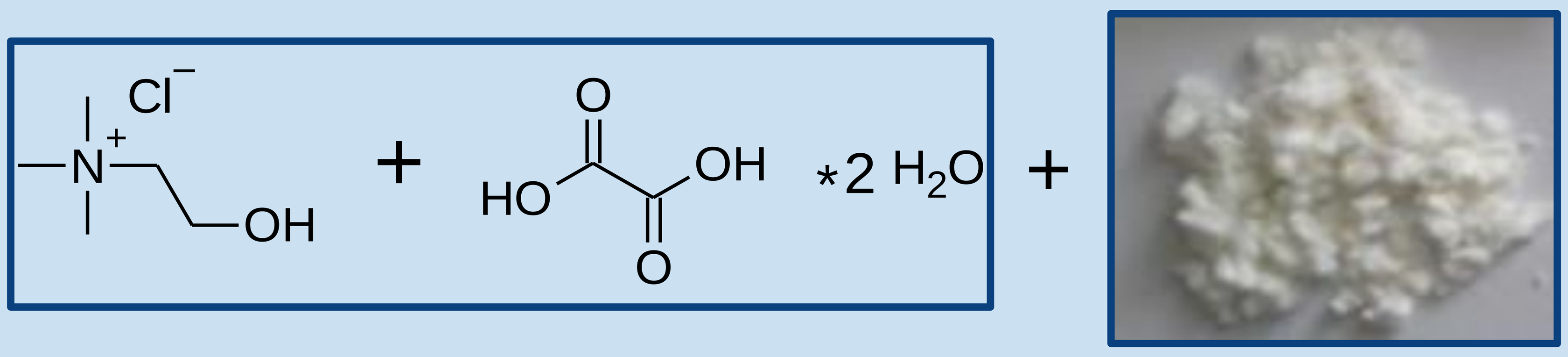
Abstract

Cellulose is the most abundant renewable polymer. It offers a green alternative source to develop sustainable chemicals that could replace the present synthetic additives, largely used in froth flotation. In the present study, we introduce a new environmentally friendly approach to produce potential froth flotation chemicals.

Figure 1. From tree to nanocellulose: mechanical, chemical, or enzymatic methods can be used to fabricate celluloses nanomaterials.

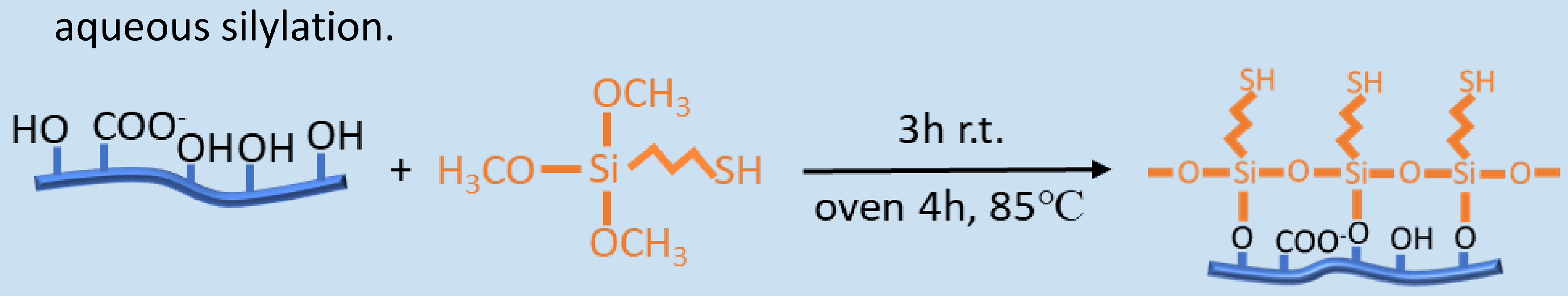
Results

- Synthesis of cellulose nanocrystals (CNC) using deep eutectic solvent (DES).



Choline Chloride | Oxalic acid dihydrate | Dissolving pulp

- Fabrication of cellulose nanofibers (CNF) and cellulose nanocrystals (CNC) with a thiol-functional moieties (3-mercaptopropyl-trimethoxysilane) through an aqueous silylation.



The hydrophobicity of both CNFs and CNCs increased following the introduction of the new thiol functional moieties (Table 1).

