Activities 2021
(publications)

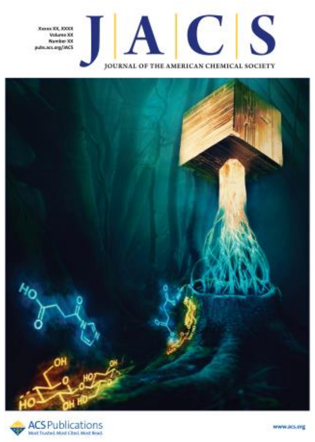
Activities 2020, Activities 2019, Activities 2018, Activities 2017, Activities 2016, Activities 2015

Publications 2021 (BiCMat)

For all group publications: LINK

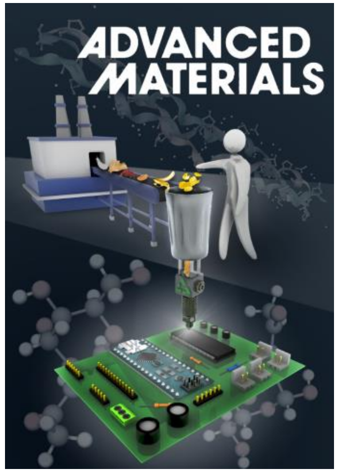
Highlights 2021

Nanopolysaccharides

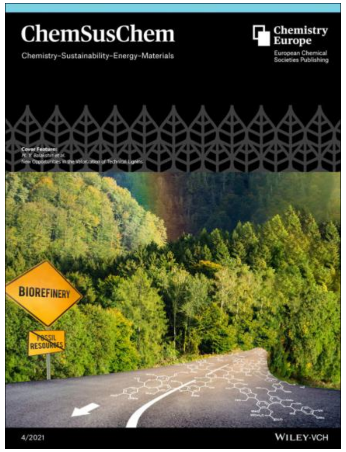


Biofabrication

Biomass valorization

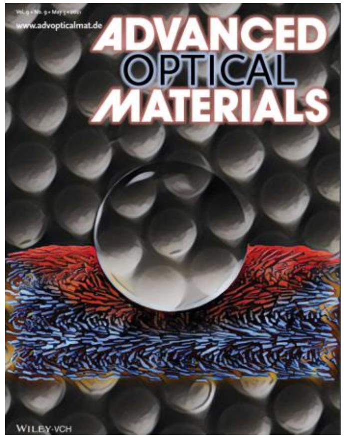


Lignin, polyphenols



Supraparticles/colloids

Films, coatings, filaments

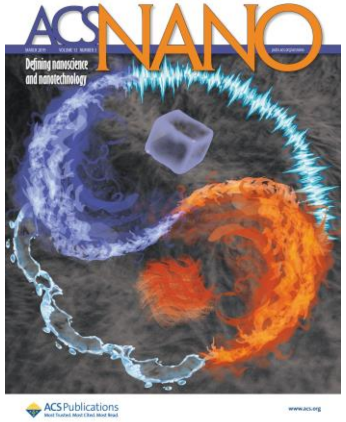


Hydrogels, light materials

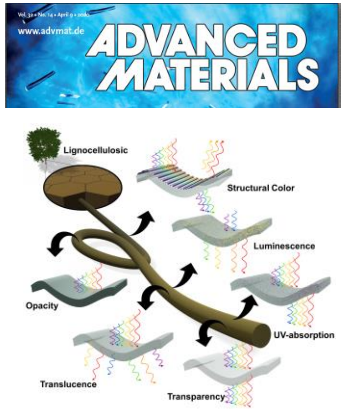
Rheology, 3D printing

Multiphase systems

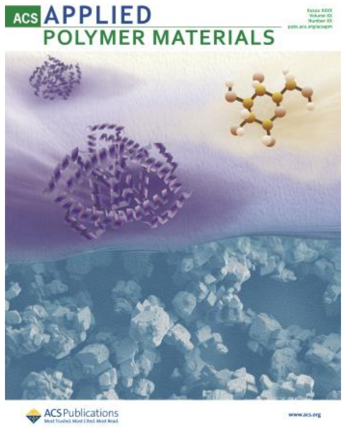
Composites



Active materials



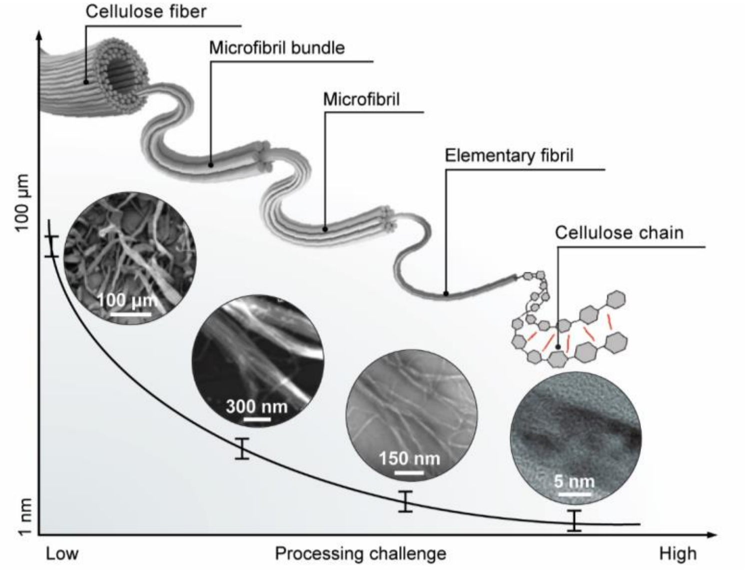
Sensing and actuation



Nanopolysaccharides, morphogenesis, biocatalysis (publications 2021)

Perspective about fibrillated cellulose as current and future technological material

We discuss research directions for the practical exploitation of cellulose fibril structures and the challenges to overcome before reaching their full potential



Li T., Chen C., Brozena A.H., Zhu J.Y., Xu L., Driemeier C., Dai J., Rojas O.J., Isogai A., Wågberg L., Hu L., Developing fibrillated cellulose as a sustainable technological material. **Nature** 590, 47–56 (2021). DOI: 10.1038/s41586-020-03167-7

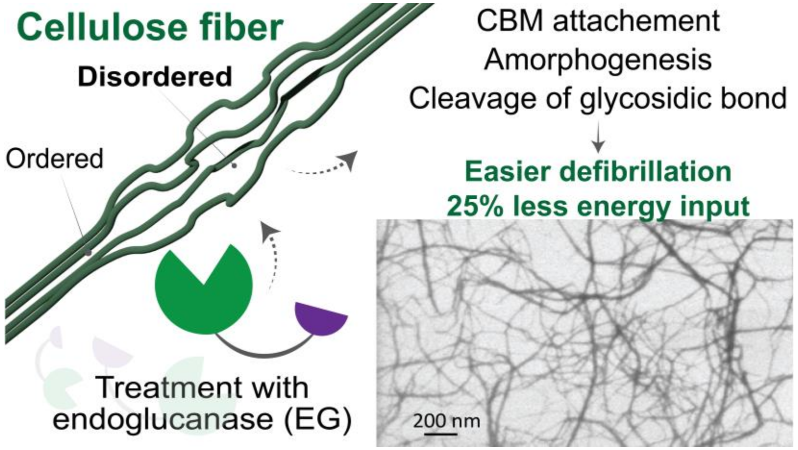
Partially acetylated cellulose nanofibrils were obtained from the major residual stream associated with tequila production

Agave Bagasse CNF offers a great potential as Pickering emulsion stabilizers, which can be considered in the food, cosmetic and pharmaceutical fields

Sulbarán-Rangel B., Hernández Díaz J.A., Guzmán González C.A., Rojas O.J., Partially acetylated cellulose nanofibrils from *Agave tequilana* bagasse and Pickering stabilization, **Journal of Dispersion Science and Technology**, Accepted (2021). DOI: 10.1080/01932691.2020.1858855

Monocomponent endoglucanase for energy efficient CNF production

We investigated the effect of process parameters on the enzyme-cellulose interactions and correlation with the energy intake for fiber defibrillation.

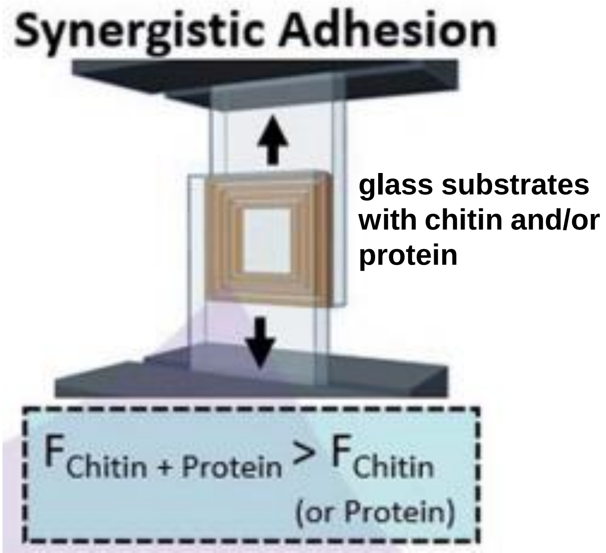


Berto G.L., Mattos B.D., Rojas O.J., Arantes V., Single-step fiber pre-treatment with monocomponent endoglucanases: defibrillation energy and cellulose nanofibril quality, **ACS Sustainable Chemistry & Engineering**, 9, 2260 (2021). DOI: 10.1021/acssuschemeng.0c08162

Nanopolysaccharides, morphogenesis, biocatalysis (pub 2021), Cont'd

Chitin–amyloid synergism and its use as sustainable structural adhesives

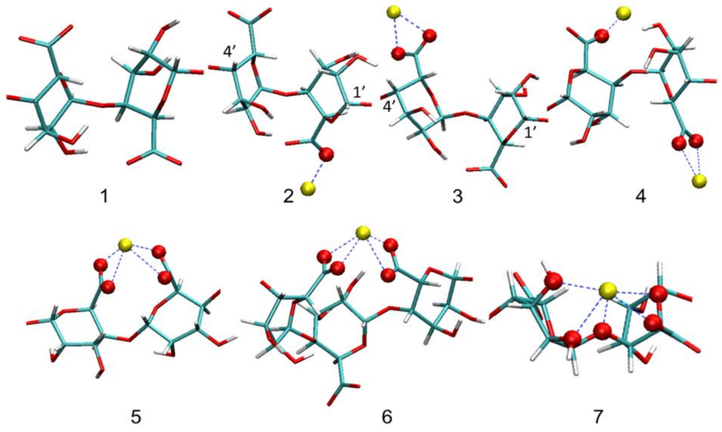
Chitin nanocrystal and lysosome amyloid adhesives are more sustainable than their petrochemical alternatives and outperform other green adhesives in lap shear load per mass.



Greca L.G., De France K.J., Majoinen J., Kummer N., Luotonen O.I.V., Campioni S., Rojas O.J., Nyström G., Tardy B.L., Chitin–amyloid synergism and their use as sustainable structural adhesives, **J. Materials Chem. A**, 9, 19741 (2021). DOI: 10.1039/D1TA03215A

Cation interactions with single-chain poly-guluronate alginates are studied by MDS

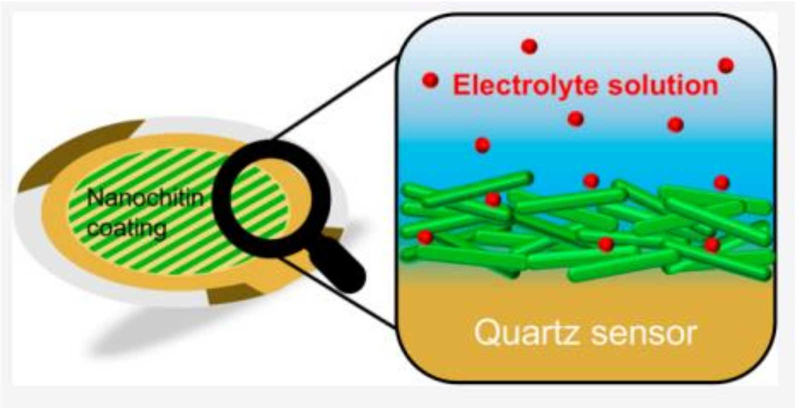
Calcium ions affect the formation of intra hydrogen bonding of alignate and water structuring. We offer new insights about alginate-ion complexation



Li Z.J., Srebnika S., Rojas O.J., Revisiting Cation Complexation and Hydrogen Bonding of Single-Chain poly-Guluronate Alginate, **Biomacromolecules**, 22, 4027 (2021). DOI: 10.1021/acs.biomac.1c00840

Anion-specific water interactions with nanochitin is investigated by QCM

Nanochitin interacts differently with anions of varying valence, electronegativity, and size. Among all the halide ions examined, fluorine ions induce remarkable swelling effects in nanochitin films.

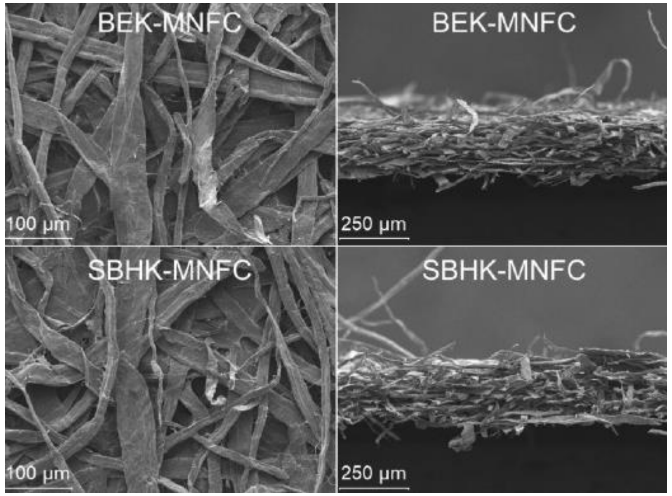


Jin S-A., Khan S.A., Spontak R.J., Rojas O.J., Anion-specific water interactions with nanochitin: Donnan and osmotic pressure effects as revealed by quartz microgravimetry, **Langmuir**, 37, 11242–11250 (2021). DOI: 10.1021/acs.langmuir.1c01585

Nanopolysaccharides, morphogenesis, biocatalysis (pub 2021), Cont'd

Effect of micro- and nanofibrillated cellulose (MNFC) on the tensile index, softness, and water absorbency of tissue paper.

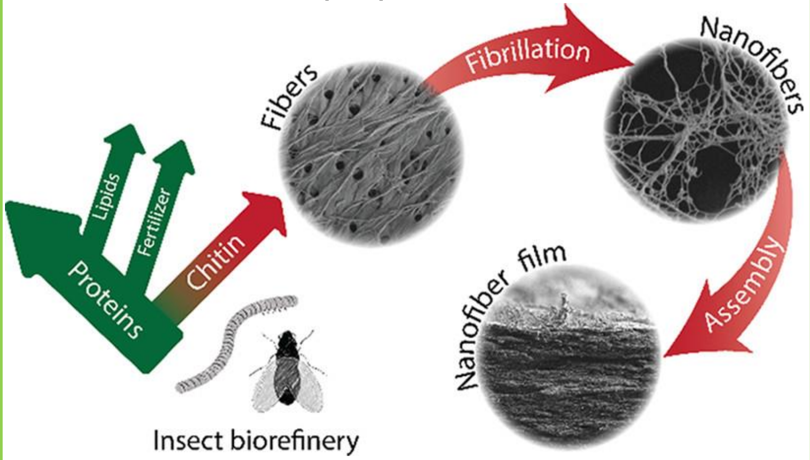
MNFC increased the tensile index of tissue paper but decreased water absorbency and softness. MNFCs from NBSK and SBHK yielded comparable trade-offs in tissue properties.



