



2017

BiCMat
Bio-based Colloids & Materials

2017 report of the Bio-based Colloids and Materials group, BiCMat
Department of Bioproducts and Biosystems
School of Chemical Engineering
Aalto University



2017 Summary

(click on tags to navigate)

Intro

Group chart for next year (2018)

Highlight of 2017

New members (8) and PhD students who defended (5)

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Invited talks (23)

Papers published in peer-review journals (46)

Patents (3)

Talks in conferences (> 50)

BiCMat

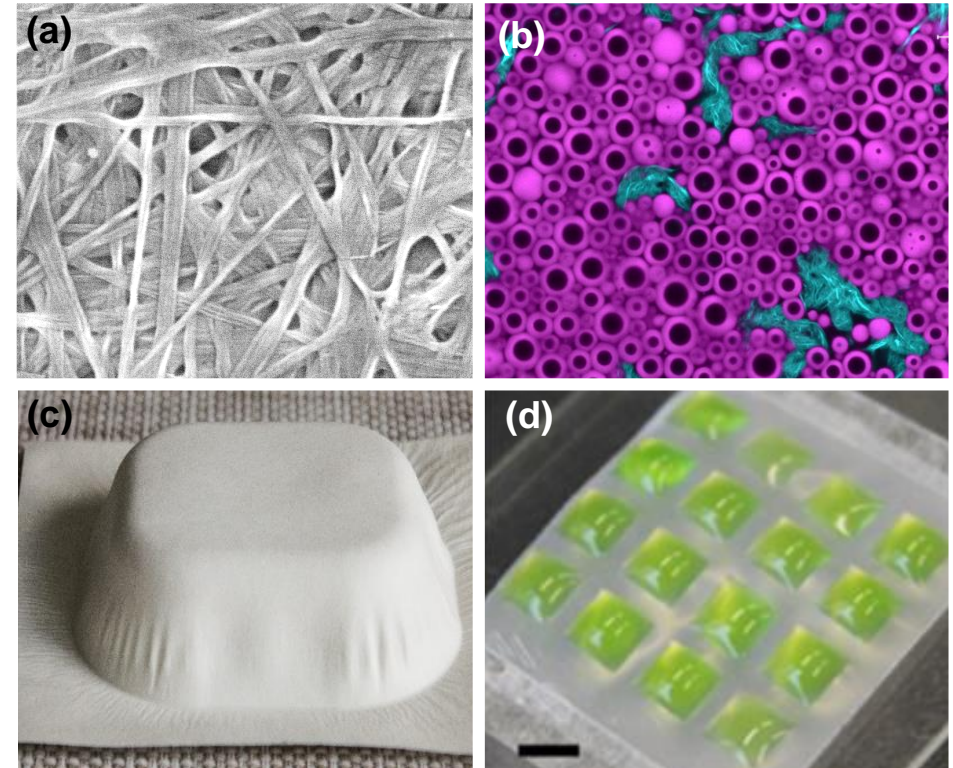
Bio-based Colloids & Materials

Research Strategy

Our core activities involve biobased materials at different size scales, mainly those displaying large interfacial areas such as fibers (micro/nano fibers), fiber networks, particles, colloids and multiphase systems.

Focus areas

- Nano/microfibrillar ligno-cellulose, nanocrystals & bacterial cellulose. Bio-colloids.
- Multiphase systems: dispersions, foams, gels, membranes and aerogels.
- Stimuli-responsive materials.
- Proteins, enzymes and (bio)sensing.



(a) Bacterial cellulose for bio-separations;
(b) double emulsions with CNF;
(c) protein application for super-stretchable paper in thermoforming;
(d) super-hydrophobic patterning of CNF films via photo-click modification.