Contact angle	CNF	Si-CNF	Si-CNF [0.5]	Si-CNF [1.5]	Si-CNF [3]	CNC	Si-CNC [3]
Θ	51.20°	53.27°	79.33°	67.33°	70.07°	46.47°	63.87°
XPS	**CNF**	**Si-CNF**	**Si-CNF [0.5]**	**Si-CNF [1.5]**	**Si-CNF [3]**	**CNC**	**Si-CNC [3]**
S%	0.18	6.97	6.97	3.65	7.67	0.07	5.77
Si%	0.33	7.53	7.54	4.37	8.54	0.39	6.79

Table 1. Contact angle measurements and XPS analyses

Contact information:

Feliciana Ludovici (M.Sc.), feliciana.ludovici@oulu.fi
Dr. Ossi Laitinen, ossi.laitinen@oulu.fi
Professor Henrikki Liimatainen, henrikki.liimatainen@oulu.fi

According to TEM images (Figure 2) cellulose nanofibers existed as long and elongated filaments and cellulose nanocrystals as stiff rods. The width of individual CNF typically varied from 3 to 8 nm, while their length ranged from 100 nm to several micrometers. The width of individual CNC varied from 6-14 nm, while their length ranged from 50-360 nm.

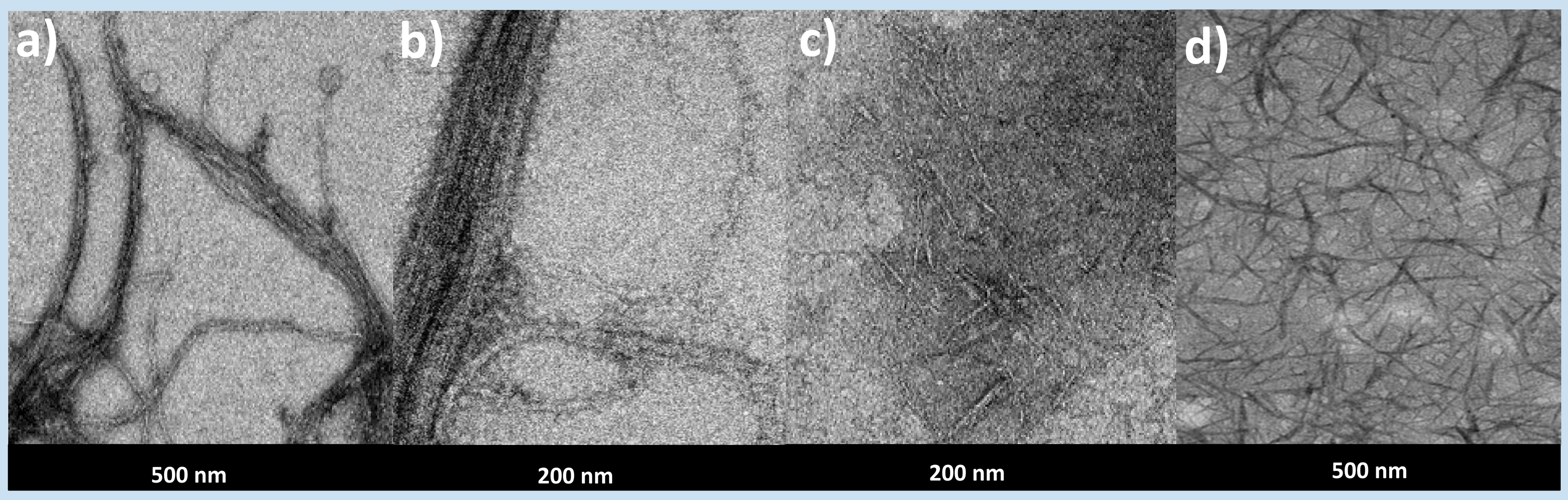
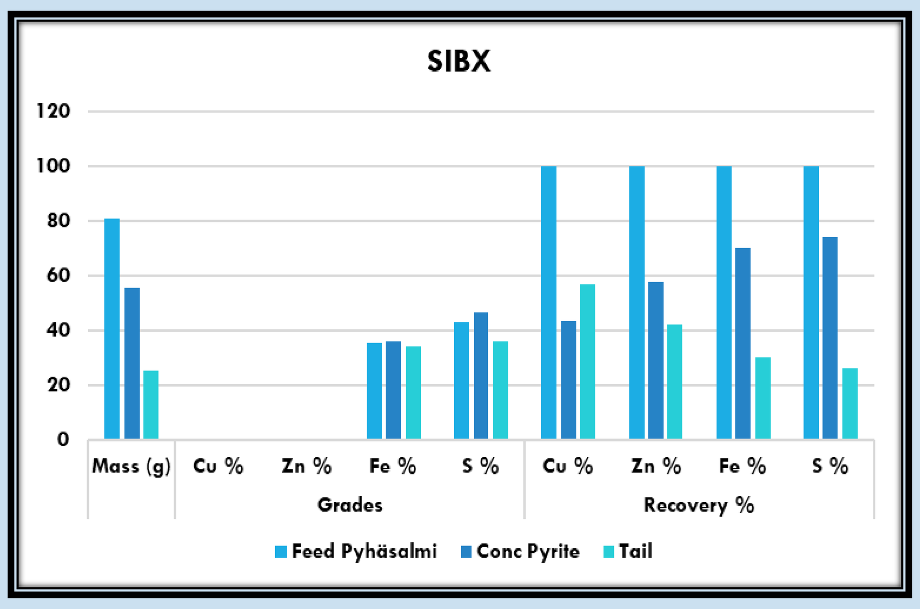
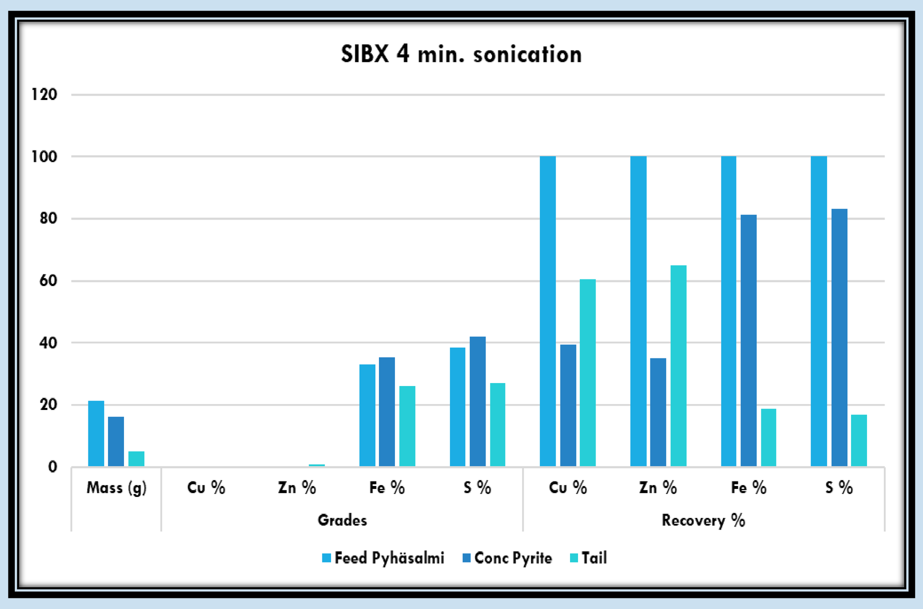
