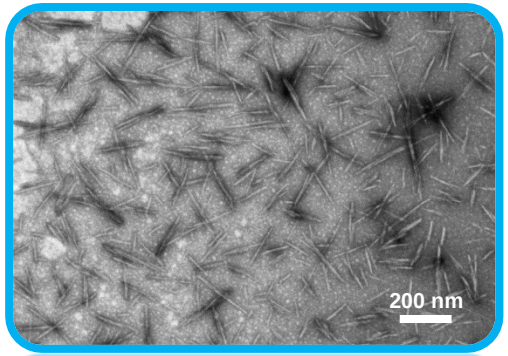
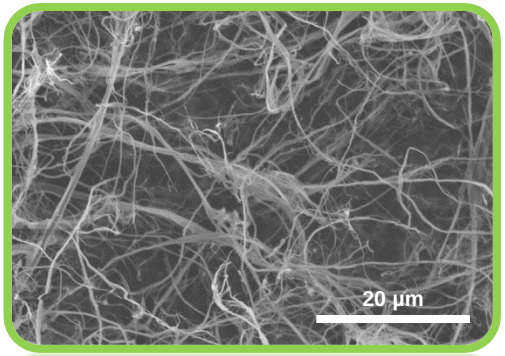
Summary of International Activities on Cellulosic Nanomaterials





Contribution of

ISO/TC 6/TG 1 – Cellulosic Nanomaterials

Contents are correct as of July 15, 2015
(to be updated periodically)

ISO/TC6/TG1

- TG1 is an advisory Task Group of ISO/TC6 on cellulosic nanomaterials, composed of 22 experts representing 11 countries

- Mandate of TG1:
  - *To identify ISO projects (TR, TS, standards) on cellulosic nanomaterials and advise on which Working Group shall lead them*
  - *To examine the possibility of including cellulosic nanomaterials specificity factors in existing TC6 standards when they come up for systematic review*

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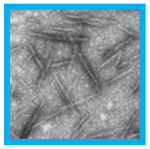
N.B. Information in red is unconfirmed

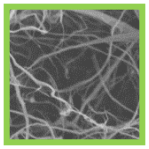
Countries of activity



Cellulose Nanocrystals

Canada
USA
Brazil
Sweden
UK
France
Austria
Switzerland
Italy
Spain
Iran
Israel
China
India
Malaysia
South Korea
Australia

Countries hosting conferences:
Portugal
Poland
United Arab Emirates

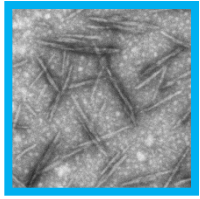


Cellulose Nanofibrils

Canada
USA
Brazil
Norway
Sweden
Finland
UK
Ireland
Spain
France
Germany
Netherlands
Switzerland
Iran
China
India
Malaysia
Japan
South Korea
Singapore
Australia
New Zealand
Tunisia

Production activities

- Large-scale producers of cellulosic nanomaterials are included in this section, regardless of whether their product is sold on the market
  - Scale-ups
  - Pilot plants
  - Demonstration plants
  - Manufacturers
- CNMs may be used in industrial applications or for research purposes
- Where known, * indicates pre-commercial and ** indicates commercial production

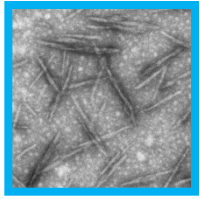


Cellulose Nanocrystals (CNCs)