Proteins, fat colloids, BC and other biopolymers



Robertus Nugroho, PhD



Janika Lehtonen

Protein and fat colloids



Liang Liu

Interfacial adhesion/composites

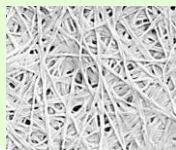


Sanna Hokkanen, PhD



Annamari Jukkola

Bacterial cellulose, chitin, alginate & bioactive systems

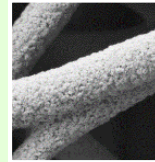


Virtanen Riikka

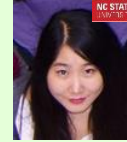
Advanced Lignocellulosics



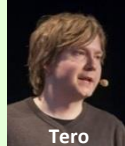
Katariina Solin



Photocatalytic activity, energy harvesting



Soo Ah Jin



Tero Kämäräinen



Emily Facchine



Joice Kaschuk



Imani Monireh
Nov'17-Mar'17



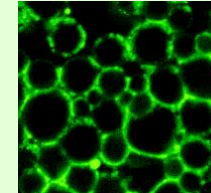
Maryam Borghei, PhD

Hydrogels, Aerogels, Foams & Emulsions

Lignocellulose-stabilized emulsions and aerogels



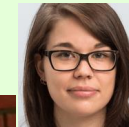
Siqi Huan, PhD



Foam forming



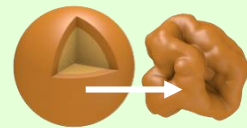
Long Bai, PhD



Annika Ketola



Okada Keisuke



Structural color

Particles and suprastructures



Haiming Li, PhD
Dec'17-Nov'18



Blaise Tardy, PhD



Konrad Klockars



Noora Yau



Luiz Greca

Filaments, barriers

Wet- and hydrogel spinning



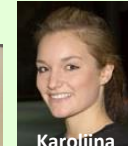
Ling Wang



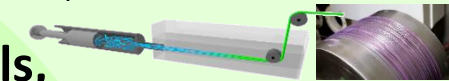
Anurodh Tripathi



Meri Lundahl



Karoliina Helanto



Coatings



Rafael Grande
April'18-Feb'19

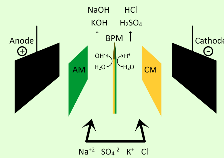


Guillermo Reyes, Ph.D.

Separation



Alvaro Gonzalez

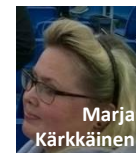


Electro-dialysis in water purification



Support staff:

Kati Miettunen, PhD
Coordinator Mat. Platform



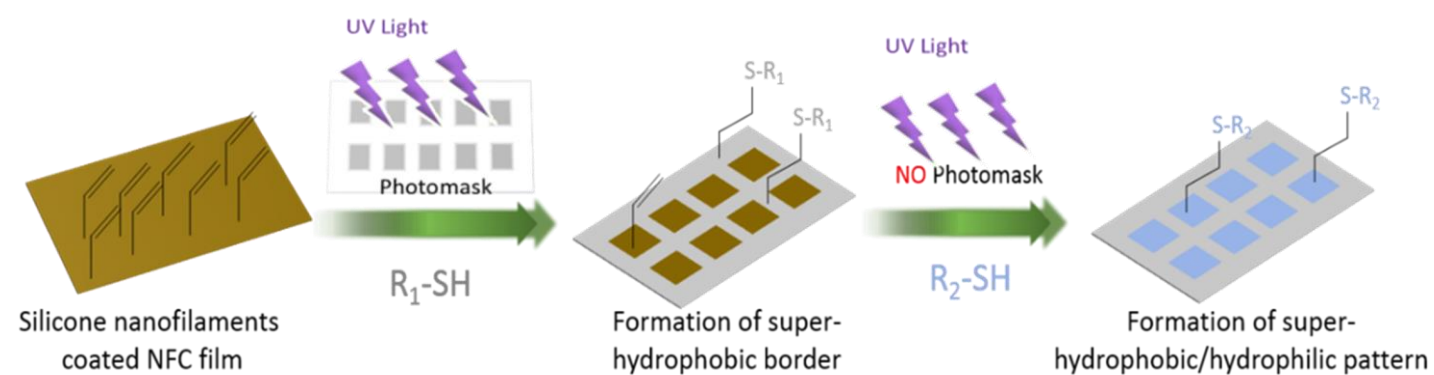
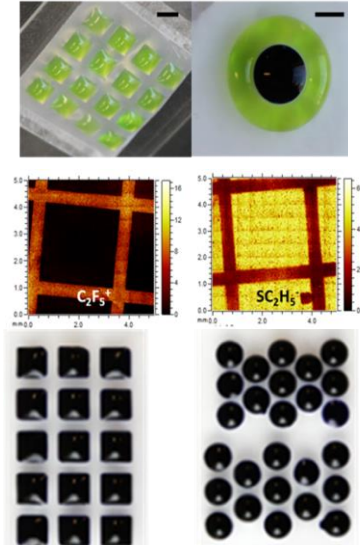
Marja Kärkkäinen