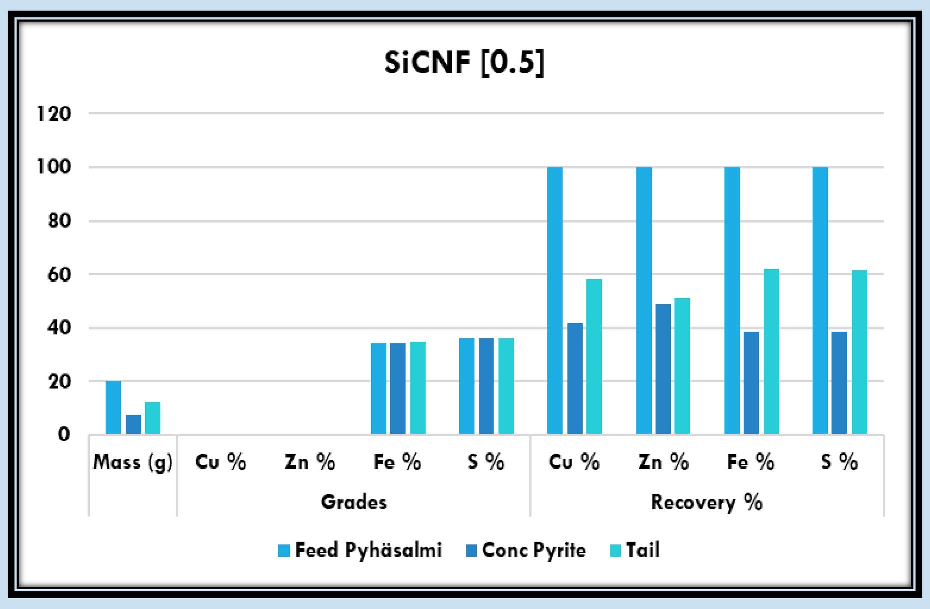


Figure 2. TEM images of a) CNF, b) Si-CNF, c) CNC and d) Si-CNC.

Pyrite froth flotation: grade and recovery







Conclusions

- The silylation reaction in aqueous condition proved to be an environmentally friendly approach for the functionalization of green nanoparticles (CNFs and CNCs) with thiol moieties.
- Grade and recovery of floated pyrite improved after sonicating, using sodium isobutyl xanthate (SIBX, industrial collector).
- The silylated cellulose nanofibers (Si-CNF [0.5]), has been tested as collector in the pyrite flotation; the same parameters used with SIBX were studied.
- The low pH of mixture was found to result in flocculation of the mineral.

Next step

Further tests using the green nanoparticles (Si-CNF [0.5]) are required. The following approach will be perform pyrite flotation at higher pH, changing the amount of the nanocellulose collector.

MSCA-ETN SULTAN

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon 2020 under Grant Agreement No 812580.