Production activities

Americas

Country	Company	Product/ Trade name	Production Capacity	Source/*Method*
Canada	CelluForce*	NCC™	1 ton/day	**Bleached kraft pulp** *Sulfuric acid hydrolysis*
	Alberta Innovates (AITF)	CNCs	20 kg/day	**MCC, bleached kraft pulps (softwood and hardwood), dissolving pulp** *Sulfuric acid hydrolysis*
	Blue Goose Biorefineries Inc.	CNCs	10 kg/day	**Lignocellulosic feedstocks including wood, grasses and cereal straws** *Oxidative, nanocatalytic process*
	FPInnovations	CNCs	2 kg/day	**Bleached chemical pulp and others** *Sulfuric acid hydrolysis*
USA	American Process Inc.**	Nanocellulose *BioPlus™* *CNCs* *Lignin-coated hydrophobic CNCs*	0.5 ton/day (est.)	**Wood chips** **Agricultural residues** **Bamboo, grasses** *Sulfur dioxide and ethanol pretreatment (Patented AVAP® technology)*
	USDA-Forest Service-Forest Products Laboratory (FPL)	CNCs *Aqueous suspensions* *Freeze-dried*	50 kg/week	**Wood pulp** *Sulfuric acid hydrolysis*

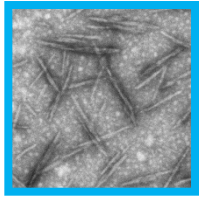


Cellulose Nanocrystals (CNCs)

Production activities

Nordic Countries

Country	Company	Product/ Trade name	Production Capacity	Source/*Method*
Sweden	MoRe Research *backed by Holmen Pulp and Paper and SP Technical Research Institute of Sweden*	Nanocrystalline cellulose	0.1 ton/day *pilot plant in place during first half of 2016*	**Paper industry sludge** *Controlled sulfuric acid hydrolysis + washing, sonication* *Based on technology by Melodea*

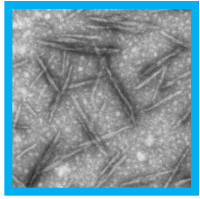


Cellulose Nanocrystals (CNCs)

Production activities

Middle East, Asia and Australia

Country	Company	Product/ Trade name	Production Capacity	Source/*Method*
Israel	Melodea Ltd. *backed by Holmen Pulp and Paper, Sweden*	Nanocrystalline cellulose (NCC) NCC foam	--	**Paper industry sludge** **Bleached pulp** **Flax, Hemp** *Hydrolysis + washing, sonication*
Iran	Nano Novin Polymer Co	Bacterial nanocellulose	--	**Bacterial cellulose** *Production of cellulose nanofibers using bottom-up approach of bacterial synthesis Provide nanocellulose and other bio-based nanopolymers using top-down approaches*

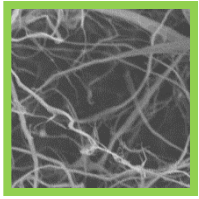


Cellulose Nanocrystals (CNCs)

Production activities

Middle East, Asia and Australia

Country	Company	Product/ Trade name	Production Capacity	Source/*Method*
China	Tianjin Haojia Cellulose Co., Ltd.	CNCs *Suspension* *Spray-dried* *Freeze-dried* *Chemically modified?*	--	**Dissolving pulp** **Cotton** **Bleached kraft pulp (softwood, hardwood)** *Mechanical shearing + combined enzymatic and acidic hydrolysis*
India	Indian Council of Agricultural Research - Central Institute for Research on Cotton Technology (ICAR-CIRCOT)	CNCs *and CNFs*	10 kg/day	**Cotton linters** **MCC from short staple cotton fibers** **Sugarcane bagasse, other agro-biomass** *Novel microbial, enzymatic and chemo-mechanical processes, e.g. in membrane reactor for continuous hydrolysis and removal of nanocellulose without substrate inhibition*

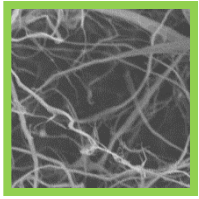


Cellulose Nanofibrils (CNFs)

Production activities

Americas

Country	Company	Product/ Trade name	Production Capacity	Source/*Method*
Canada	Kruger Bioproducts Inc.**	FILOCELL *Cellulose filaments*	5 tons/day	**Bleached kraft pulp or TMP** *Mechanical treatment*
	Performance BioFilaments Inc.**	Cellulose filaments *Wet fluff form or rolls of dried film*	--	**Bleached kraft pulp or TMP** *Mechanical treatment*
	GreenCore Composites Inc.**	NCell™ *Natural fiber-reinforced thermoplastics*	--	**Wood or agricultural fibers** *"In-situ generation of lignocellulosic microfibers"* PP or PE matrix reinforced with up to 40% natural cellulosic microfibers