Zambrano F., Wang Y., Zwilling J.D., Venditti R.A., Jameel H., Rojas O.J., Gonzalez R., Micro- and nanofibrillated cellulose from virgin and recycled fibers: A comparative study of its effects on the properties of hygiene tissue paper, **Carbohydrate Polymers**, 254, 117430 (2021). DOI: 10.1016/j.carbpol.2020.117430

Chitin nanofibers and films were produced from byproducts of insect farms and compared with commercial shrimp chitin

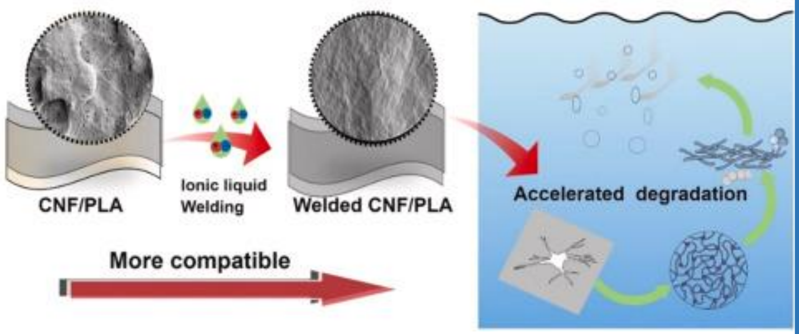
Fibrillated F-ChNF showed higher transmittance in suspensions and produced higher transparent films than commercial S-ChNF, noting that the crystallinity, degree of acetylation, and film mechanical properties were similar.



Pasquier E., Beaumont M., Mattos B.D., Otoni C.G., Winter A., Rosenau T., Belgacem M.N., Rojas O.J., Bras J., Upcycling Byproducts from Insect (Fly Larvae and Mealworm) Farming into Chitin Nanofibers, **ACS Sustainable Chemistry & Engineering**, 9, 13618–13629 (2021). DOI: 10.1021/acssuschemeng.1c05035

Green and facile method to compatibilize polylactide (PLA) with cellulose nanofibers (CNF) by using ionic liquid welding with gamma-valerolactone cosolvent

Incorporation of nanocellulose and welding accelerates the otherwise slow degradation of PLA in seawater. The welding process makes it possible to achieve strong, lightweight and transparent films.



Niu X., Huan S.Q., Li H.M., Pan H., Rojas O.J., Transparent films by ionic liquid welding of cellulose nanofibers and polylactide: Enhanced biodegradability in marine environments, **Journal of Hazardous Materials**, 402, 124073 (2021). DOI: 10.1016/j.jhazmat.2020.124073

Nanopolysaccharides, morphogenesis, biocatalysis (pub 2021), Cont'd

Fractionation and use of fibrillated cellulose from hemp hurd

Rolled coatings and films of LCMF from Hemp were found to have hydrophobic properties

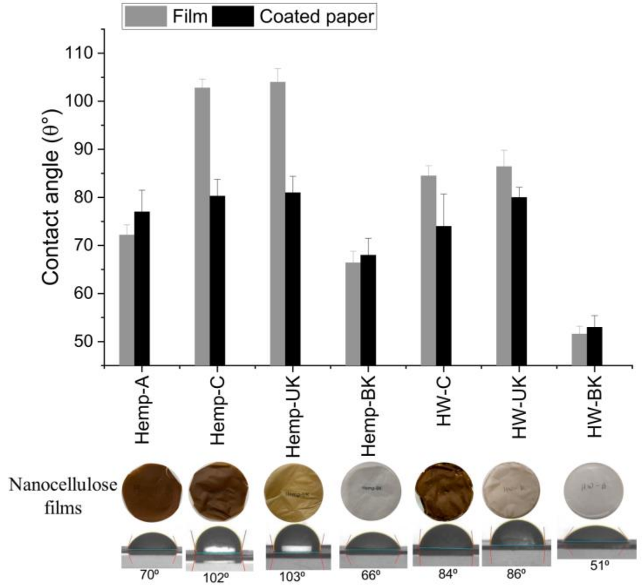
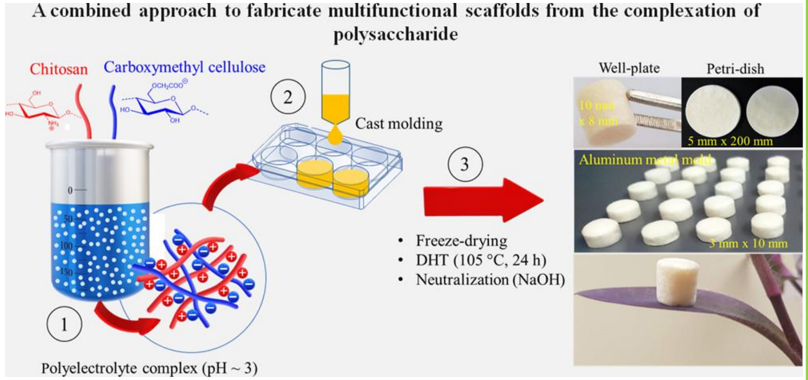


Fig. 6. Contact angle of nanocellulose films and coated paper.

Tyagi P., Gutierrez J.N., Nathani V., Lucia L.A., Rojas O.J., Hubbe M.H., Pal L., Hydrothermal and mechanically generated hemp hurd nanofibers for sustainable barrier coatings/films, **Industrial Crops & Products**, 168, 113582 (2021). DOI: 10.1016/j.indcrop.2021.113582

Fabrication process and mechanical properties of chitosan-carboxymethyl cellulose crosslinked scaffolds.

Light-weighted, mechanically strong, porous scaffolds were fabricated by mixing chitosan and carboxymethyl cellulose at low pH, followed by freeze drying, dehydrothermal, and neutralization treatments.



Štiglic A.D., Kargl R., Beaumont M., Strauss C., Makuc D., Egger D., Plavec J., Kasper C., Rojas O.J., Kleinschek K.S., Mohan T., The influence of charge and heat on the mechanical properties of scaffolds from ionic complexation of chitosan and carboxymethyl cellulose, **ACS Biomaterials Sci. & Eng,** 7, 3618 (2021). DOI: 10.1021/acsbiomaterials.1c00534

Microbial cellulose, biofabrication (publications 2021)

Impact of incubation conditions and post-treatment on the properties of bacterial cellulose membranes

We investigate the performance of BNC in pressure-driven filtration as a function of incubation conditions and post-culture treatment.

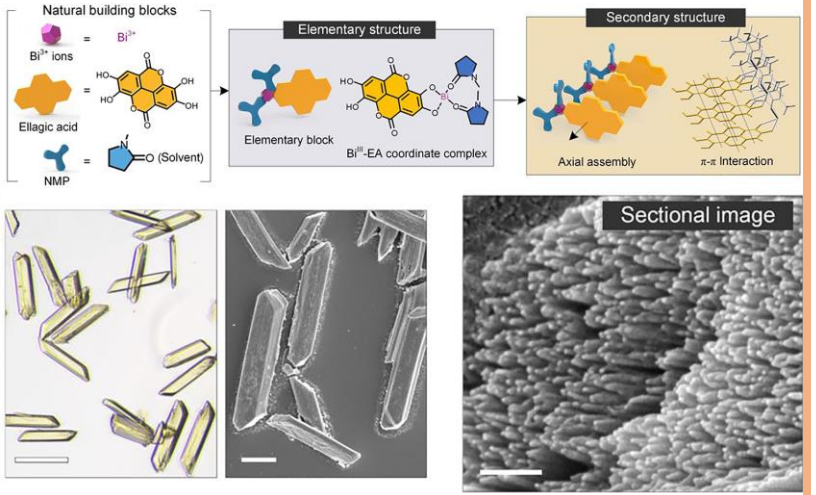
Lehtonen J., Chen X., Beaumont M., Hassinen J., Orelma H., Dumée L.F., Tardy B.L., Rojas O.J., Impact of incubation conditions and post-treatment on the properties of bacterial cellulose membranes for pressure-driven filtration, **Carbohydrate Polymers**, 251, 117073 (2021). DOI: [10.1016/j.carbpol.2020.117073](https://doi.org/10.1016/j.carbpol.2020.117073)

Our diverse BiCMat group is represented by members of 21 different nationalities (2021)

Biomass valorization, bark and proteins (publications 2021)

Metal-phenolic self-assemble into functional multi-level mesocrystal for sodium-ion battery

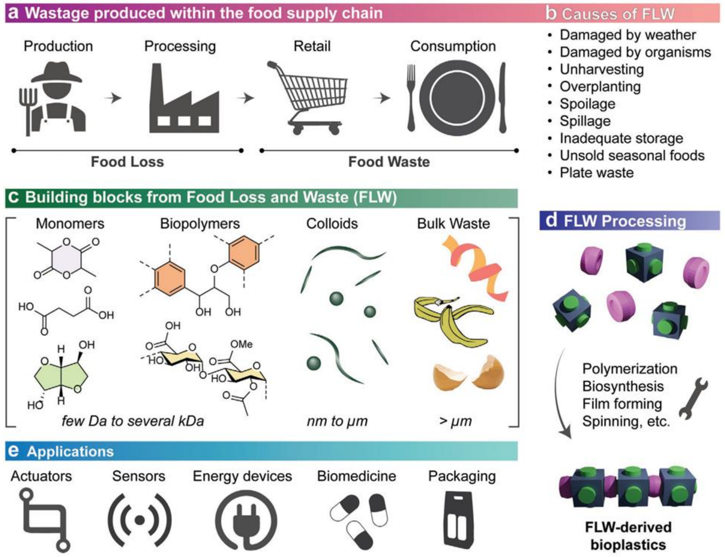
Phenolic complexes self-assemble in tertiary and quaternary superstructures. The hierarchical framework is preserved after thermal conversion and used in sodium energy storage.



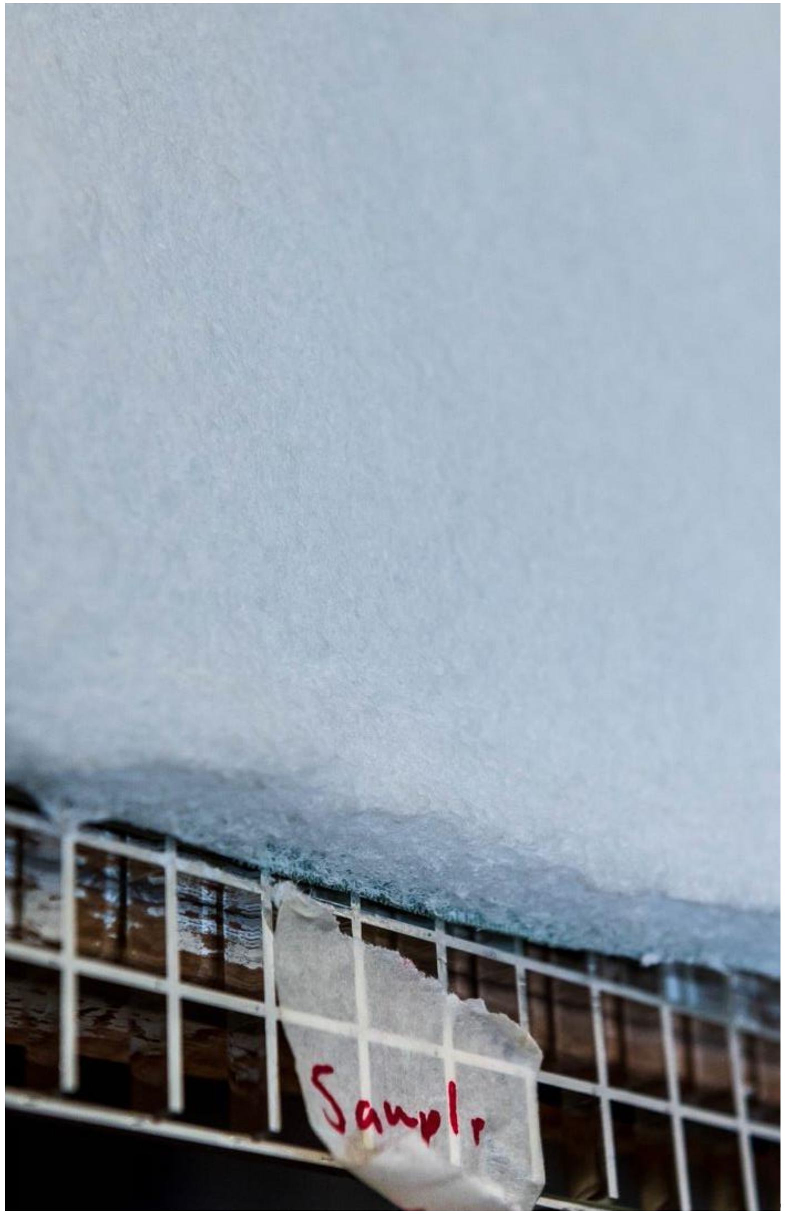
Qiu X., Wang X., He Y., Liang J., Liang K., Tardy B.L., Richardson J.J., Hu M., Wu H., Zhang Y., Rojas O.J., Manners I., Guo J., Superstructured mesocrystals through multiple inherent molecular interactions for highly reversible sodium-ion batteries, **Science Advances**, 7, eabh3482 (2021). DOI: [10.1126/sciadv.abh3482](https://doi.org/10.1126/sciadv.abh3482)

Advanced biobased materials from loss and waste streams in the food supply chain

Strategies to valorize food wastes through biobased material development for a future circular bioeconomy.



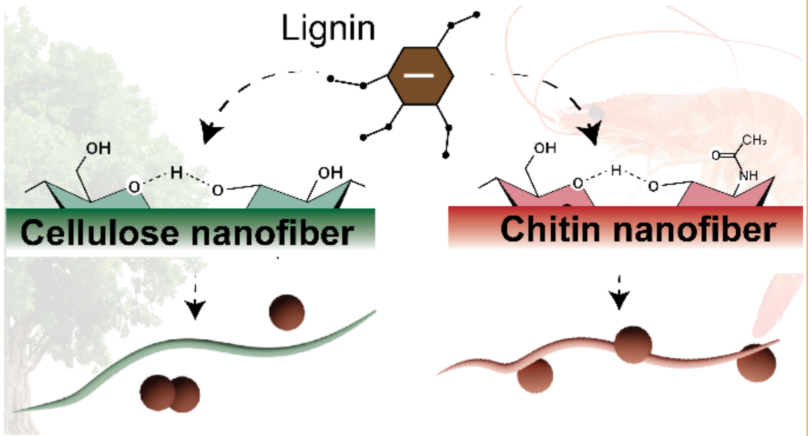
Otoni C.G., Azeredo H.M.C., Mattos B.D., Beaumont M., Correa D.S., Rojas O.J., The Food-Materials Nexus: Next Generation Bioplastics and Advanced Materials from Agri-Food Residues, **Advanced Materials**, 2102520 (2021). DOI: [10.1002/adma.202102520](https://doi.org/10.1002/adma.202102520)



Lignin, polyphenols and proteins (publications 2021)

Lignin nanoparticle nucleation and growth on nanopolysaccharides

We developed a new process to produce lignin nanoparticles in the presence of bio-based nanofibers via solvent shifting.



Pasquier E., Mattos B.D., Belgacem N., Bras J., Rojas O.J., Lignin nanoparticle nucleation and growth on cellulose and chitin nanofibers, **Biomacromolecules**, 22, 880 (2021). DOI: [10.1021/acs.biomac.0c01596](https://doi.org/10.1021/acs.biomac.0c01596)

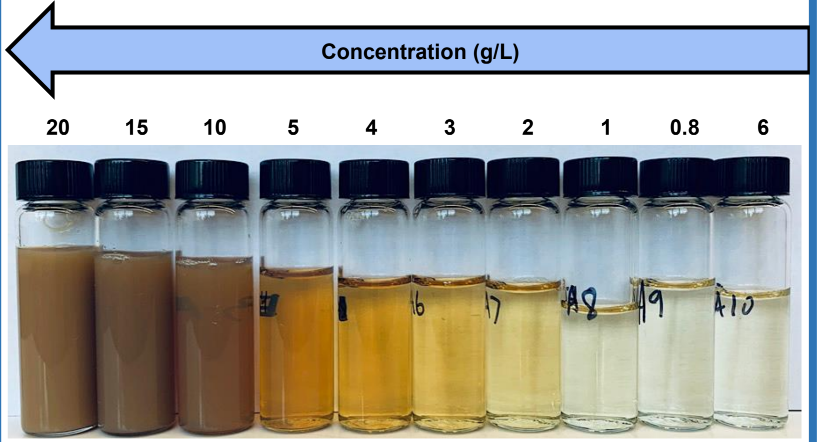
Lignin to enhance the mechanical properties of castor oil-based polyurethanes.