Leena-Sisko Johansson, PhD

2017 highlight

Biobased Colloids and Materials (BiCMat) group

Topic	Patterning of nanocellulose-based surfaces
What?	Novel approaches were developed for making films of nanocellulose super-hydrophilic, super-slipery and superhydrophobic
How?	<p>Thio-ene and thiol-yne, UV-activated coupling was developed.</p>  <p>Silicone nanofilaments coated NFC film</p> <p>UV Light Photomask R_1-SH</p> <p>Formation of super-hydrophobic border $S-R_1$</p> <p>UV Light NO Photomask R_2-SH</p> <p>Formation of super-hydrophobic/hydrophilic pattern $S-R_2$</p> 
Possible application	Flexible electronics, microfluidics, sensing, etc.

New members 2017 (8)

1. Klockars Konrad (M.S.)
2. Riikka Virtanen (M.S.)
3. Guillermo Reyes (Postdoc)
4. Robertus Nugroho (Postdoc)
5. Sanna Virtanen (Postdoc)
6. Siqi Huan (Postdoc)
7. Long Bai (Postdoc)
8. Kati Miettunen (Postdoc, MP platform manager)



Supervised PhD students who graduated in 2017 (5)

1. Jiaqi Guo (1)
2. Maija Vuoriluoto (2)
3. Alexey Khalalo (3)
4. Fatima Vargas Gonzalez (UdC, Spain)
5. Miika Nikinmaa (BiCMat, US)





Visiting Scholars Hosted by the Group in 2017 (12)

1. Prof. Guihua Yang, Qilu University, China, Nanocomposites, 3 months.
2. Prof. Haiming Li, Dalian Polytechnic University, Nanocellulose in 3D printing, 1 year
3. Dr. Marco Beaumont, University of Natural Resources and Life Sciences (BOKU), Vienna, Austria, Cellulose Nanoparticles, 2 months
4. Dr. Oriol Cusola, UPC Spain, Lignin Nanoparticle Coatings, 6 months
5. Dr. Kyujeong, Sim, Seoul National University, Capacitive separation, 6 months
6. Bruno Mattos, Ph.D. Student, Materials Science and Engineering, Universidade Federal do Paraná, Curitiba, Brazil, Suracoloids, 6 months.
7. Joice Kaschuk, Ph.D. student, Institute of Chemistry, University of São Paulo, São Carlos, Brazil, Solar cells, 6 months
8. Liang Liu, Ph.D. student, Key Laboratory of Forest Genetics and Biotechnology, Nanjing Forestry University, Nanjing, China, chitin nanofibers, 1 year



Visiting Scholars Hosted by the Group in 2017 (12), Contd

9. Okada Keisuke, Visiting Researcher from Arakawa Chemical, Osaka, nanocellulose in Papermaking, Japan, 2 years
10. Anurodh Tripathi, Ph.D. student, North Carolina State University, Raleigh, NC, USA, Acetylated nanostructures, 6 months
11. Imani Monireh, Ph.D. student, College of Wood and Paper Engineering, Gorgan University of Agricultural Sciences and Natural Resources, Iran, Printing, 6 months
12. Diego Gómez-Maldonado, M.S. student, Universidad Autónoma Metropolitana – Cuajimalpa, México, Quartz microgravimetry, 2 months

International Seminars organized in Aalto (1)

Workshop on Colloids and Surfaces, RISE/KTH (SWE)- Carnegie Mellon (USA) - Deakin Univ (AUS) - Aalto (FIN), September 28, 2017, 9AM-6PM. External Speakers included: Ludovic Dumeénil, Institute for Frontier Materials, Deakin University, Australia; Illia Dobryden, Royal Institute of Technology, Sweden; Agne Swerin, RISE and KTH, Sweden; Tiffany Abitbol, RISE, Sweden; Robert D. Tilton, Center for Complex Fluids Engineering, Carnegie Mellon, USA



Seminars and talks hosted in 2017 (4)