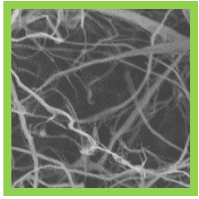


Cellulose Nanofibrils (CNFs)

Production activities

Americas

Country	Company	Product/ Trade name	Production Capacity	Source/*Method*
USA	American Process Inc. (AVAPCO)**	Nanocellulose *BioPlus™* *CNFs* *Lignin-coated hydrophobic CNFs*	0.5 ton/day (est.)	**Wood chips** **Agricultural residues** *SO_2/ethanol pulping* *Mechanical treatment*
	USDA-Forest Service-Forest Products Laboratory (FPL)	CNFs *Aqueous suspensions* *Freeze-dried*	1 kg/week	**Wood pulp** *TEMPO oxidation and mechanical treatment*
	UMaine	CNFs *Aqueous suspensions*	1 ton/week	**Wood pulp** *Mass colloider grinder*
	paperlogic	CNFs *Planned for first half of 2015*	--	**Wood pulp** *Mechanical treatment*

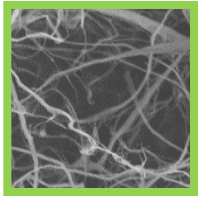


Cellulose Nanofibrils (CNFs)

Production activities

Nordic Countries

Country	Company	Product/ Trade name	Production Capacity	Source/*Method*
Norway	Borregaard	CMFs "Exilva MFC"	~3 ton/day *planned for mid-2016*	**"Specialty cellulose"** *Mechanical treatment*
	Norske Skog Saugbrugs	CMFs/ nanocellulose	Pilot plant *planned as of Dec 2013*	**Thermomechanical pulp** *High pressure treatment*
Sweden	Innventia AB	CMFs	100 kg/day *pilot plant* Mobile demo plant *July 2014, planned with BillerudKorsnäs*	**Wood fibers** *Chemical and/or enzyme pre-treatment, Mechanical treatment (homogenization)*
Finland	UPM-Kymmene Ltd.*	Biofibrils™	Pilot-scale demo plant *"For trials at UPM mills"*	**Wood fibers** *Mechanical treatment*
	Stora Enso Ltd.	CMFs "Microcellulose"	Pilot plant *started up end 2011*	**Wood fibers** *Mechanical treatment*
	VTT* *collaboration with Aalto U, UPM*	CNFs *Roll-to-roll film*	Pilot scale	Birch **fibril pulp** *Mechanical treatment*

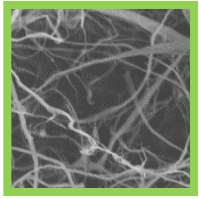


Cellulose Nanofibrils (CNFs)

Production activities

Europe

Country	Company	Product/ Trade name	Production Capacity	Source/*Method*
UK	Zelfo Technology GmbH	MFC	--	**Cellulose fibres, fibre-based waste (recycled)** *CORE technology enables modification of cellulose fibres using minimum energy* BASF SE owns exclusive rights to industrialise Zelfo MFC fibre technology within pulp, paper and board industries
	CelluComp 11 partners in 5 countries, supported by Strathclyde U and Reading U, coordinated by Institute of Nanotechnology UK	CNFs Curran® *Paste/slurry* *Powder* *Thin sheets* *Composites*	Small plant running	**Waste streams of root vegetables** ***"Proprietary technology"***
	Imerys	FibreLean MFC *combination of kaolin or calcium carbonate with MFCs*	1000 to > 10,000 tons/year	**Range of (wood) pulp species** *No fiber pretreatment; co-grinding mineral with fiber* On trial by Imerys customers in a wide range of papers

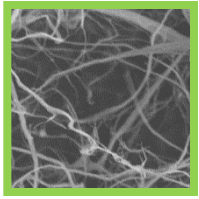


Cellulose Nanofibrils (CNFs)