Differences of four orders of magnitude in viscoelastic moduli are observed by using lignin: Outstanding resistance and cushioning properties are obtained

Borrero-López A.M., Wang W., Valencia C., Franco J.M., Rojas O.J., Lignin effect in castor oil-based elastomers: Reaching new limits in rheological and cushioning behaviors, **Composites Science and Technology**, 203, 108602 (2021). DOI: [10.1016/j.compscitech.2020.108602](https://doi.org/10.1016/j.compscitech.2020.108602)

Nucleation and growth of LPs to develop value-added applications for kraft lignin

We elucidate solvent–lignin–water interactions in relation to molecular weight and functional groups of the lignin fractions and solvent/water polarity.

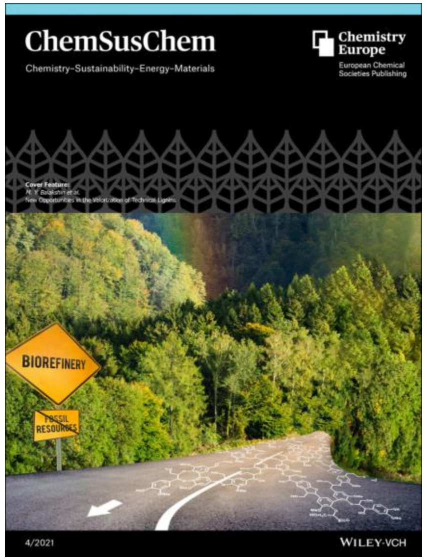


Zwilling J., Jiang X., Venditti R.A., Jameel H., Velev O.D., Rojas O.J., Gonzalez R., Understanding lignin micro- and nanoparticle nucleation and growth in aqueous suspensions by solvent fractionation, **Green Chemistry,** 23, 1001 (2021). DOI: 10.1039/D0GC03632C

Lignin, polyphenols and proteins (publications 2021), Cont’d

New opportunities in the valorization of technical lignins – lignin-centered biorefineries

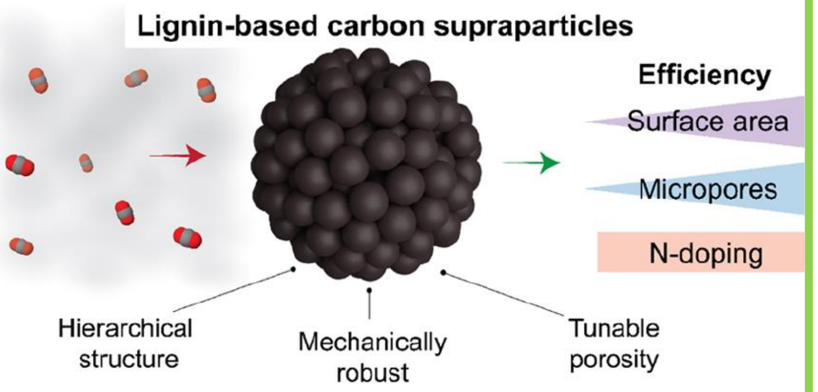
Critical review on the state-of-the-art in the valorization of technical, biorefinery lignins. We discuss “best-for-everything” lignin or “killer application” for all lignin types.



Balakshin M.Y., Capanema E.A., Sulaeva I., Schlee P., Huang Z., Feng M., Borghei M., Rojas O.J., Potthast A., Rosenau T. New opportunities in the valorization of technical lignins, **ChemSusChem**, 14, 1016 (2021). DOI: 10.1002/cssc.202002553

We synthesized multiscale carbon supraparticles (SPs) bound by cellulose nanofibrils (CNFs).

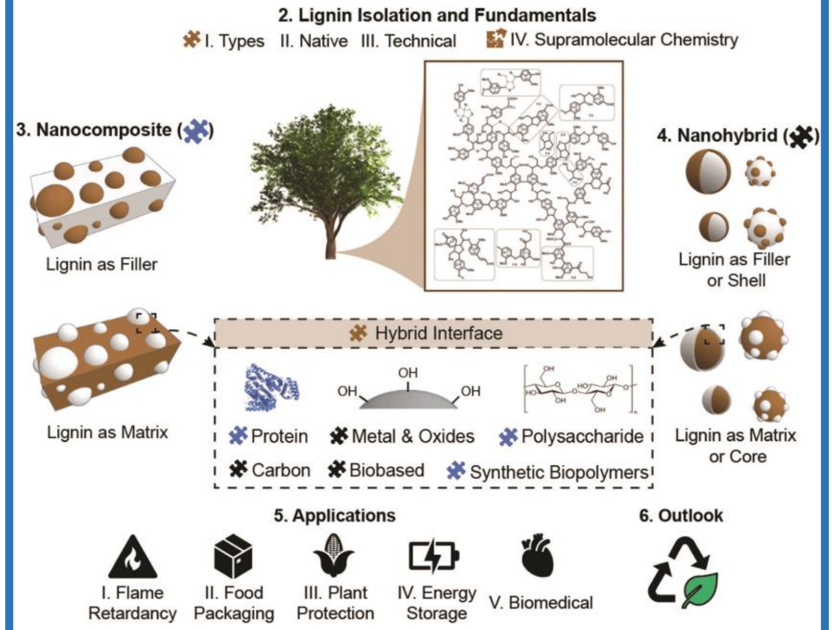
The SPs were carbonized to achieve high mechanical strength, surface area and CO_2 capture capacity



Zhao B., Borghei M., Zou T., Wang L., Johansson L-S., Majoinen J., Sipponen M.H., Österberg M., Mattos B.D., Rojas O.J., Lignin-Based Porous Supraparticles for Carbon Capture, **ACS Nano**, 15, 6774–6786 (2021). DOI: 10.1021/acsnano.0c10307

Review on lignins, their self-assembly and supramolecular organization in hybrid materials.

A review on recent progress in lignin-based nanocomposites and nanohybrids

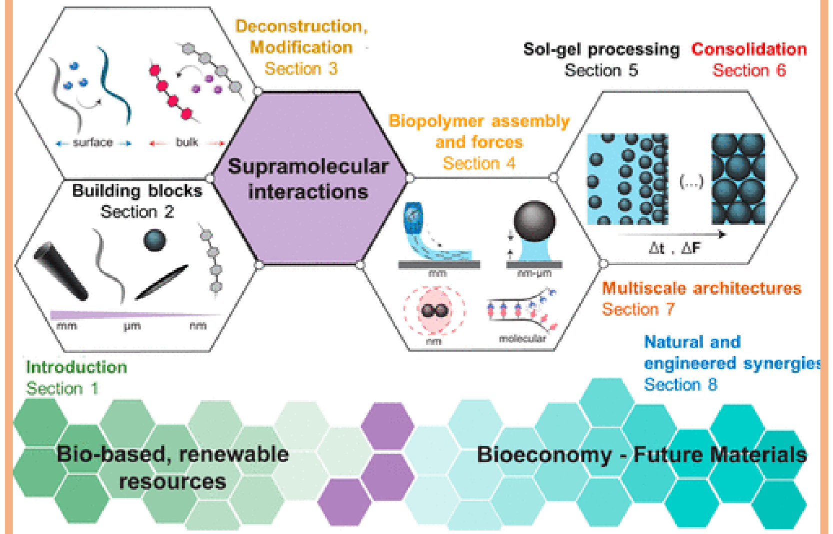


Lizundia E., Sipponen M.H., Greca L.G., Balakshin M., Tardy B.L., Rojas O.J., Puglia D., Multifunctional lignin-based nanocomposites and nanohybrids, **Greeen Chemistry**, 23, 6698-6760 (2021). DOI: 10.1039/D1GC01684A

Supraparticles and colloidal assemblies (publications 2021)

A comprehensive review of supramolecular biopolymers and biocolloid materials

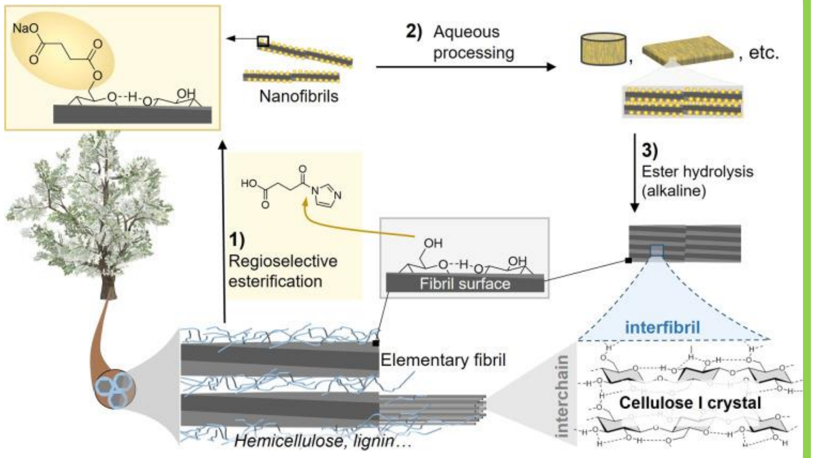
Review of current developments of bio-based building blocks, colloidal interactions, assembly of supra-structures, and perspectives in high-performance biomaterials.



Tardy B.L., Mattos B.D., Otoni C.G., Beaumont M., Majoinen J., Kämäräinen T., Rojas O.J., Deconstruction and Reassembly of Renewable Polymers and Biocolloids into Next Generation Structured Materials, **Chemical Reviews**, 121, 14088 (2021). DOI: [10.1021/acs.chemrev.0c01333](https://doi.org/10.1021/acs.chemrev.0c01333)

Surface functionalization of CNF while maintaining native surface chemistry

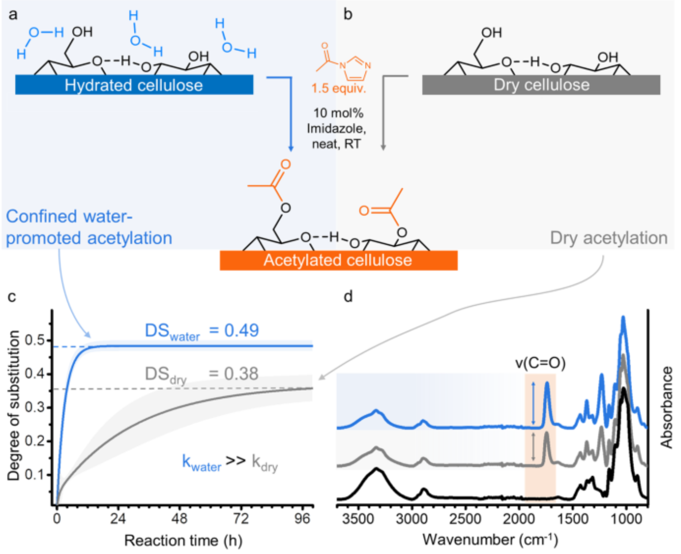
Succinylated CNF produced via esterification with preservation of native cellulose crystallinity and crosslinking, with rheological properties similar to TEMPO-oxidized CNF



Beaumont M., Tardy B.L., Reyes G. Koso T.V., Schaubmayr E., Jusner P., King A.W.T., Dagastine R.R., Potthast A. Rojas O.J., Rosenau T., Assembling Native Elementary Cellulose Nanofibrils via a Reversible and Regioselective Surface Functionalization, **J Am Chem Soc**, 41, 17040 (2021). [DOI: 10.1021/jacs.1c06502](https://doi.org/10.1021/jacs.1c06502)

Using surface-bound water in CNFs to control hydroxyl availability in esterification reactions

Compared regioselectivity & reaction rate of dry *vs* hydrated cellulose with imidazole, proposing a transition state where surface confined water increases reaction selectivity and efficiency

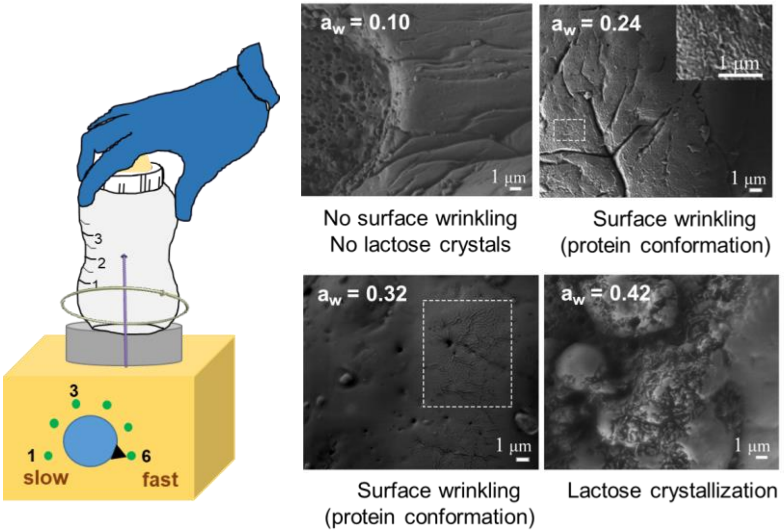


Beaumont M., Jusner P., Gierlinger N., King A.W.T., Potthast A., Rojas O.J., Rosenau T., Unique Reactivity of Nanoporous Cellulosic Materials Mediated by Surface-Confined Water, **Nature Communications**, 12, 2513 (2021). DOI: [10.1038/s41467-021-22682-3](https://doi.org/10.1038/s41467-021-22682-3)

Supraparticles and colloidal assemblies (publications 2021), Cont'd

Evolution of milk powder macronutrients (lactose, fat, and proteins) under storage conditions and

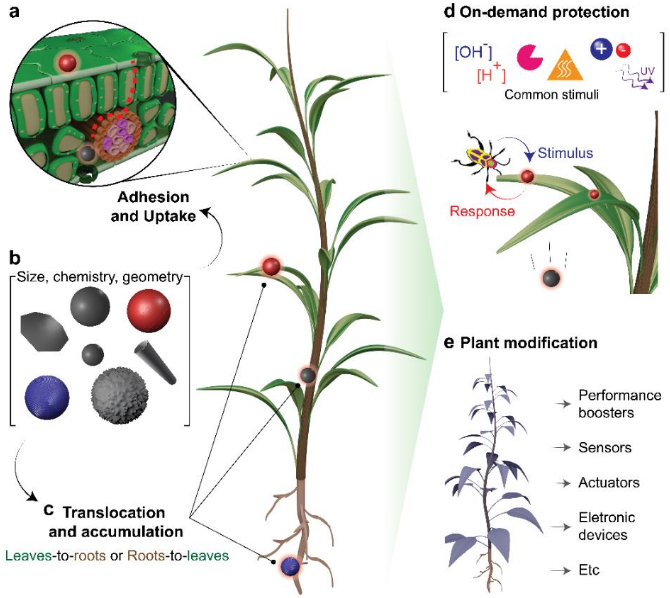
Microstructural, chemical and wettability analyses to troubleshoot the onset of related changes upon IF powder reconstitution



Nugroho R.W.N., Outinen M., Toikkanen O., Heino A., Sawada D., Rojas O.J., Effect of water activity on the functional, colloidal, physical, and microstructural properties of infant formula powder, **Journal of Colloid and Interface Science**, 586, 56 (2021). DOI: 10.1016/j.jcis.2020.10.069

Particulate delivery systems within nano-enabled agriculture

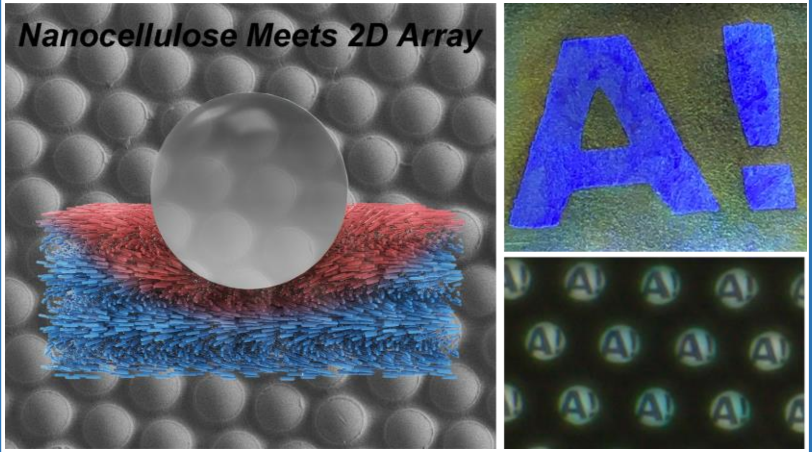
We review interactions between particles and plant tissues, considering adhesion, uptake, allocation and transport.