1. Prof. Gregory Parsons, Department of Chemical and Biomolecular Engineering, NC State, January 12, 2017
2. Dr. Ewellyn Capanema, RISE, Sweden, June 12, 2017
3. Prof. Jose Moran-Mirabal, Department of Chemistry and Chemical Biology, School of Biomedical Engineering, McMaster University, October 31, 2017
4. Pablo Zavattieri, Lyles School of Civil Engineering, Purdue University, May 15, 2017

Awards and personnel highlights 2017 (10)

1. Wenchao Xiang, Ling Wang and Alexey Khakalo: Selected to participate and present in the Wallenberg Prize workshop, Stockholm, Sweden.
2. Meri Lundhal review article chosen as “Editor’s Choice” in ACS Ind. Eng. Chem. Res
3. Meri Lundhal: Best Poster, International Conference on Nanotechnology for Renewable Materials, TappiNano, Montreal, Canada, June 5-8, 2017
4. Meri Lundhal: KAUTE Foundation
5. Orlando Rojas most prolific (top 10) authors in the last 5 years in the journal **Biomacromolecules**
6. Maija Vuoriluoto: Niilo Ryti Award from The Forest Products Engineers’ Association (2017)
7. Maija Vuoriluoto: Best Department paper (2017)
8. Maryam Borghei: Research Action of the year 2017



Awards and personnel highlights 2017 (Cont)

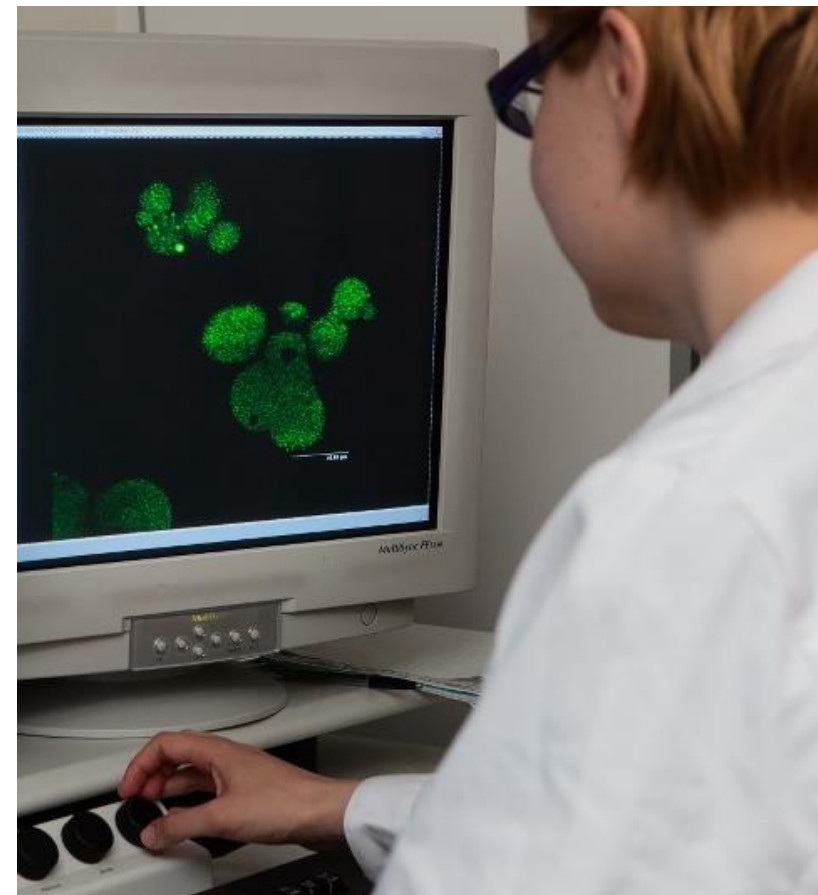
9. Orlando Rojas: Member of the Finnish Academy of Science and Letters
10. Orlando Rojas: Auburn University Weaver Lecturer of 2017



Projects Awarded 2017

Projects awarded:

- Inspire, EU Horizon 2020, PILOTS-05-2017, 1.1.2017-2020
- 3D-Biomat, 3D-manufacturing of novel biomaterials, Academy of Finland, 1.1.2017-31.12.2020
- Nordforsk, High-value materials from lignin, 1.1.2017-31.12.2019
- LICOS: Seed funding from Aalto's Living+ platform