Production activities

Europe

Country	Company	Product/ Trade name	Production Capacity	Source/ *Method*
France	CTP/FCBA InTechFibres partnership (to summer 2014)	CMFs/CNFs	~ 0.1 ton/day *capacity 100 g to 80 kg CMF/CNF*	**Lignocellulosics** *TEMPO-catalyzed oxidation* *Meca-enzymatic pre-treatments* *Other pre-treatments* *Ariete NS3075H* *1000 L/h, 55 kW motor, 1500 bars maxi* *Semi-industrial production* *For research applications: Panther homogenizer 50 L/h and lab microfluidizer*
	InoFib LGP2 start-up	CMFs Modified CMFs	unavailable	**Cellulosic fibres** *Mechanical treatment*
Switzerland	Swiss Federal Laboratories for Materials Science and Technology Empa	CNFs	15 kg/day	**Wood and other lignocellulosic fiber sources** *Enzymatic pre-treatment* *Microfluidizer*
Germany	J. Rettenmaier & Söhne GmbH	CMFs (maybe)	--	--

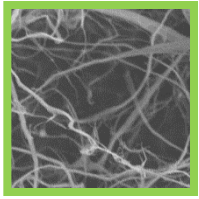


Cellulose Nanofibrils (CNFs)

Production activities

Europe

Country	Company	Product/ Trade name	Production Capacity	Source/*Method*
Netherlands/ UK	Sappi *in partnership with Edinburgh Napier University, on Brightlands Chemelot Campus in Sittard-Geleen, the Netherlands*	CNFs *dry powder readily re-dispersed in water*	8 tons/year target (pilot plant) *planned for early 2016*	**Wood fibres** *"New low-cost process"* CNFs with unique morphology, specifically modified for either hydrophobic or hydrophilic applications

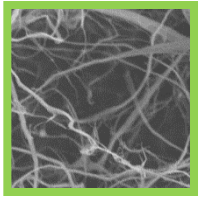


Cellulose Nanofibrils (CNFs)

Production activities

Middle East, Asia and Australia

Country	Company	Product/ Trade name	Production Capacity	Source/*Method*
Iran	Nano Novin Polymer Co	Industry	--	**Bacterial cellulose** *Production of cellulose nanofibers using bottom-up approach of bacterial synthesis* *Provide nanocellulose and other bio-based nanopolymers using top-down approaches*
China	Tianjin Haojia Cellulose Co., Ltd.	CNFs Modified CNFs *TEMPO-oxidized, cationized, carboxymethylated, polymer grafted*	--	**Dissolving cotton pulp** **Bleached sulfate pulp (soft- and hardwood)** *High pressure homogenizer* *-or-* *Super micro-grinder*
India	Indian Council of Agricultural Research - Central Institute for Research on Cotton Technology (ICAR-CIRCOT)	CNFs *and CNCs*	10 kg/day Pilot plant	**Cotton linters** **MCC from short staple cotton fibers** **Sugarcane bagasse** **Other agro-biomass** *Novel microbial, enzymatic and chemo-mechanical processes, e.g. in membrane reactor for continuous hydrolysis and simultaneous removal of nano-cellulose without substrate inhibition*

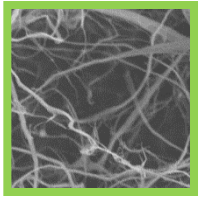


Cellulose Nanofibrils (CNFs)

Production activities

Middle East, Asia and Australia

Country	Company	Product/ Trade name	Production Capacity	Source/*Method*
Japan	Daicel**	Nano Celish™ *filtration/food/industrial grades*	-- 10-35% solids	**Purified pulp** *Mechanical treatment*
	Dai-ichi Kogyo Seiyaku Co., Ltd.	"Cellulose single nanofiber": Rheocrysta™	50 ton/year 2% solids	**NO INFO** *TEMPO oxidation*
	Daio Paper	CNFs	--	**NO INFO** *Mechanical treatment, etc.*
	Sugino Machine	BiNFi-s Biomass nanofiber	-- 2, 5, 10% solids	**NO INFO** *Ultra-high pressure water jet*
	Chuetsu Pulp & Paper	CNFs CNF/plastic composites	--	**Bleached kraft pulp: Bamboo, Softwood/Hardwood** *Aqueous counter collision*
	Nippon Paper Industries*	CNFs Cellenpia™	> 30 ton/year (> 0.1 ton/day)	**Wood pulp** *TEMPO oxidation* *Carboxymethylation* *Mechanical treatment*