Grillo R., Mattos B.D., Antunes D.R., Forini M.M.L., Monikh F.A., Rojas O.J. Foliage adhesion and interactions with particulate delivery systems for plant nanobionics and intelligent agriculture, **Nano Today,** 37,101078 (2021). DOI: 10.1016/j.nantod.2021.101078

Multifunctional optical films (polarization sensitive retroreflector and microlens array) produced from cellulose nanocrystals and microspheres.

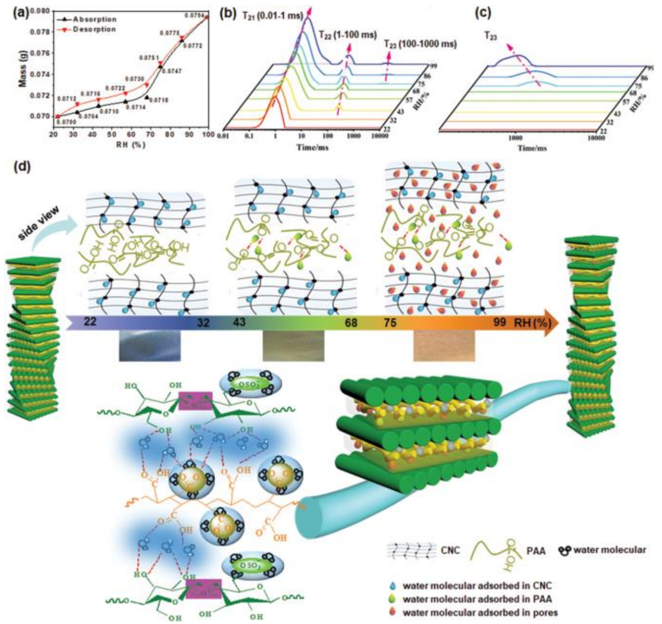
Micropatterned photonic films from bottom-up cholesteric self-assembly of cellulose nanocrystals and top-down transfer imprinting of polystyrene microspheres.



Chu, G.; Chen, F.; Zhao, B.; Zhang, X., Zussman, E. and Rojas O.J., Self-Assembled Nanorods and Microspheres for Functional Photonics: Retroreflector Meets Microlens Array **Advanced Optical Materials,** 2002258 **(**2021). DOI: 10.1002/adom.202002258

Chiral nematic coatings based on cellulose nanocrystals as a multiplexing platform for humidity sensing and dual anti-counterfeiting

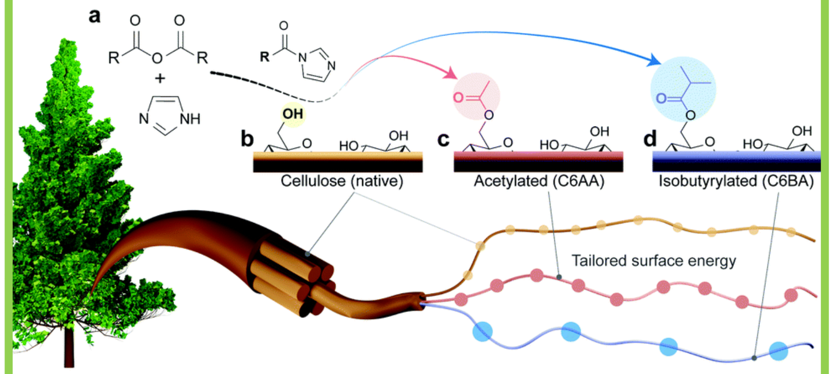
Self-assembled iridescent coatings are produced under the effect of electrostatic interactions



Zhao G., Huang Y., Mei C., Zhai S., Xuan Y., Liu Z., Pan M., Rojas O.J., Chiral nematic coatings based on cellulose nanocrystals as a multiplexing platform for humidity sensing and dual anti-counterfeiting, **Small**, 2103936 (2018). DOI: [10.1002/smll.202103936](https://doi.org/10.1002/smll.202103936)

Cellulose can be esterified in aqueous media and high solids concentration

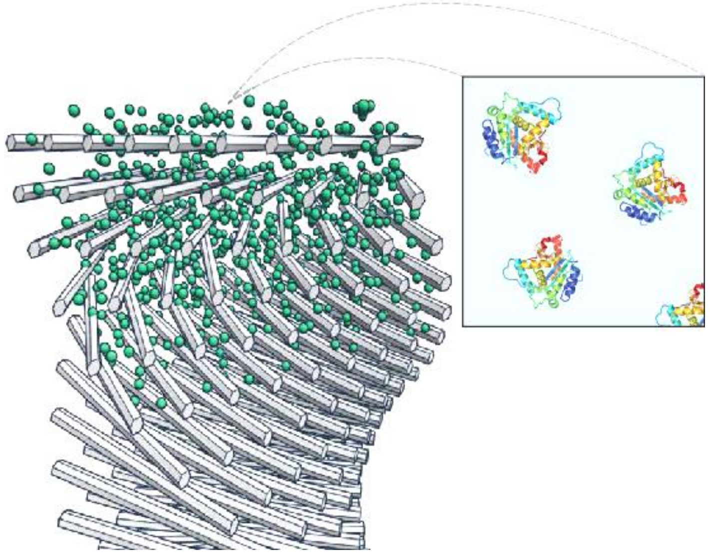
Never dried cellulose was surface esterification affording CNF of adjustable surface energy.



Beaumont M., Otoni C.G., Mattos B.D., Koso T.V., Abidnejad R., Zhao B., Kondor A., King A.W.T., Rojas O.J., Regioselective and water-assisted surface esterification of never-dried cellulose: nanofibers with adjustable surface energy, **Green Chemistry**, 23, 6966 (2021). DOI: 10.1039/D1GC02292J

Infiltration of Proteins in Cholesteric Cellulose Structures

We propose infiltration of CNCs to enable nanocomposite formation that is otherwise not possible using simple mixing or other conventional approaches.

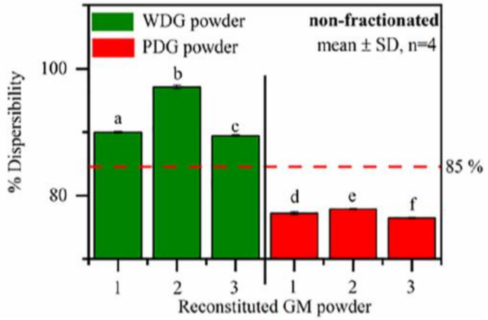


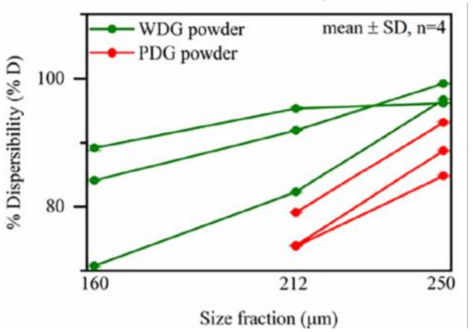
Bast L.K., Klockars K.W., Greca L.G., Rojas O.J., Tardy B.L., Bruns N., Infiltration of Proteins in Cholesteric Cellulose Structures, **Biomacromolecules** 22, 2067 (2021). DOI: 10.1021/acs.biomac.1c00183

Supraparticles and colloidal assemblies (publications 2021), Cont'd

Correlation of fat encapsulation in milk powder, size distribution and dispersibility in water

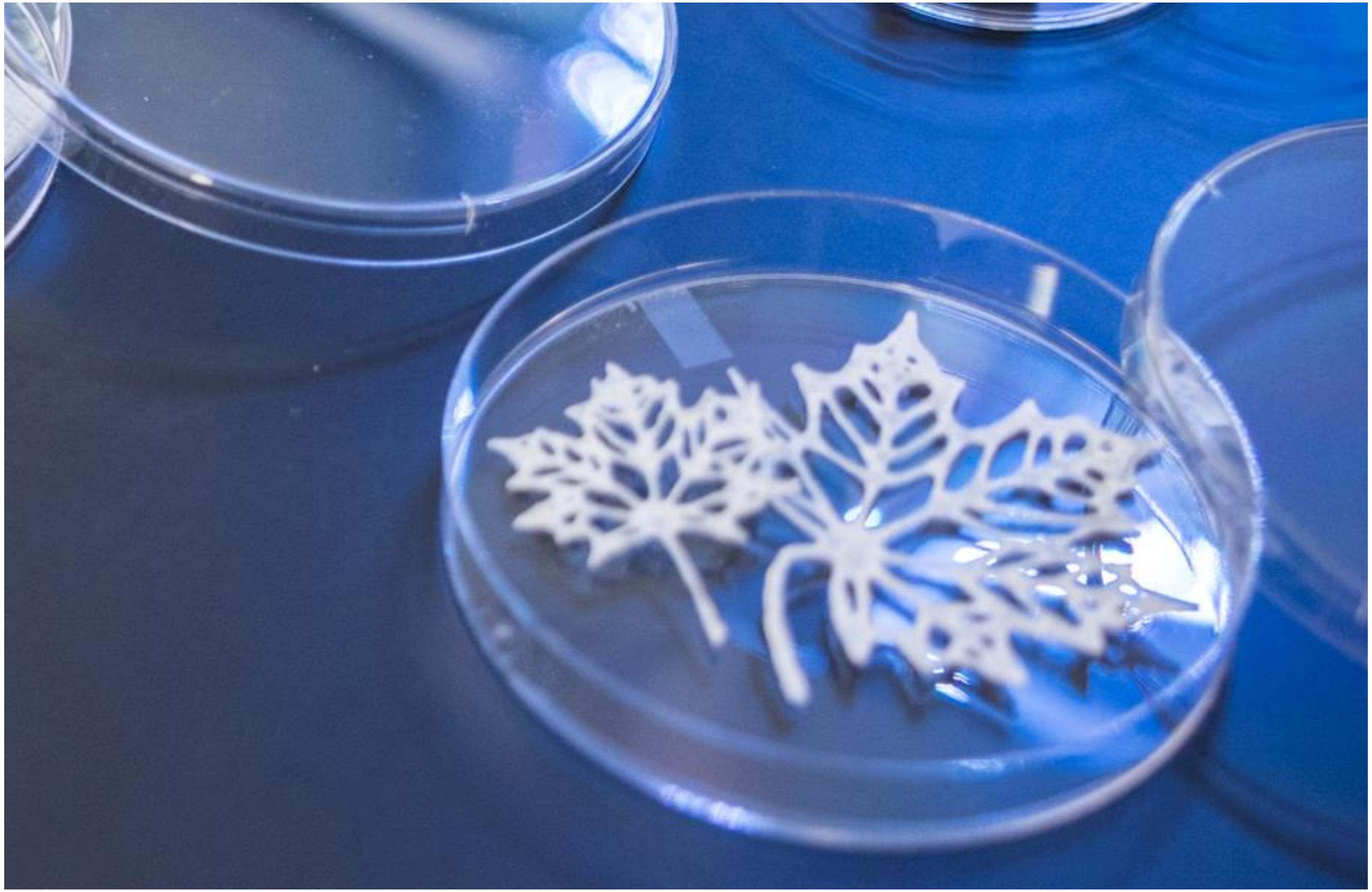
Highly dispersible milk powder contains small encapsulated fat particles





Nugroho et al. Particle Size and Fat Encapsulation Define the Colloidal Dispersibility and Reconstitution of Growing-up Milk Powder. **Powder Technology**, *391*, 133 (2021).

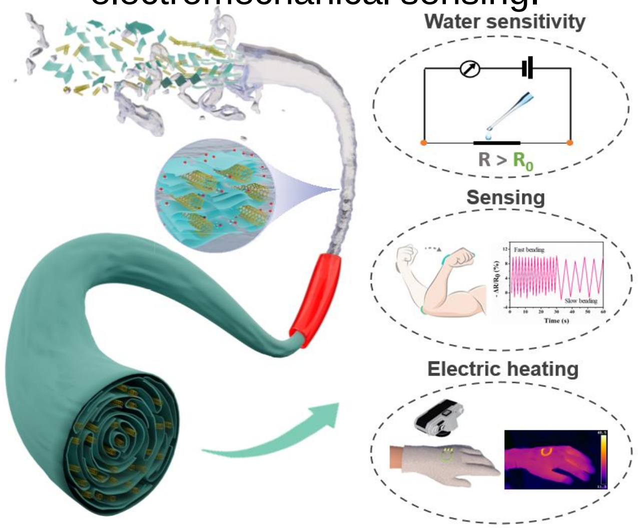
DOI: [10.1016/j.powtec.2021.06.008](https://doi.org/10.1016/j.powtec.2021.06.008)



Films, coatings, filaments (publications 2021)

Intermolecular self-assembly of dopamine-conjugated carboxymethylcellulose and carbon nanotubes toward supertough and multifunctional wearables

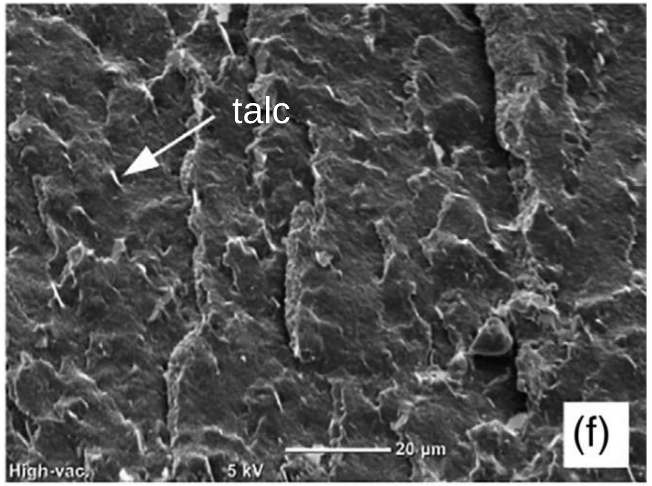
We report on the fabrication of water-resistant and supertough filaments by self-assembly an demonstrate rapid electrothermal and electromechanical sensing.



Guo T., Wan Z., Li D., Song J., Rojas O.J., Jin Y. Intermolecular self-assembly of dopamine-conjugated carboxymethylcellulose and carbon nanotubes toward supertough filaments and multifunctional wearables, **Chemical Engineering Journal**, 416, 128981 (2021). DOI: 10.1016/j.cej.2021.128981

Composites produced at pilot-scale by melt compounding of PLA/biodegradable polyester and talc.

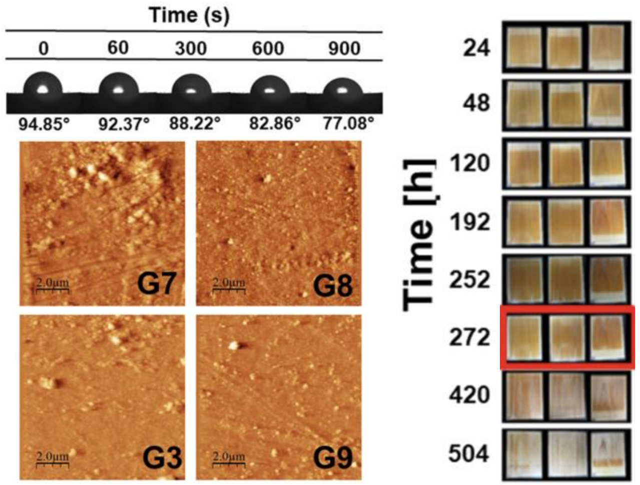
After injection-molding or film extrusion, talc acts as a nucleating agent in the composites and increases the degree of crystallinity, leading to a slight increase of the elastic modulus and significant increase of the barrier properties.