Committee membership, Editorial appointments in 2017 (10)

1. Aalto University Materials Platform, chair
2. Tappi Research Committee Nanotechnology of Renewable Materials, chair
3. Serra Húnter Programme (SHP) fostered by the Government of Catalonia and the Catalan public universities for Appointment of Assistant Professor in UPC-Terrassa
4. Aalto Tenure Committee, member
5. Nature's editorial Board of **Scientific Reports**
6. **Editor in Chief of Journal** of Dispersion science and Technology
7. Selection Committee of Aalto Provost, Chair
8. PI Bioeconomy Flagship
9. Valios-Aalto program, Steering Committee, member
10. Kemira-Aalto, Steering Committee, member

Opponent duties (1)

Hui Huang, “Electrochemical Application and AFM Characterization of Nanocomposites: Focus on Interphase Properties”, School of Chemical Science and Engineering, Department of Chemistry, Division of Surface and Corrosion Science, Royal Institute of Technology, Stockholm, Sweden, March 10, 2017

Evaluation of Promotion and Tenure (3)

1. Mohamed Naceur BELGACEM for Research Chair, Directeur de Grenoble INP-Pagora, October 2017
2. Johan Foster, Materials Science & Engineering Department , Virginia Tech, associate professor with Tenure (2017)
3. Lim Jit Kang, Colloid and Interface Sciences , to Full Professor, Universiti Sains Malaysia, Penang, Malaysia (2017)





Conference Organization (member of organizing or international committee) (7)

1. **4th International Cellulose Conference, Organized by The Cellulose Society of Japan (ICC 2017)**, Fukuoka, Japan, Oct. 18-20, 2017.
2. **International Conference on Nanotechnology for Renewable Materials, TappiNano**, Montreal, Canada, June 5-8, 2017
3. **253rd ACS National Meeting**, San Francisco, California, April 2-6, 2017 (organized two symposia)
4. International Conference «Renewable Resources: Chemistry Technology, Medicine» (RR 2017), Saint Petersburg, Russia, September 18-22, 2017
5. **19th International Symposium on Wood, Fibre and Pulping Chemistry, ISWFPC 2017**, Porto Seguro, Bahia – Brazil, August 30 – September 01, 2017
6. **3rd International Conference on Natural Fibers** (Advanced Materials for a Greener World), Braga, Portugal, June 21-23, 2017
7. **1st International Symposium on Nanocellulosic Materials**, Hangzhou, Zhejiang, China, May 20-22, 2017.

Invited talks in Universities and Conferences in 2017 (23)

1. Stora Enso, (Ligno)nanocellulose and material developments, January 18, 2017
2. APS March Meeting 2017, Adhikari P., Burns N., Tripathi A., Rojas O.J., Raghavan S., Khan S., Self-Supporting Nanodiamond Gels: Elucidating Colloidal Interactions Through Rheology March 13–17, 2017; New Orleans, Louisiana
3. Department of Chemical and Biomolecular Engineering, NC State, Development of Advanced Lignocellulosic Bioproducts templated from Multiphase Systems, Raleigh, NC, USA, March 28, 2017.
4. AATCC 2017 (Association of Textile, Apparel and Materials Professionals), Lundahl M., Klar V., Wang L., Ago M., Rojas O.J. Wet Spinning of Cellulose Nanofibrils, Wilmington, NC, USA, March 28-30, 2017
5. Auburn University, Weaver Lecture, Development of Advanced Lignocellulosic Bioproducts templated from Multiphase Systems, Auburn, AL, March 30, 2017.
6. Bionavis Workshop, Some of my experiences with lignocellulose, Helsinki, April 28, 2017
7. The Royal Society, New Horizons for nanocellulose Technology, Development of Advanced Lignocellulosic Bioproducts templated from Multiphase Systems, London, UK, May 2-3, 2017
8. 1st International Symposium on Nanocellulosic Materials (PLENARY TALK), Multiphase Systems Stabilized by Cellulose Nanofibrils and Nanocrystals: Colloidal behavior, Phase Transitions and Applications, Hangzhou, Zhejiang, China, May 20-22, 2017.
9. Xiang W., Li S., Filpponen I., Saharinen E., Salminen K., Lappalainen T., Rojas O.J., Effect of amphiphilic compounds in foam forming, PaperCon, May 30, 2017.
10. Department of Chemical Engineering, University of Toronto, Development of Advanced Lignocellulosic Bioproducts, Toronto, Canada, June 9, 2017
11. 3rd International Conference on Natural Fibers (Advanced Materials for a Greener World), Lundahl M., Ville Klar V., Wang L., Ago M., Rojas O.J., Gel Spinning of Cellulose Nanostructures, Braga, Portugal, June 21-23, 2017