Cellulose Nanofibrils (CNFs)

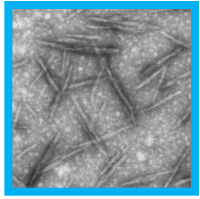
Production activities

Middle East, Asia and Australia

Country	Company	Product/ Trade name	Capacity	Source/*Method*
Japan	Oji Holdings	CNFs CNF transparent films *No information on website currently*	--	*Chemical modification* *Mechanical treatment*
	Asahi Kasei**	Precisé™ (non-woven containing CNFs)	--	--
	Seiko PMC	CNF nanocomposites *Mentioned in slide from TAPPI Nano conference, holds patent with DIC Products*	--	**Wood pulp** *Mechanical treatment + Hydrophobization*
	DIC Corporation	CNF/plastic nanocomposites	--	--
	Tokushu Tokai Paper	Absorbent products (SAP and CNF)	--	*No information on company website*

Research Activities

- Research activities are classified as those performed by independent groups:
  - Universities
  - Research Institutes (may be allied with industry)
  - Industry (generally in companies which are not currently producing CNMs or which are incorporating them into products they are selling)

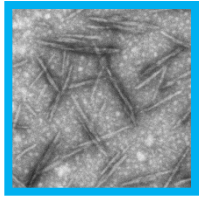


Cellulose Nanocrystals (CNCs)

Research activities

Americas

Country	Institution	Type	Areas of interest
Canada	McGill University	University	Characterization Nanocomposites Catalyst supports Photonics and sensors
	Université Laval	University	Bio-composites (project ended) Paints, varnishes
	Waterloo Institute for Nanotechnology	University	Cosmetics and personal care Polymer nanocomposites
	McMaster University	University	Nanocomposites, mechanical properties Cellulose foams/gels/Pickering emulsions Tailored CNC grades
	Queen's University	University	Surface modification for new hybrid materials from renewables for the automotive industry pH-sensitive switching devices (CO_2-switchable aggregation)
	University of British Columbia	University	Rheology of CNC suspensions Templating of mesoporous structures for developing electronics, photonics and sensors High-yield production Drug delivery and tissue engineering
	Dalhousie University	University	CNCs in explosives

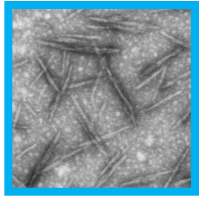


Cellulose Nanocrystals (CNCs)

Research activities

Americas

Country	Institution	Type	Areas of interest
Canada	Université du Québec à Trois-Rivières	University	Modelling Optical properties
	École Polytechnique de Montréal - CREPEC	University	Biocomposites
	University of Toronto	University	Conductive polymer nanocomposites for sensors and other applications Chiral plasmonic films Gold nanoparticle and CNC composite films
	University of Alberta	University	Rheology Functionalization/characterization Composites Foams Construction, drilling Biomedical, hydrogel
	National Institute for Nanotechnology (NINT)	Research Institute	Modelling/rational design for surface modifications of CNCs for green products Characterization
	Alberta Innovates – Technology Futures (AITF)	Research Institute	Processes and applications development & optimization Characterization Composites Standards development

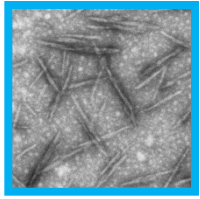


Cellulose Nanocrystals (CNCs)