Helanto K., Talja R., Rojas O.J., Talc reinforcement of polylactide and biodegradable polyester blends via injection-molding and pilot-scale film extrusion, **Journal of Applied Polymer Science**, 10.1002/app.51225

Wood waterborne coatings based on CNC (blueberry pruning residues), SiO_2 and TiO_2.

The incorporation of nanocomposite coatings improves the wood's mechanical performance (adhesion and abrasion) and stability (transparency, gloss, color, contact angle).

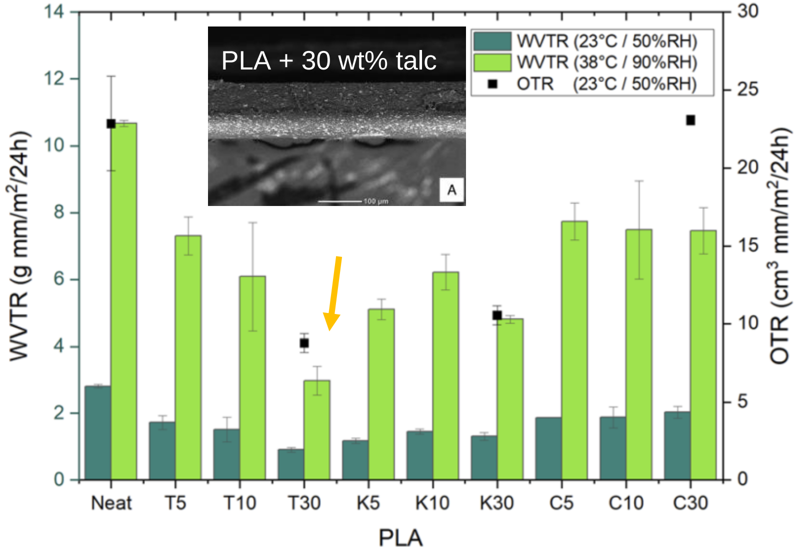


Pacheco C.M., Bustos A.C., Reyes G., Oviedo C., Fernández-Pérez A., Elso M., Rojas O.J., Nanocomposite additive of SiO2/TiO2/nanocellulose on waterborne coating formulations for mechanical and aesthetic properties stability on wood, **Materials Today Communications**, 102990 (2021). DOI: 10.1016/j.mtcomm.2021.102990

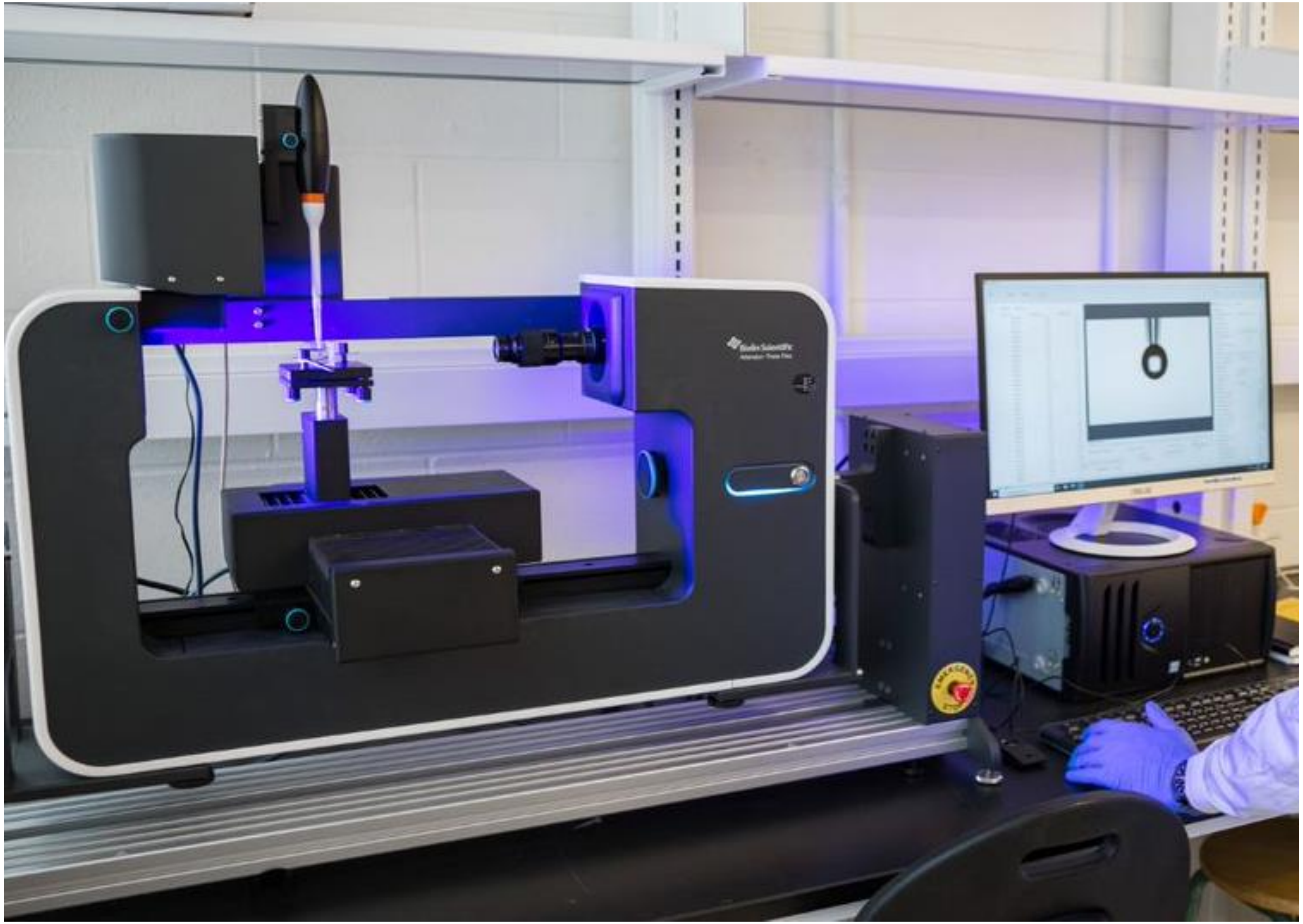
Films, coatings, filaments (publications 2021)

Improved performance of bio-based and biodegradable polymers (PLA, PBAT, PHBV) by the addition of inorganic fillers

Injection- and compression-molded specimens exhibit a homogeneous dispersion of fillers (talc, kaolin and calcium carbonate), and increase of elastic modulus. Talc leads to the best water vapor and oxygen barrier properties.



Helanto K., Talja R., Rojas O.J., Effects of talc, kaolin and calcium carbonate as fillers in biopolymer packaging materials, **Journal of Polymer Engineering**, 10.1515/polyeng-2021-0076



Solutions, Hydrogels and Lightweight materials (publications 2021)

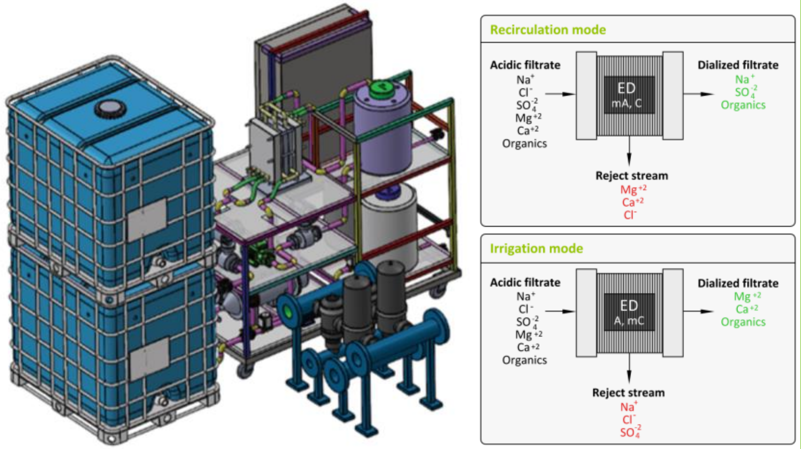
Cellulos dissolution NaOH–ZnO: reactivity and based on Raman spectroscopic studies.

The role of metal oxide additive was studied in cellulose dissolution. A new structure is proposed for cellulose dissolved in aqueous NaOH–ZnO

Väisänen, S., Ajdary, R., Altgen, M., Nieminen, K., Kesari, K. K., Ruokolainen, J., Rojas O.J., Vuorinen, T. (2021). Cellulose dissolution in aqueous NaOH–ZnO: cellulose reactivity and the role of ZnO. **Cellulose**, 28, 1267 (2921). DOI:[10.1007/s10570-020-03621-9](https://doi.org/10.1007/s10570-020-03621-9)

Desalination by pulsed electrodialysis reversal: Approaching fully close-loop water systems

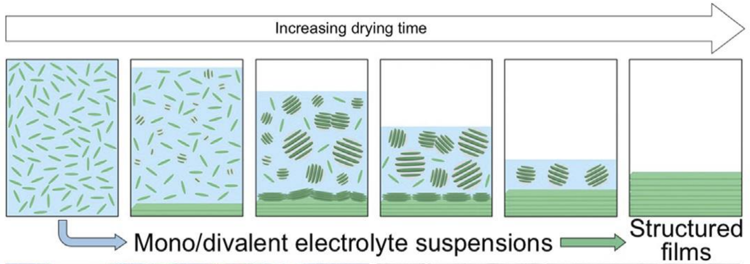
Pulsed electrodialysis reversal pilot is proposed to desalinate water, affording close-loop processing, minimizing the need for fresh water intake while maintaining the quality of recirculating process streams.

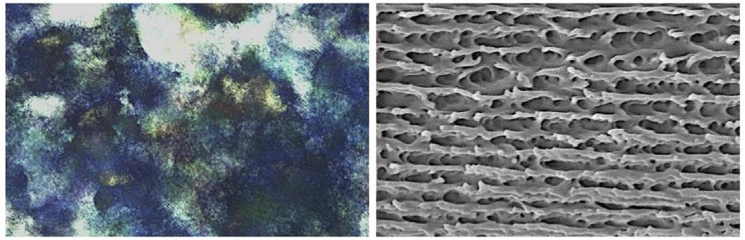


Gonzalez-Vogel A., Moltedo J.J., Quezada R., Schwarz A., Rojas O.J., Pilot treatment of bleaching acidic filtrate in Kraft pulping with high frequency pulsed electrodialysis, **Journal of Environmental Management**, 282, 111891, (2021). DOI: [10.1016/j.jenvman.2020.111891](https://doi.org/10.1016/j.jenvman.2020.111891)

Effect of the counterion type and ionic strength on the mesomorphic behavior of CNC suspensions for film casting.

Circular dichroism and UV-vis are used to assess the effect of various cations on CNC chiral-nematic properties. The electric double layer depends on cationic radius and valence, influencing the optical properties of CNC films.



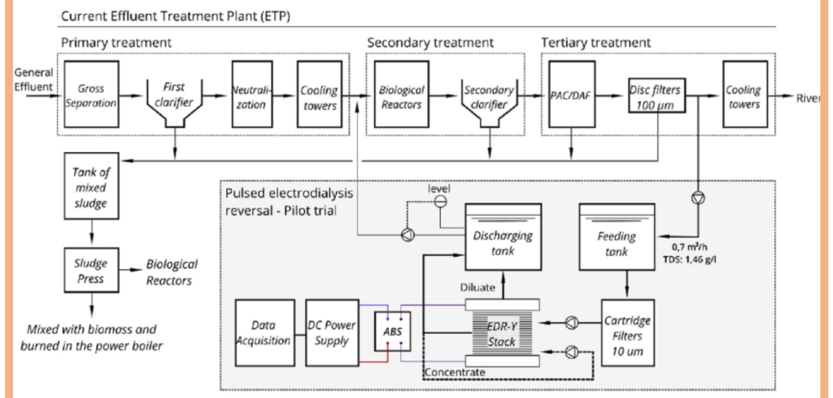


Jin S.-A., Facchine E.G**., Rojas O.J**., Khan S.A., Spontak R.J, Mesophase Characteristics of Cellulose Nanocrystal Films Prepared from Electrolyte Suspensions, **Journal of Colloid and Interface Science**, 599, 207-218 (2021). DOI: [10.1016/j.jcis.2021.04.071](https://doi.org/10.1016/j.jcis.2021.04.071)

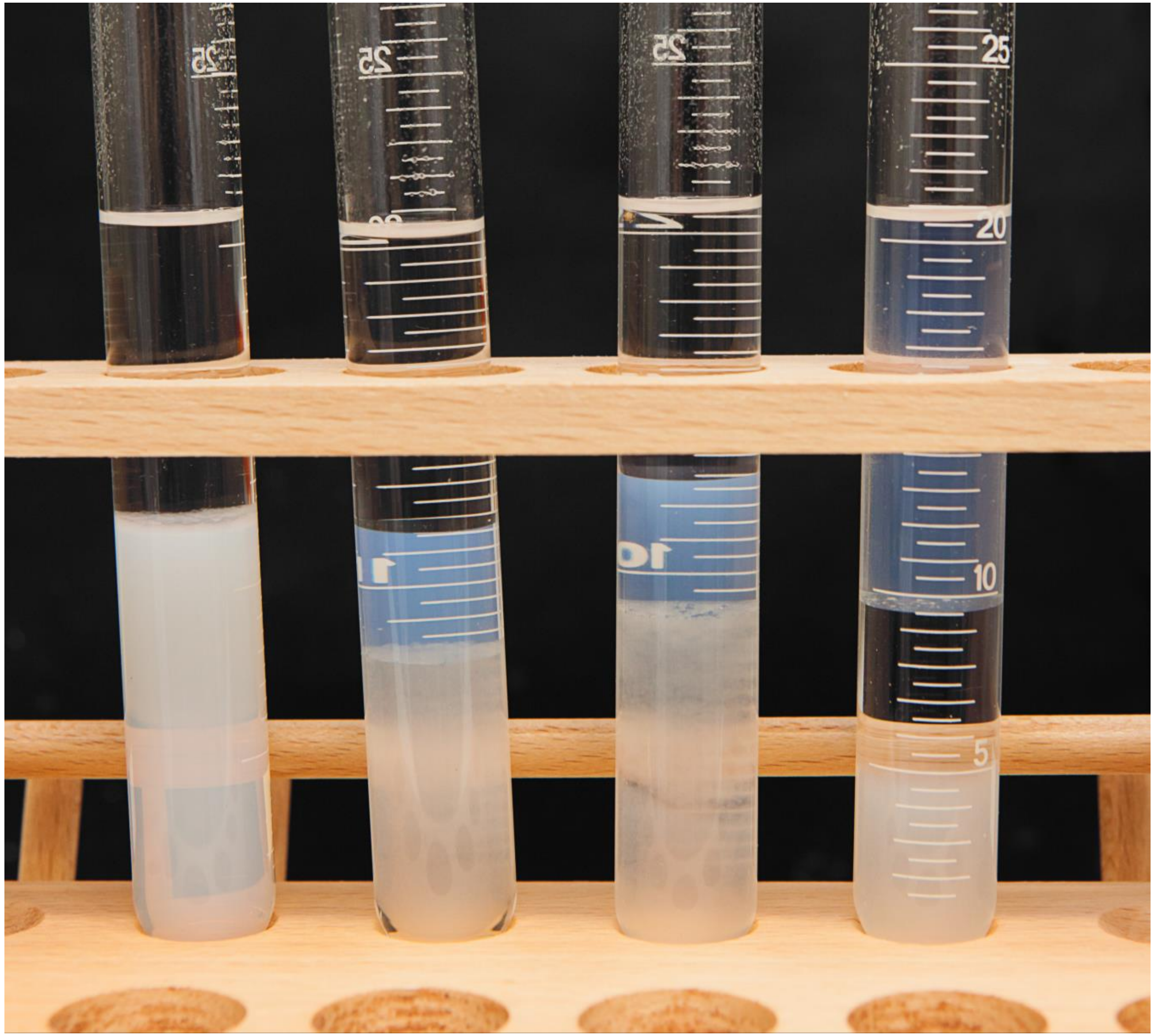
Solutions, Hydrogels and Lightweight materials (pub 2021), Cont'd

New process (desalination by pulsed electrodialysis reversal, pEDR) is proposed for water management

pEDR minimizes production losses (from 5 % to 0.6 %), extending the time for hydraulic reversal (from 15 min to at least 2 h), and reducing the conductivity of the effluent.