13. Saarland University, Dept. of Mechatronics Engineering, Dept. of Materials Science & Engineering, Saarbrücken, Germany, Development of Advanced Lignocellulosic Bioproducts, July 21, 2017
14. Aalto Sustainability Hub, Our contribution to sustainability by the use of wood: from food to energy harvesting, Aalto University, September 27, 2017.
15. ISWFPC, 19th International Symposium on Wood, Fibre and Pulping Chemistry, 3D-structured Cellulose Biofilms and Applications, Porto Seguro, Bahia, Brazil, August 30-September 01, 2017.
16. RISE-INDA Conference, M. Nikinmaa, K. Salminen, B. Pourdeyhimi, O.J. Rojas, Recent trends in wetlaying with complex fluids, Raleigh, NC, September 12-14, 2017.
17. International Conference «Renewable Resources: Chemistry Technology, Medicine» (RR 2017), Nanocelluloses in Detection, Affinity Separation and Bioactive Systems, Saint Petersburg State Forest Technical University, Institutskiy per., Saint Petersburg, Russia, September 18-22, 2017
18. 10th World Congress of Chemical Engineering, Next Generation Textile Filaments Based on Nanocellulose: Spinning Bifunctional Nanofibrils and Achieving Wet Strength, Barcelona, Spain, October 1-5, 2017.
19. European-Japanese Workshop on Cellulose and Functional Polysaccharides 2017, Kyushu University, Behavior of nanocelluloses at interfaces for bioactivity, Fukuoka, Japan, October 21, 2017
20. IOP-Finland Chapter, and RSC-Finland Local Section, Seminar of Biotechnology and Biosensors, Lignocellulosic Sensors in Material Development and Bio-interphases, Turku, Finland, October 27, 2017
21. Universidad de Bio-Bio, Nanocelluloses to build strong, light-weight materials, Concepcion, Chile, November 15, 2017
22. Universidad de Concepcion, Lignina and Lignocellulose en el desarrollo de nuevos materiales, Concepcion, Chile, November 22, 2017
23. Workshop on Second Generation Bioethanol and Biorefining 2017, Brazilian Bioethanol Science and Technology Laboratory, Development of Advanced Lignocellulosic Bioproducts, Campinas, November 29th and 30th, 2017



Peer-reviewed journal publications 2017 (46) – Papers with IF>9 are highlighted in red