Research activities

Americas

Country	Institution	Type	Areas of interest
Canada	Institut de Recherche et de Développement en Agroenvironnement (IRDA)	Research Institute	Agriculture (project ended)
	INRS/Institut Armand-Frappier	Research Institute	Bioactive films Food packaging
	INRS/EMT	Research Institute	Batteries Compatibilization
	National Research Council-INMS	Research Institute	Metrology standards Commercial reference materials
	FPInnovations	Research Institute/ Industry	Multiple interests including production, next-generation CNCs, applications and standards development
	CelluForce	Industry	Production
	Woodbridge Foam Corporation	Industry	Automotive foam applications
	Bell Helicopter	Industry	Many
	Matrix Innovation	Industry	Scale-up of CNC surface modification
	INO (National Optics Institute)	Industry	Liquid crystal displays

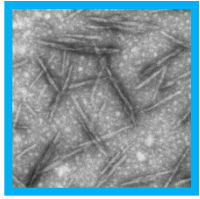


Cellulose Nanocrystals (CNCs)

Research activities

Americas

Country	Institution	Type	Areas of interest
USA	Oregon State (ODU)	University	Composites Aerogels Modeling
	Wisconsin-Madison	University	Biopolymers Injection molding Aerogels Flexible electronics
	Pennsylvania State	University	CNC production and characterization Composites Interactions with proteins, enzymes, and biologically derived polymers
	Virginia Tech	University	Composites Drug delivery Life cycle assessments
	Case Western Reserve	University	Composites, interface modification
	U Maine	University	Processing, composites
	Purdue	University	Characterization, Functionalization Composites (films, fibers, laminates) Cements Multiscale modeling

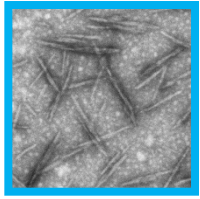


Cellulose Nanocrystals (CNCs)

Research activities

Americas

Country	Institution	Type	Areas of interest
USA	North Carolina State (NCSU)	University	Surfaces Functionalization Hybrid composites, etc.
	Georgia Tech (GaTech)/ Renewable Bioproducts Institute	University	Surfaces Fibers Composites CNC substrate materials for flexible electronics
	University of Maryland	University	Flexible electronics, batteries
	US Army Research Laboratory	Research Insititute	Fibers Film transparency
	USDA-Forest Service-Forest Products Laboratory (FPL)	Research Institute	CNC extraction Characterization Composites (films, fibers, aerogels)
	US National Institute for Occupational Safety & Health (NIOSH)	Research Institute	Detection of dispersed CNCs in air
	US National Institute of Standards (NIST)	Research Institute	CNC characterization technique development

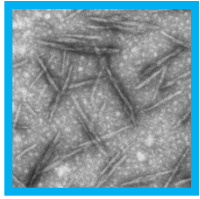


Cellulose Nanocrystals (CNCs)

Research activities

Americas

Country	Institution	Type	Areas of interest
Brazil	University of Campinas	University	CNCs from agricultural products/waste (Curauá, cotton) Nanocomposites
	Universidade Federal de Uberlândia, Campus Santa Mônica	University	CNCs from agricultural products/waste (soy hull, corncob) Nanocomposites
	Universidade Federal de Rio de Janeiro	University	CNCs from agricultural products/waste (Capim Dourado) Nanocomposites
	Universidade Estadual Paulista Julio de Mesquita Filho	University	Lignocellulosic composites Nanocomposites from natural fibers and agro industrial waste
	Brazilian Enterprise of Agricultural Research (EMBRAPA)	Research Institute	Isolation and characterization of nanocellulose from agricultural products/waste

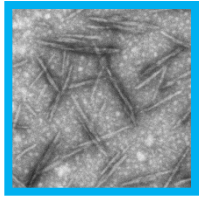


Cellulose Nanocrystals (CNCs)