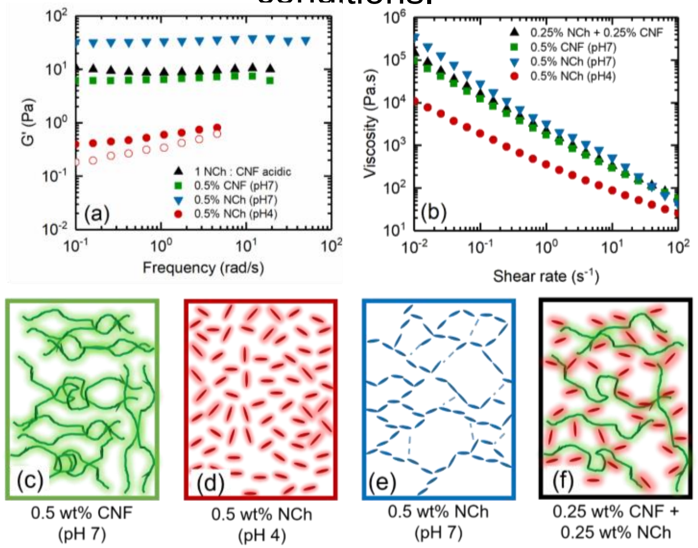
Gonzalez-Vogel A., Moltedo J.J., Rojas O.J., Desalination by pulsed electrodialysis reversal: Approaching fully closed-loop water systems in wood pulp mills, **J. Env. Management**, 298, 113518 (2021). DOI: 10.1016/j.jenvman.2021.113518



Rheology and 3D printing (publications 2021)

Associative structures form between cellulose nanofibrils and nanochitins

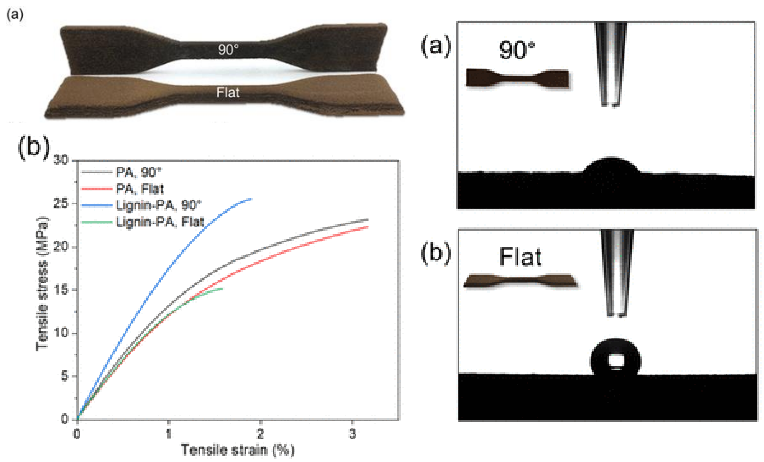
Ionic attraction, hydrophobic associations, and physical entanglement were studied for their effects on colloidal stability under broader pH conditions.



Facchine E.G., Bai L., Rojas O.J., Khan S.A., Associative structures formed from cellulose nanofibrils and nanochitins are pH-responsive and exhibit tunable rheology, **Journal of Colloid and Interface Science**, 588, 232 (2021). DOI: [10.1016/j.jcis.2020.12.041](https://doi.org/10.1016/j.jcis.2020.12.041)

Lignin produces low-cost composites *via* the SLS technique

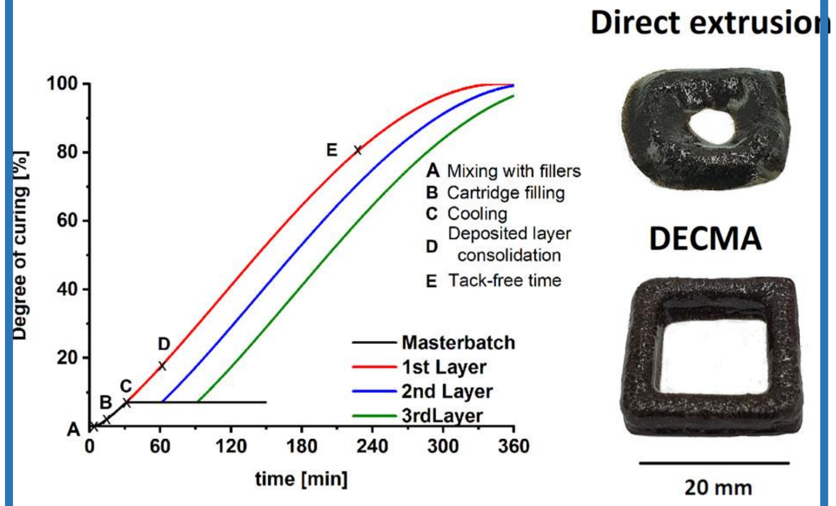
The composites oput perform those produced from neat PLA. The orientation of the composites directly influenced the mechanical properties and wettability.



Ajdary R., Kretzschmar N., Baniasadi H., Trifol J., Seppälä J.V., Partanen J., Rojas O.J., Selective Laser Sintering of Lignin-based Composites, **ACS Sustainable Chemistry & Engineering**, 9, 7, 2727–2735 (2021). DOI: 10.1021/acssuschemeng.0c07996

Delayed Extrusion of Cold Masterbatch (DECMA) technique shifts the burden in 3D printing from materials to a processing method

The use of DECMA allowed 3D printing of a highly loaded bio-based and lightweight thermoset-based resin.

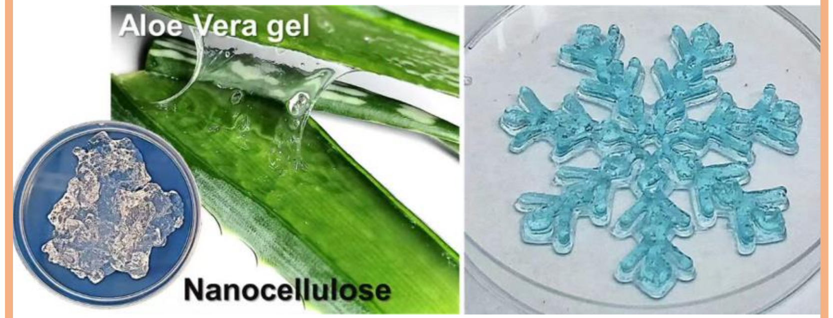


Trifol J., Jayaprakash S., Baniasadi H., Ajdary R., Kretzschmar N., Rojas O.J., Partanen J., Seppälä J.V., 3D-Printed Thermoset Biocomposites Based on Forest Residues by Delayed Extrusion of Cold Masterbatch (DECMA), **ACS Sustainable Chemistry & Engineering** 9, 13979-13987 (2021). DOI: https://doi.org/10.1021/acssuschemeng.1c05587

Rheology and 3D printing (publications 2021), Cont'd

Aloe vera/cellulose nanofibrils bio-inks for 3-D printing

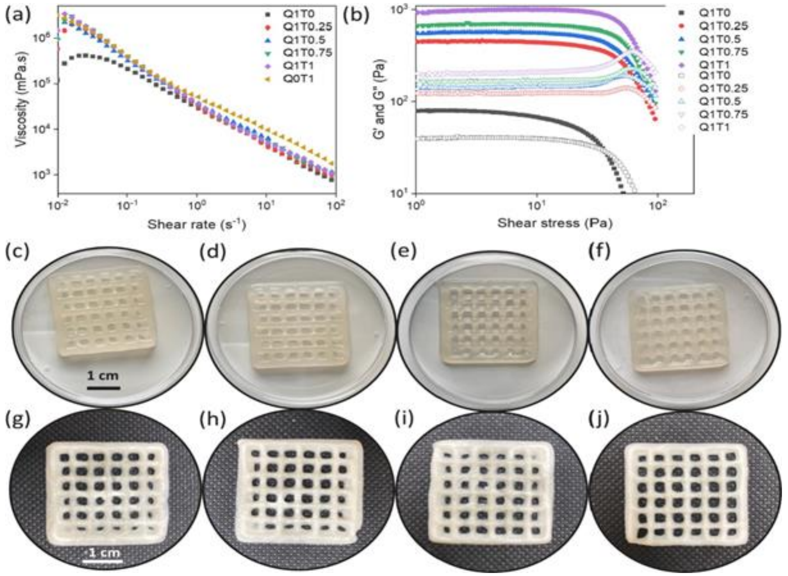
Bio-hydrogels composed of aloe vera and cellulose nanofibrils are used for direct ink writing and precise 3D printing of lattice geometry.



Baniasadi H., Ajdary R., Trifol J., Rojas O.J., Seppälä J., Direct ink writing of aloe vera/cellulose nanofibrils bio-hydrogels, **Carbohydrate Polymers,** 266, 118114 (2021). DOI: 10.1016/j.carbpol.2021.118114

Bioninks for soft-tissue engineering based on quince seed mucilage

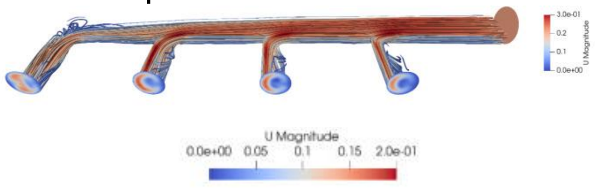
Cellulose nanofibrils enhanced quince seed mucilage effects in developing viscoelastic bio-inks. The printed 3D structures were suitable for soft tissue engineering applications.

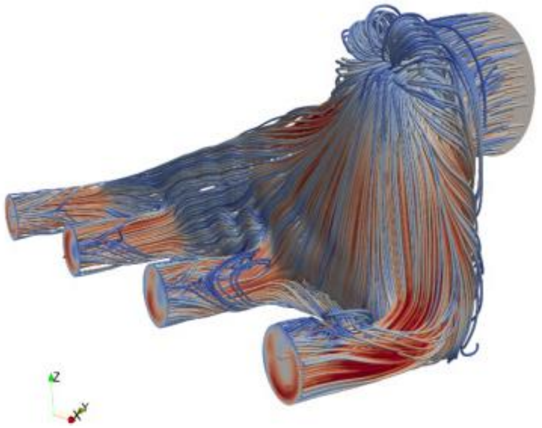


Baniasadi H., Polez R.T., Kimiaei E., Madani Z., Rojas O.J, Österberg M., Seppälä J., 3D printing and properties of cellulose nanofibrils-reinforced quince seed mucilage bio-inks, **Intl. J. Biol. Macromol**, 192, 1098-1107 (2021). DOI: 10.1016/j.ijbiomac.2021.10.078

3D printed manifolds for improved flow management in electrodialysis operation for desalination

3D-printed manifold were designed and integrated in an electrodialysis system for improved desalination.



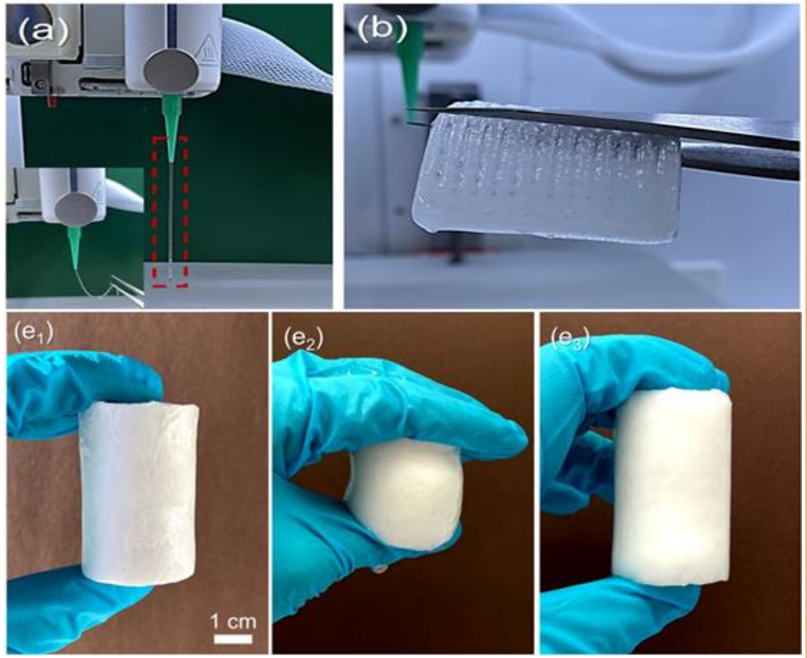


Gonzalez-Vogel A., Carrasco F.F., Rojas O.J., 3D Printed manifolds for improved flow management in electrodialysis operation for desalination, **Desalination**, 505, 114996 (2021). DOI: 10.1016/j.desal.2021.114996

Rheology and 3D printing (publications 2021), Cont'd

Superb mechanical performance and controlled drug release properties ae developed with bioinks based on nanocellulose and PVA

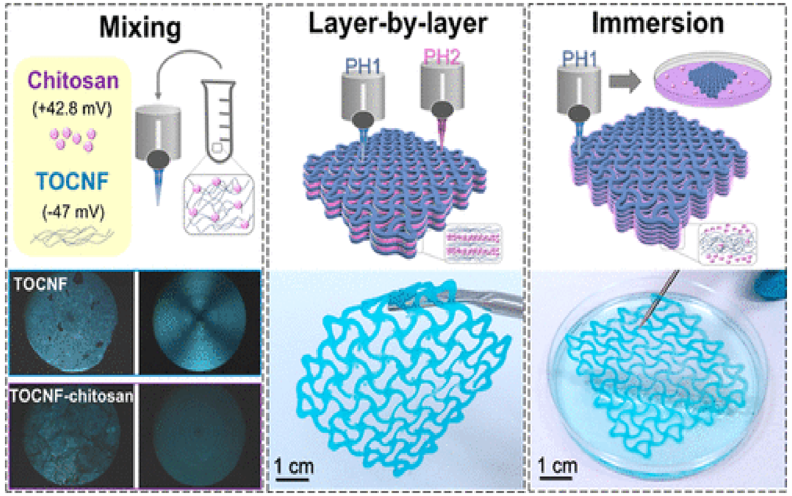
Polyvinyl alcohol/cellulose nanofibrils were used for direct ink writing to print 3D lattice structures



Baniasadi H., Madani Z., Ajdary R., Rojas O.J., Seppälä J., Ascorbic acid-loaded polyvinyl alcohol/cellulose nanofibril hydrogels as precursors for 3D printed materials, **Materials Sci. & Eng.**, 130, 112424 (2021). DOI: 10.1016/j.msec.2021.112424

Direct Ink Writing of Biocompatible Nanocellulose and Chitosan Hydrogels for Implant Mesh Matrices

The layer-by-layer mesh matrices develop via single or multi-head extrusion demonstrated an unexpectedly high wet stability arising from the electrostatic interactions of nanocellulose and chitosan.



Ajdary R., Reyes G., Kuula J., Raussi-Lehto E., Mikkola T.S., Kankuri E., Rojas O.J., Direct Ink Writing of Biocompatible Nanocellulose and Chitosan Hydrogels for Implant Mesh Matrices, ACS Polymers Au, (2022). https://doi.org/10.1021/acspolymersau.1c00045

Pickering emulgels reinforced with host-guest supramolecular inclusion complexes for high fidelity direct ink writing

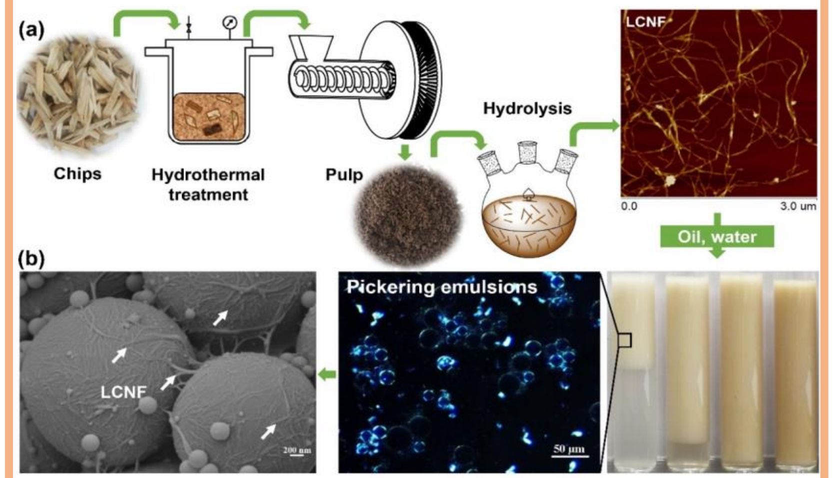
Emulgels based on α-CD/PEG stabilized by CNC were 3D printed with high resolution (up to 75 layers) with shrinkage of 9% at room temperature (7% after freeze-drying), the best reported in the literature.