1. Guo J., Filpponen I., Johansson L-S., Heißler S., Li L., Levkin P., **Rojas O.J.** Micro-patterns on nanocellulose films and paper by photo-induced thiol-yne click coupling: a facile method toward wetting with spatial resolution, **Cellulose**, DOI: [10.1007/s10570-017-1593-2](https://doi.org/10.1007/s10570-017-1593-2)
2. Jukkola A., Partanen R., **Rojas O.J.**, Heino A., Effect of heat treatment and pH on the efficiency of micro-diafiltration for the separation of native fat globules from cream in butter production, **Journal of Membrane Science**, 548, 99-107 (2018). DOI: [10.1016/j.memsci.2017.11.012](https://doi.org/10.1016/j.memsci.2017.11.012)
3. Huan S, Yokota S., Bai L., Ago Mariko, Borghei M., Kondo T., **Rojas O.J.**, Formulation and composition effects in phase transitions of emulsions co-stabilized by cellulose nanofibrils and an ionic surfactant, **Biomacromolecules** DOI: [10.1021/acs.biomac.7b01452](https://doi.org/10.1021/acs.biomac.7b01452)
4. **Borghei M., Laocharoen N., Kibena-Poldsepp E., Johansson L.S., Campbell J., Kauppinen E., Tammeveski K., Rojas O.J., Porous N,P-doped carbon from coconut shells with high electrocatalytic activity for oxygen reduction: Alternative to Pt-C for alkaline fuel cells, **Applied Catalysis B - Environmental** 204, 394-402 (2017). DOI: [10.1016/j.apcatb.2016.11.029](https://doi.org/10.1016/j.apcatb.2016.11.029)**
5. Zhang Y., **Rojas O.J.**, Immunosensors for C-Reactive Protein Based on Ultrathin Films of Carboxylated Cellulose Nanofibrils, **Biomacromolecules** 18, 526–534 (2017). DOI: [10.1021/acs.biomac.6b01681](https://doi.org/10.1021/acs.biomac.6b01681)
6. Lundahl M.J., Klar V., Wang L., Ago M., **Rojas O.J.**, Spinning of Cellulose Nanofibrils into Filaments: A Review, **Industrial & Engineering Chemistry Research** 56, 8–19 (2017). DOI: [10.1021/acs.iecr.6b04010](https://doi.org/10.1021/acs.iecr.6b04010) (ACS Editor's choice)
7. Abdelgawad A.M., El-Naggar M.E., Eisa W.H., **Rojas O.J.**, Clean and high-throughput production of silver nanoparticles mediated by soy protein *via* solid state synthesis, **Journal of Cleaner Production** 144, 501-510 (2017). DOI: [10.1016/j.jclepro.2016.12.122](https://doi.org/10.1016/j.jclepro.2016.12.122)
8. Abdelgawad A.M., El-Naggar M.E., Hudson S.M., **Rojas O.J.**, Fabrication and characterization of bactericidal thiol-chitosan and chitosan iodoacetamide nanofibers, **International Journal of Biological Macromolecules** 94, 96-105 (2017) DOI: [10.1016/j.ijbiomac.2016.07.061](https://doi.org/10.1016/j.ijbiomac.2016.07.061)
9. Mattos B.D., **Rojas O.J.**, Magalhães W.L.E., Biogenic silica nanoparticles loaded with neem bark extract as green, slow-release biocide, **Journal of Cleaner Production** 142, 4206-4213 (2017) DOI: [10.1016/j.jclepro.2016.11.183](https://doi.org/10.1016/j.jclepro.2016.11.183)
10. Douglass E.F., Avci H., Boy R., **Rojas O.J.**, Kotek R., A Review of Cellulose and Cellulose Blends for Preparation of Bio-derived and Conventional Membranes, Nanostructured Thin Films, and Composites, **Polymer Reviews** 1-62 (2017) DOI: [10.1080/15583724.2016.1269124](https://doi.org/10.1080/15583724.2016.1269124)
11. Sipponen M.H., **Rojas O.J.**, Pihlajaniemi V., Lintinen K., Österberg M., Calcium Chelation of Lignin from Pulping Spent Liquor for Water-Resistant Slow-Release Urea Fertilizer Systems, **ACS Sustainable Chemistry & Engineering** 5, 1054-1061 (2017). DOI: [10.1021/acssuschemeng.6b02348](https://doi.org/10.1021/acssuschemeng.6b02348)
12. Tripathi A., Ferrer A., Khan S.A., **Rojas O.J.** (2017) Morphological and thermo-chemical changes upon autohydrolysis and microemulsion treatments of coir and Empty Fruit Bunch (EFB) residual biomass to isolate lignin-rich micro and nano fibrillar cellulose (MNFC), **ACS Sustainable Chemistry Engineering** 5, 2483–2492 (2017) DOI: [10.1021/acssuschemeng.6b02838](https://doi.org/10.1021/acssuschemeng.6b02838)

13. Hubbe M.A., Ferrer A., Tyagi P., Yin Y., Salas C., Pal L., **Rojas O.J.** Nanocellulose in thin films, coatings, and plies for packaging applications: A review, **Bioresources** 12, [2143-2233](#) (2017). DOI: [link](#)
14. Khakalo A., Vishtal A., Elias V., Filpponen I., **Rojas O.J.** (2017) Mechanically-induced dimensional extensibility of fibers towards tough fiber networks, **Cellulose** 24, 191-205 (2017). DOI: [10.1007/s10570-016-1102-z](#)
15. Guo J., Filpponen I., Johansson L-S., Mohammadi P., Latikka M., Linder M.B., Ras R.H.A., **Rojas O.J.**, Complexes of Magnetic Nanoparticles with Cellulose Nanocrystals as Regenerable, Highly Efficient, and Selective Platform for Protein Separation, **Biomacromolecules** 18, 898–905 (2017). DOI: [10.1021/acs.biomac.6b01778](#)
16. Song J., Yang F., Zhang Y., Hu F., Wu S., Jin Y., Guo J., **Rojas O.J.**, Interactions between fungal cellulases and films of nanofibrillar cellulose determined by a quartz crystal microbalance with dissipation monitoring (QCM-D), **Cellulose** 24, 1947-1956 (2017). DOI: [10.1007/s10570-017-1234-9](#)
17. Pereira A., Hoeger I.C., Ferrer Carrera A., Rencoret J., Carlos Del Rio J., Kruus K., Rahikainen J., Kellock M., Gutierrez A., **Rojas O.J.**, Lignin films from spruce, eucalyptus and wheat straw studied with electroacoustic and optical sensors: Effect of composition and electrostatic screening on enzyme binding, **Biomacromolecules** 18, 1322-1332 (2017). DOI: [10.1021/acs.biomac.7b00071](#)
18. Tardy B.L., Yokota S., Ago M., Xiang W., Kondo T., Bordes R., **Rojas O.J.**, Nanocellulose–surfactant interactions, **Current Opinion in Colloid & Interface Science** 29, 57–67 (2017). DOI: [10.1016/j.cocis.2017.02.004](#)
19. Khakalo A., Filpponen I., **Rojas O.J.**, Protein adsorption tailors the surface energies and compatibility between polylactide and cellulose nanofibrils, **Biomacromolecules** 18, 1426-1433 (2017). DOI: [10.1021/acs.biomac.7b00173](#)
20. Ago M., Blaise L.T., Wang L., Guo J., Khakalo A., **Rojas O.J.**, Supramolecular assemblies of lignin into nano- and microparticles, **MRS Bulletin**, 42, 371-378 (2017). DOI: [10.1557/mrs.2017.88](#)
21. Tayeb A.H., Hubbe M.A., Zhang Y., **Rojas O.J.** Effect of lipoxygenase oxidation on surface deposition of unsaturated fatty acids, **Langmuir** 33, 4559-4566 (2017). DOI: [10.1021/acs.langmuir.7b00908](#) (ACS Editors' choice).
22. Capron I., **Rojas O.J.**, Bordes R. Behavior of nanocelluloses at interfaces, **Current Opinion in Colloid & Interface Science** 29, 83–95 (2017). DOI: [10.1016/j.cocis.2017.04.001](#)
23. Abbati de Assis C., Gonzalez R., Houtman C., Phillips R., Bilek T., **Rojas O.J.**, Pal L., Peresin M.S., Hasan J. Understanding the Conversion Economics of Cellulose Nanocrystals, **Biofuels, Bioproducts & Biorefining**, 11, 682–700 (2017). (Journal's cover). DOI: [10.1002/bbb.1782](#).
24. Tayeb A.H., Sadeghifar H., Hubbe M.A., **Rojas O.J.** Lipoxygenase-mediated peroxidation of model plant extractives, **Industrial Crops and Products**, 104, 253–262 (2017). DOI: [10.1016/j.indcrop.2017.04.041](#)
25. Jukkola A., **Rojas O.J.**, Milk fat globules and associated membranes: colloidal properties and processing effects, **Advances in Colloid and Interface Science**, 245, 92–101 (2017). DOI: [10.1016/j.cis.2017.04.010](#)
26. Uddin K.M.A., Orelma H., Mohammadi P., Borghei M., Laine J., Linder M., **Rojas O.J.** Retention of lysozyme activity by physical immobilization in nanocellulose aerogels and antibacterial effects, **Cellulose**, 24, 2837–2848 (2017). DOI: [10.1007/s10570-017-1311-0](#)

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Patents 2017 (from NCSU time)

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2. Hall L.J., Deville J.P., **Rojas O.J.**, Carrillo C.A., Salas C.L.: [WO2016099534](#) (A1) — 2016-06-23 Additive of cellulose nanofibrils or nanocrystals and a second polymer.
3. Tripathi, Anurodh; Khan, Saad A.; **Rojas O.J.**: [WO2017127828](#) (A1) — 2016-01-21 Cellulose acetate aerogels

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