Pang B., Ajdary R., Antonietti M., Rojas O.J., Filonenko S., Pickering emulgels reinforced with host guest supramolecular inclusion complexes for high fidelity direct ink writing, Materials Horizons, (2022). https://doi.org/10.1039/D1MH01741A

Multiphase systems (emulsions) (publications 2021)

Effect of residual lignin in cellulose nanofibrils enhances the interfacial stabilization of Pickering emulsions

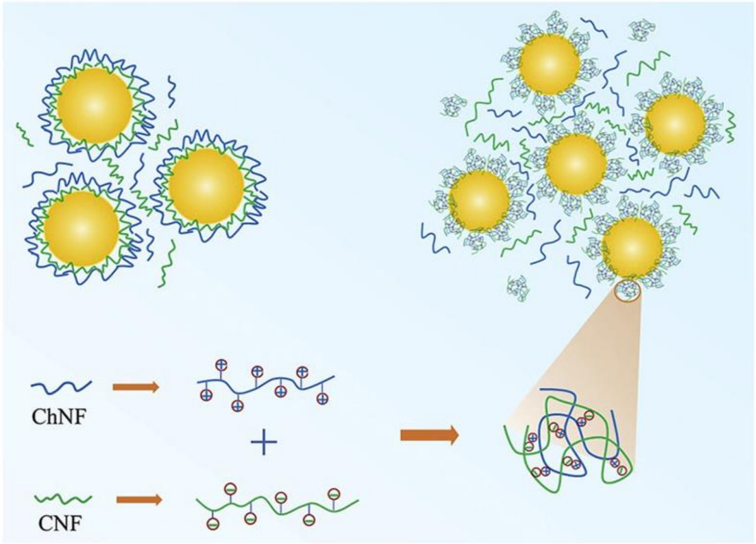
We systematically investigated the effect of residual lignin in LCNF in the stabilization of O/W Pickering emulsions.



Guo S., Li X., Kuang Y., Liao J., Li J., Mo L., He S., Zhu W., Song J., Song T., Rojas O.J., Residual Lignin in Cellulose Nanofibrils Enhances the Interfacial Stabilization of Pickering Emulsions, **Carbohydrate Polymers**, 253, 117223 (2021). DOI: [10.1016/j.carbpol.2020.117223](https://doi.org/10.1016/j.carbpol.2020.117223)

Pickering emulsions produced by combining nanochitin and nanocellulose.

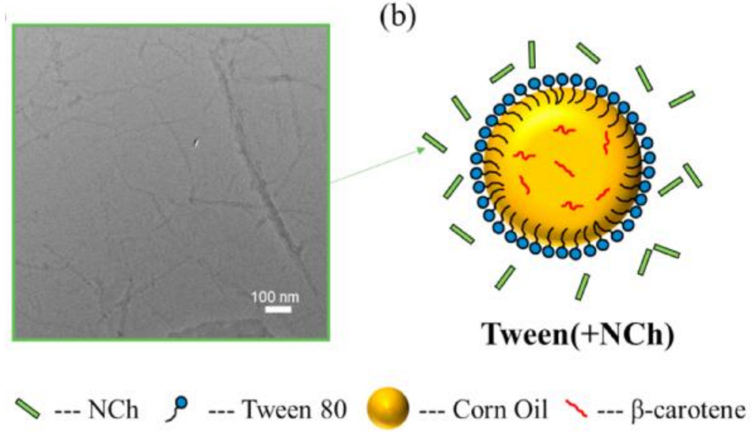
The Pickering emulsions produced show good stability against coalescence during storage.



Lv S., Zhou H., Bai L., Rojas O.J., McClements D.J., Development of food-grade Pickering emulsions stabilized by a mixture of cellulose nanofibrils and nanochitin, **Food Hydrocolloids**, 113, 106451 (2021). DOI: [10.1016/j.foodhyd.2020.106451](https://doi.org/10.1016/j.foodhyd.2020.106451)

Chitin nanocrystals reduce lipid digestion and β-carotene bioaccessibility

The impact of chitin nanocrystals on the gastrointestinal fate of a model emulsion was investigated using a standardized in vitro digestion model (INFOGEST).

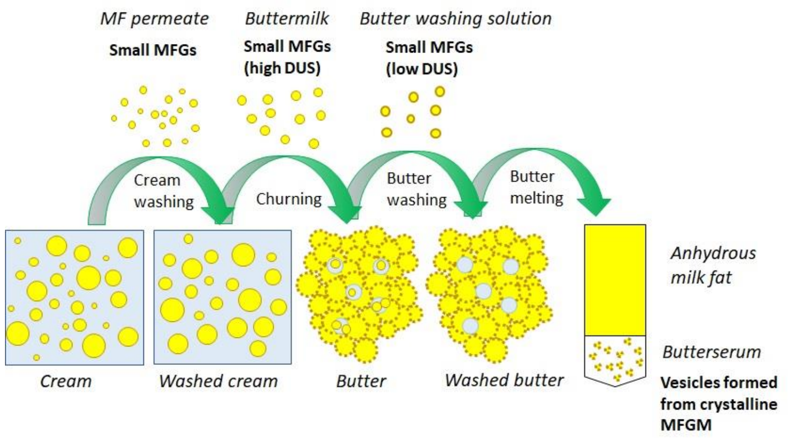


Zhou H., Dai T., Liu J., Tan Y., Bai L., Rojas O.J., McClements D.J., Chitin Nanocrystals Reduce Lipid Digestion and β-Carotene Bioaccessibility: An In-Vitro INFOGEST Gastrointestinal Study, **Food Hydrocolloids**, 113, 106494 (2021). DOI: [10.1016/j.foodhyd.2020.106494](https://doi.org/10.1016/j.foodhyd.2020.106494)

Multiphase systems, emulsions (publications 2021) (cont’d)

Milk fat globule membranes (MFGM) is studied for valuable nutrients and in bringing structure and stability in emulsified food systems

Milk fat globule membranes: size, thermal behavior, crystallization, phospholipids, buttermilk, butter serum, cream washing



Hokkanen S.P., Partanen R., Jukkola A., Frey A.D., Rojas O.J., Partitioning of the milk fat globule membrane between buttermilk and butter serum is determined by the thermal behaviour of the fat globules, **International Dairy Journal**, 112, 104863 (2021). DOI: 10.1016/j.idairyj.2020.104863

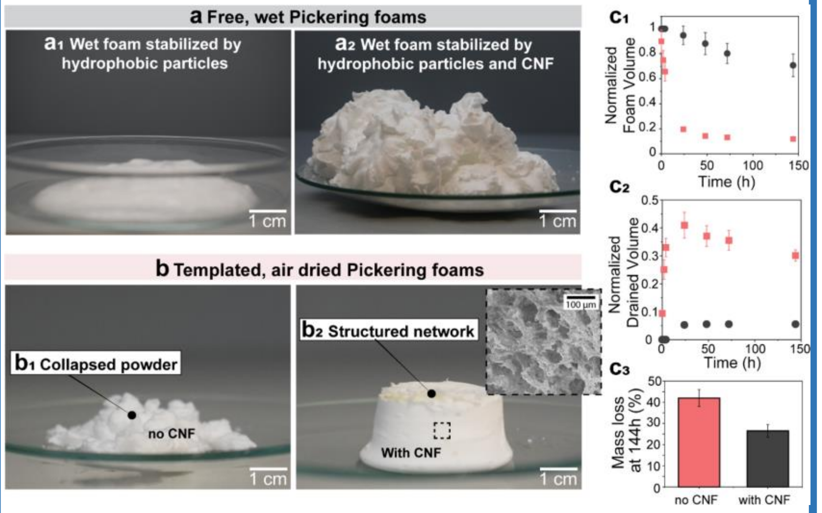
The future food nanotechnologies based on renewable nanoparticles

We consider nanocelluloses as materials that offer interesting opportunities in foodstuff, especially in the formulation of food emulsions.

Bai L., Huan S., Zhu Y., Chu G., McClements D.J., Rojas O.J., Recent Advances in Food Emulsions and Engineering Foodstuffs Using Plant-Based Nanocelluloses, **Annual Review of Food Science and Technology**, 12, 383 (2021). DOI: 10.1146/annurev-food-061920-123242

Superstable wet foams and lightweight solid composites from nanocellulose and hydrophobic particles

Using CNF + hydrophobic particles instead of surfactants yields wet foams with little or no drainage and greatly reduces coarsening, yielding materials with very fine porosity.

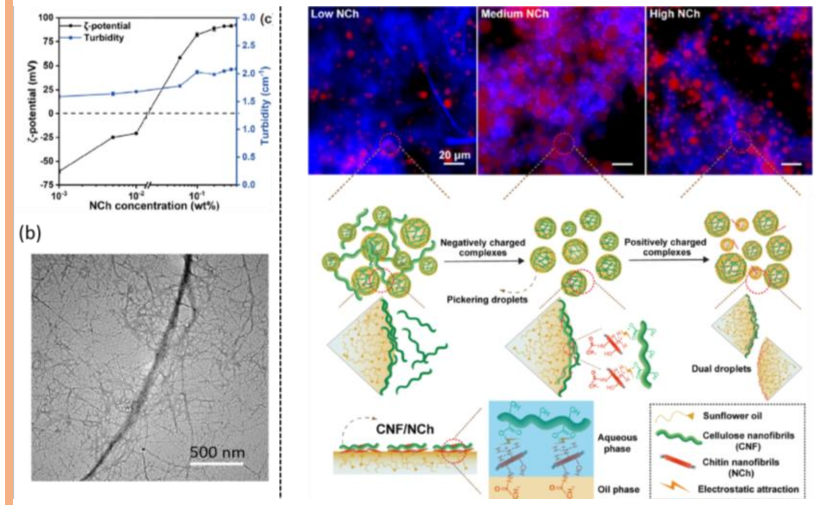


Abidnejad R., Beaumont M., Tardy B.L., Mattos B.D., Rojas O.J., Superstable Wet Foams and Lightweight Solid Composites from Nanocellulose and Hydrophobic Particles, **ACS Nano**, accepted (2021). DOI: 10.1021/acsnano.1c07084

Multiphase systems, emulsions (publications 2021) (cont'd)

Complexation of Oppositely Charged nanopolysaccharides(CNF/NCh) to facilitate adsorption and tailorable Pickering emulsion

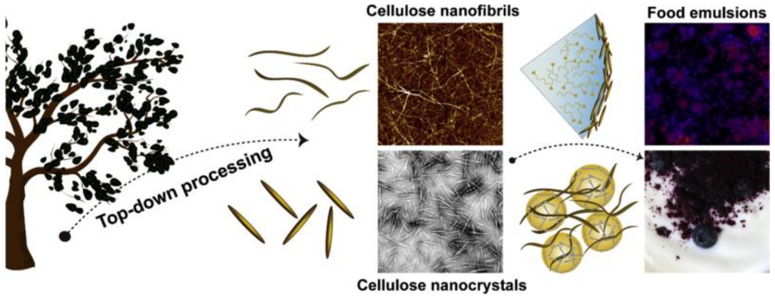
We combine CNF/NCh complexes to facilitate interfacial adsorption by *in situ* physical electrostatic complexation



Huan S., Zhu Y., Xu W., McClements D.J., Bai L., Rojas O.J., Pickering Emulsions via Interfacial Nanoparticle Complexation of Oppositely Charged Nanopolysaccharides, **ACS Applied Materials & Interfaces**, 13, 12581 (2021). DOI: 10.1021/acsami.0c22560

Recent developments in food emulsion stabilized by plant-based cellulose nanoparticles

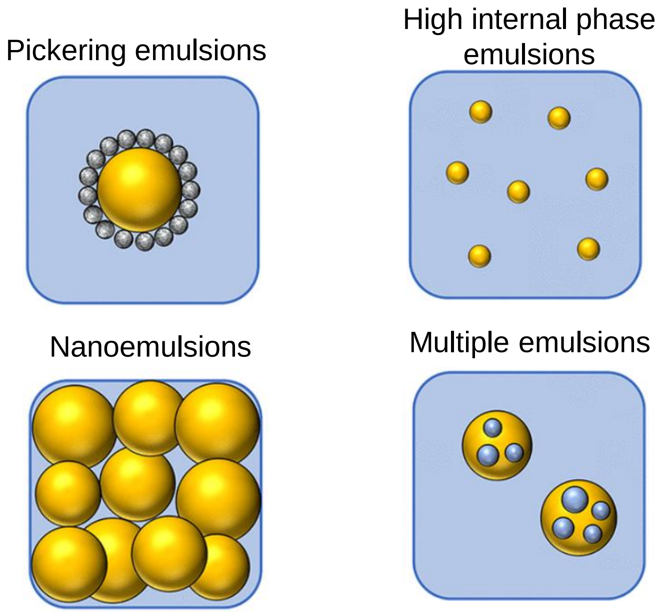
We provide an overview of recent advances in the utilization of nanocelluloses for the formation and stabilization of food emulsions, as well as the unique functions they provide.



Zhu M., Huan S., Liu S., Li Z., He M., Yang G., Liu S., McClements D.J., Rojas O.J., Bai L., Recent development in food emulsion stabilized by plant-based cellulose nanoparticles, **Current Opinion in Colloid & Interface Science**, 56, 101512 (2021). DOI: 10.1016/j.cocis.2021.101512

Recent Innovations in Emulsion Science and Technology for Food Applications

Overview of advanced emulsion technologies, including Pickering emulsions, high internal phase emulsions, nanoemulsions, and multiple emulsions.

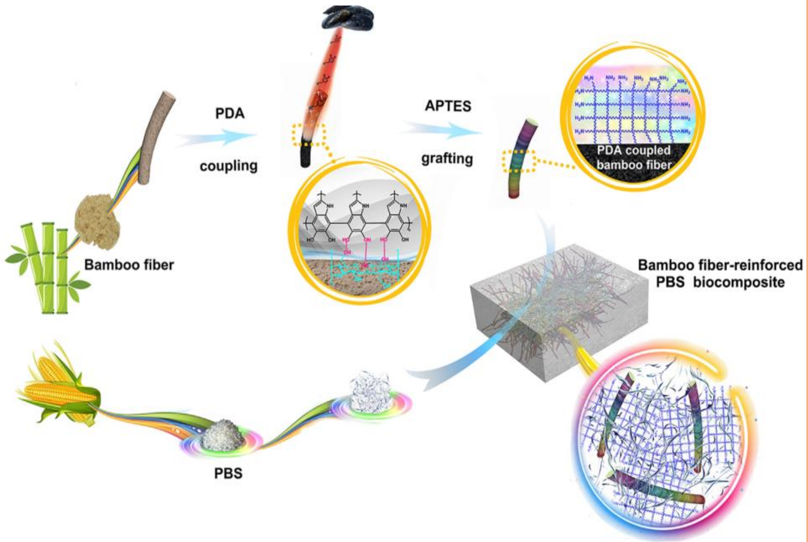


Bai L., Huan S., Rojas O.J., McClements D.J., Recent Innovations in Emulsion Science and Technology for Food Applications, **J. Agricultural & Food Chem** 69, 8944, DOI: 10.1021/acs.jafc.1c01877

Composites, hybrid materials (publications 2021)

We study the interfacial interactions of bamboo reinforced with PDA-silanol

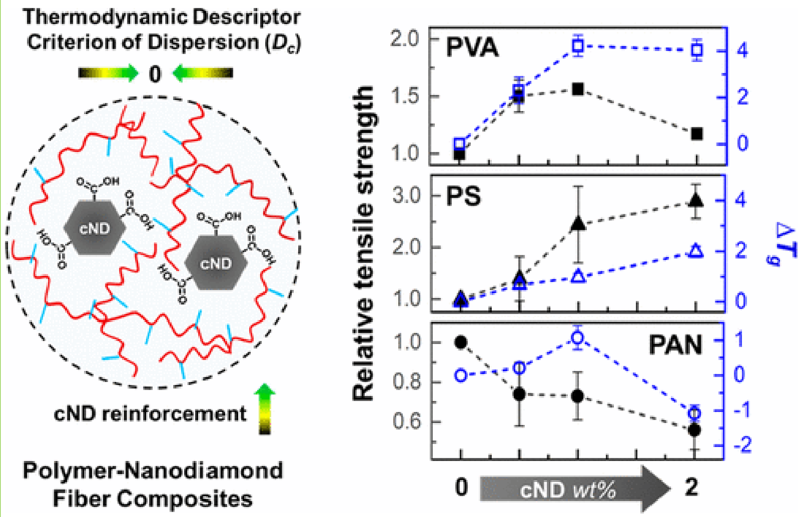
We successfully fabricated the PBS biocomposite with enhanced mechanical performance and water resistance.



Hong G., Cheng H., Zhang S., Rojas, O.J. Mussel-inspired reinforcement of a biodegradable aliphatic polyester with bamboo fibers, **Journal of Cleaner Production**, 296, 126587 (2021). DOI: 10.1016/j.jclepro.2021.126587

Thermodynamics & interfacial energy in the dispersion of nanodiamond and reinforced polymeric fibers

We investigated the thermodynamic parameters and surface energy of nanodiamond-polymer composites to explain the dispersion stability and mechanical enhancement

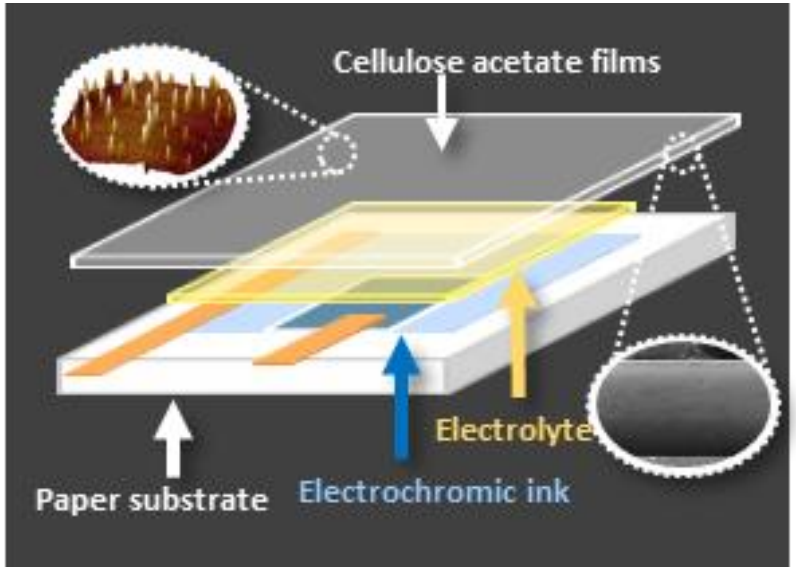


Adhikari P., Pallav J., Hsiao L., Rojas O.J., Khan, S., Interfacial Contributions in Nanodiamond-reinforced Polymeric Fibers, **The Journal of Physical Chemistry B**, 125, 36, 10312–10323 (2021). DOI: 10.1021/acs.jpcb.1c03361

Electroactive materials, energy harvesting (publications 2021)

Highly transparent and solvent resistant cellulose acetate films for electronics.

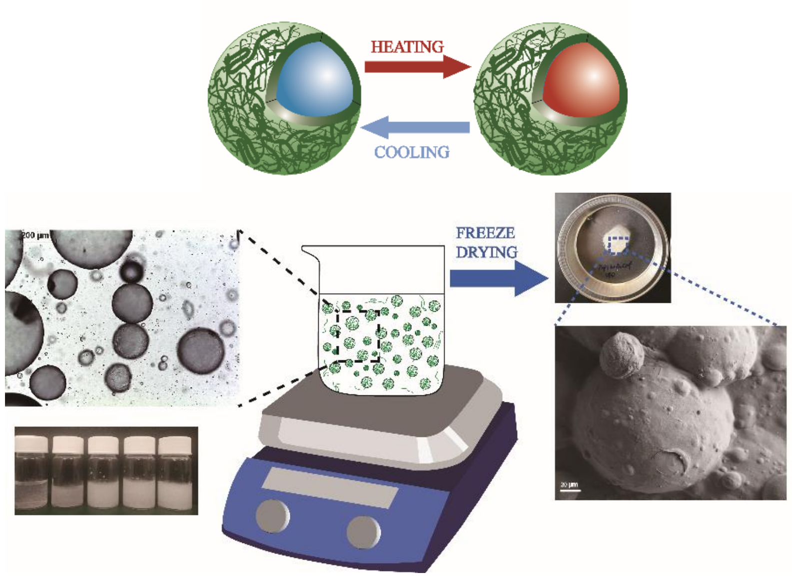
We produced substrates suitable for electrochromic devices.



Kaschuk J.J., Borghei M., Solin K., Tripathi A., Khakalo A., Leite F.A.S., Branco A., de Sousa M.C.A., Frollini E., Rojas O.J., Cross-linked and surface-modified cellulose acetate as a cover layer for paper-based electrochromic devices, **ACS Applied Polymer Materials** 3, 2393 (2021). DOI: 10.1021/acsapm.0c01252

Leakage-proof microencapsulation of phase change materials (PCM) by emulsification with acetylated CNF

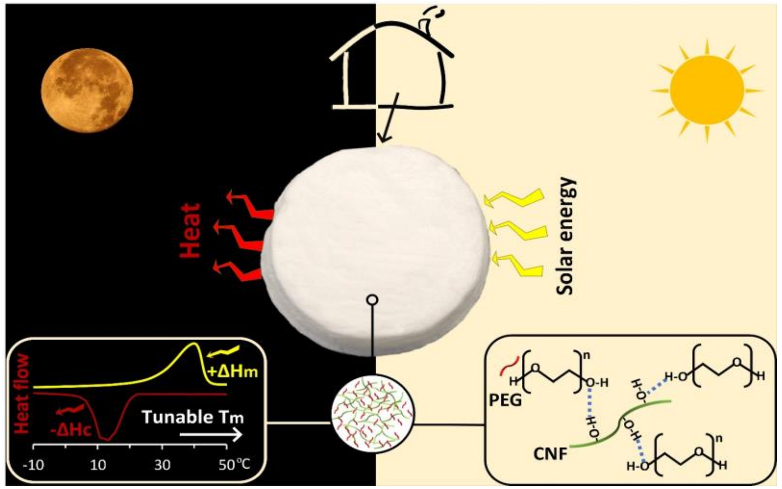
AcCNF-supported PCM forming shape- and thermally-stable systems, exhibits ideal thermal energy storage properties and durability.



Shi X., Yazdani M.R., Ajdary R., Rojas O.J., Leakage-proof microencapsulation of phase change materials by emulsification with acetylated cellulose nanofibrils, **Carbohydrate Polymers**, 254, 117430 (2021). DOI: 10.1016/j.carbpol.2020.117279

Cellulose nanofibrils for thermal energy storage and light-to-heat conversion

Lightweight, green nanohybrid structures were developed for smart-energy buildings and waste heat generating electronics for thermal energy storage and management.

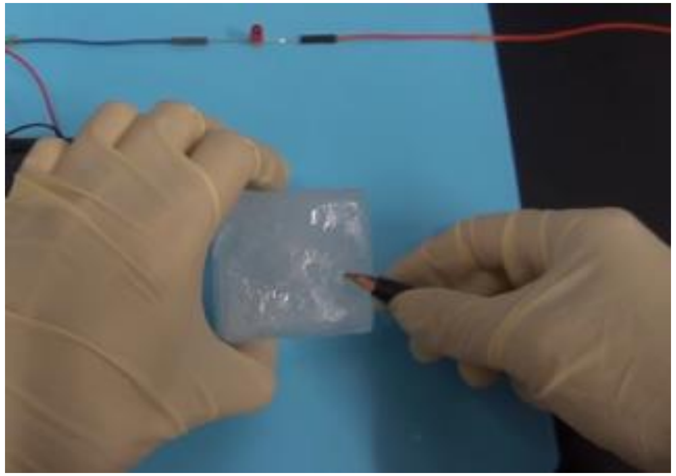


Yazdani, M., Ajdary, R., Kankkunen, A, Rojas O.J., Seppala A. Cellulose nanofibrils endow phase change polyethylene glycol with form control and solid-to-gel transition for thermal energy storage and light-to-heat conversion, **ACS Applied Nanomaterials,** 13, 6188 (2021). DOI: 10.1021/acsami.0c18623

Electroactive materials, energy harvesting (publications 2021), Cont'd

Conductive electrolyte hydrogels with tolerance to dehydration and extreme cold with double networks of PAM/CNF/LiCl

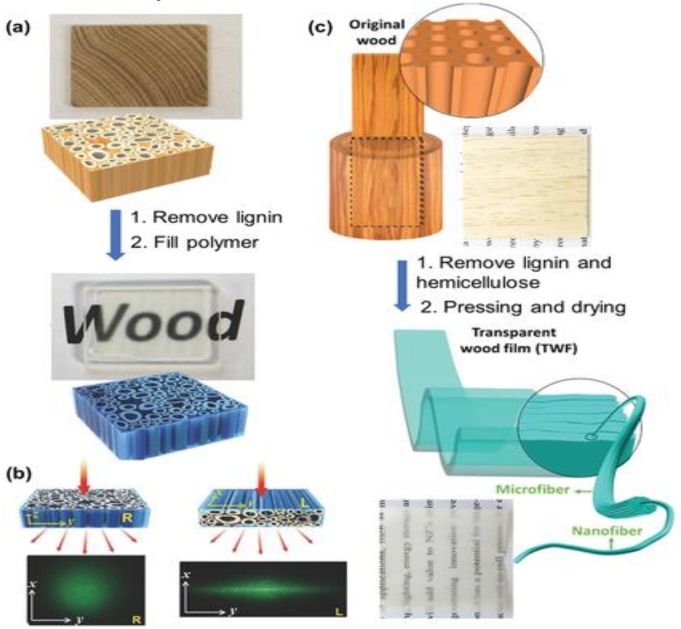
LiCl in the hydrogel provides freezing and dehydration tolerance, stretchability and conductivity



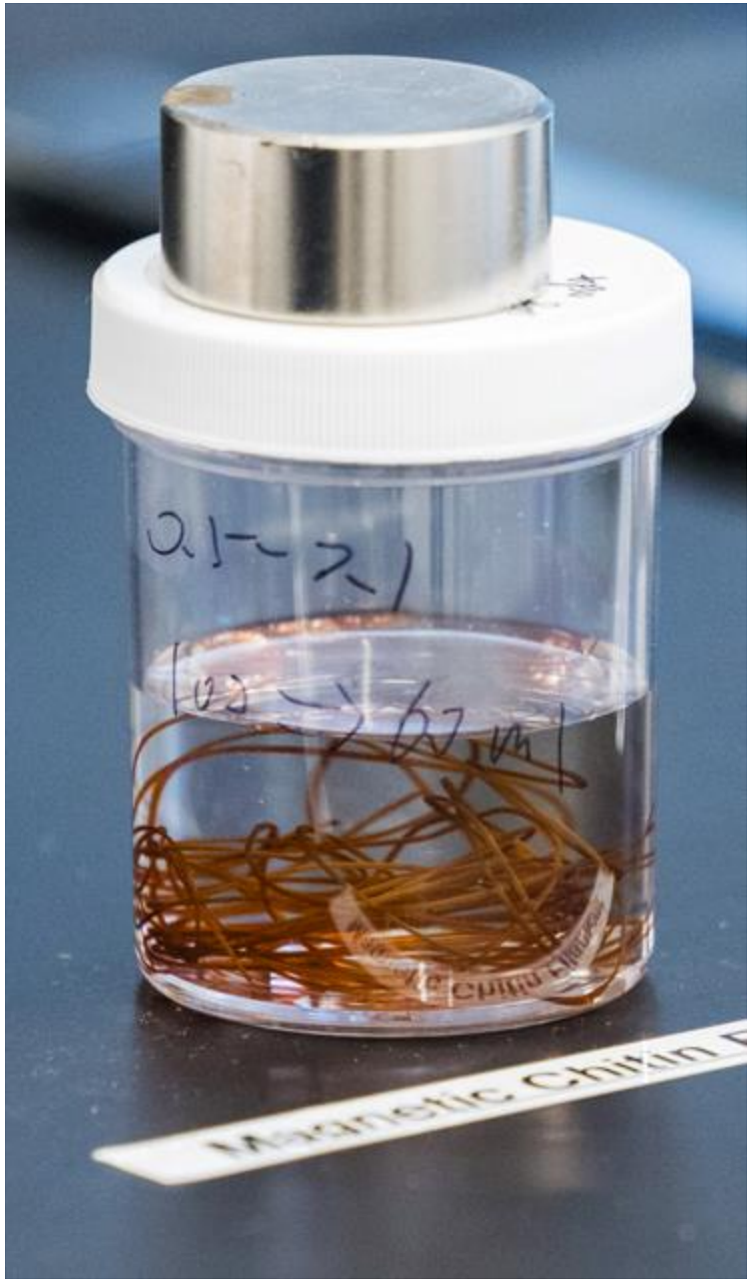
Ge W., Cao S., Yang Y., Rojas O.J.**,** Wang X., Nanocellulose/LiCl Systems Enable Conductive and Stretchable Electrolyte Hydrogels with Tolerance to Dehydration and Extreme Cold Conditions, **Chemical Engineering Journal**, 408, 127306 (2021). DOI: 10.1016/j.cej.2020.127306

Light management materials with customized optical properties designed from plant-based structures

We reviewed recent developments related to the use of bio-derived lignocellulosic materials for optical functionalization



Kaschuk J.J., Haj Y.A., Rojas O.J., Miettunen K., Abitbol T., Vapaavuori J., Plant-based Structures as an Opportunity to Engineer Optical Functions in next-generation Light Management, **Advanced Materials**, 2104473 (2021). DOI: 10.1002/adma.202104473

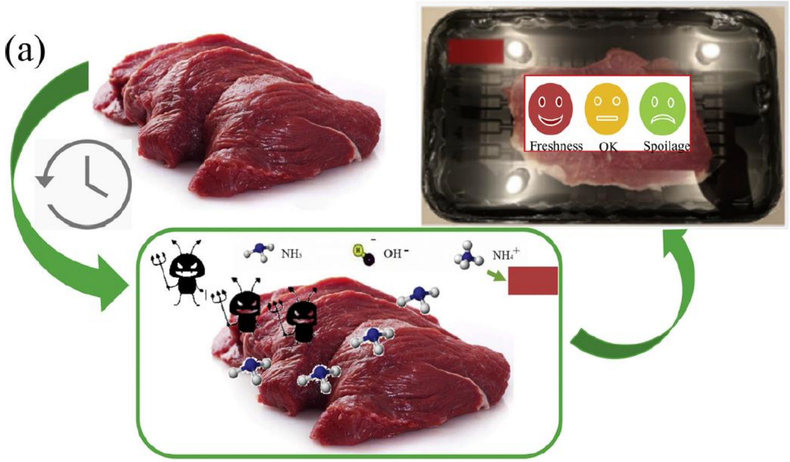


Sensing and actuation (publications 2021)

Use of pH and fluorescent dyes for optical and colorimetric sensors to track seafood freshness

The review discusses current optical and colorimetric methods to monitor seafood freshness, pointing towards polymer-based sensors to improve efficiency and accuracy.

(a)



Ma et al. Recent Developments in Colorimetric and Optical Indicators Stimulated by Volatile Base Nitrogen to Monitor Seafood Freshness. **Food Packaging and Shelf Life**, *28*, 100634 (2021).
DOI: 10.1016/j.fpsl.2021.100634