Research activities

Europe

Country	Institution	Type	Areas of interest
UK	University of Bath	University	Surface modification
	University of Cambridge	University	Bio-inspired photonics and Photonic structures in nature including CNCs
	University of Exeter	University	Nanocomposites CNCs as tissue engineering material Raman spectroscopy for the characterisation of nanocellulose
	Queen Mary College, University of London	University	CNCs are used to create fully biobased nanostructured materials with interesting mechanical and optical properties
	BioComposites Centre, Bangor University	University	March 2014 "COST" (European Cooperation in Science and Technology) held a workshop entitled "Science and uses of nanocellulose"
	University of Nottingham	University	Preparation/Surface modification
	JCH Industrial Ecology Limited	Industry	Environmental impact associated with nanocellulose (all types) production-LCA (Life cycle assessment)

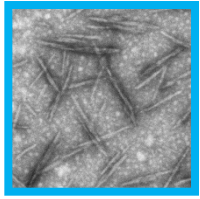


Cellulose Nanocrystals (CNCs)

Research activities

Europe

Country	Institution	Type	Areas of interest
France	Grenoble Institute of Technology (INP)	University/ Research Institute (LPG2-Pagora)	Production of CNCs and CNFs New approaches to functionalization Nanocomposite properties
	CERMAV	Research Institute (SPG)	CNCs from different sources CNC characterization CNC liquid crystals
	INRA Nantes, Groupe BIA (Biopolymer Interactions and Assemblies)	Public Research Institute	CNCs in Pickering emulsions
	Mines ParisTech – CEMEF	Research Institute	Composites
	LCPO – Biopolymers & Bio-sourced polymers	Research Institute (University of Bordeaux, CNRS, Bordeaux National Polytechnic Institute)	Functional materials – surface tailoring of nanocelluloses by chemical functionalization: CNC composites, Pickering emulsions, aerogels, templates
	LRP – Laboratoire Rhéologie et Procédés	Research Institute (UMR 5520 – UJF – Grenoble INP – CNRS)	Rheology of CNC suspensions Drying of CNC suspensions Composites with CNCs

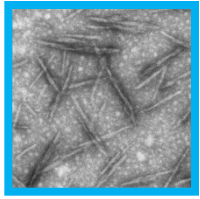


Cellulose Nanocrystals (CNCs)

Research activities

Europe

Country	Institution	Type	Areas of interest
Spain	Universidad de Alicante	University	CNC bionanocomposites
	Universidad del País Vasco	University	CNC bionanocomposites
	Universitat Politècnica de Catalunya	University	CNC surface modification using biotechnological approaches
	Universidad Politécnica de Valencia	University	CNC surface modification
	Institute of Polymer Science and Technology, CSIC	Research Institute	CNC for stabilizing emulsions
	ITENE	Research Institute	CNC isolation and modification CNCs as reinforcement for improving materials barrier properties for packaging applications

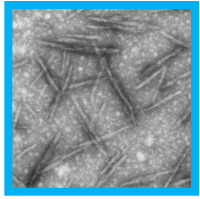


Cellulose Nanocrystals (CNCs)

Research activities

Europe

Country	Institution	Type	Areas of interest
Austria	University of Natural Resources and Life Sciences (Boku University)	University	Cellulosic aerogels Nanoparticles from hemicelluloses "Biomaterials chemistry"
Switzerland	Fribourg Center for Nanomaterials, FriMat University of Fribourg, Adolphe Merkle Institute	University/ Multidisciplinary Research Institute (Christophe Weder)	Phosphoric acid hydrolysis Nanocomposites Adaptive nanocomposites Interactions of CNCs with living cells (toxicity, product life cycle)
Italy	Università degli Studi di Perugia – Dipartimento di ingegneria civile ed ambientale	University	Waste re-valorization and use Extraction of CNCs Use of CNCs in nanocomposites
	Institute of Composite and Biomedical Materials (IMCB), University of Pisa	University	Composites with natural fillers CNFs as well?



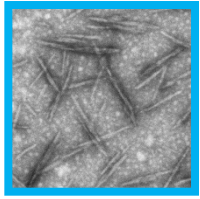
Cellulose Nanocrystals (CNCs)

Research activities

Middle East, Asia and Australia

Country	Institution	Type	Areas of interest
Israel	Hebrew University Jerusalem	University/ Research Institute	Textile, construction, medical applications: Nanocomposites of proteins/CNCs for stem cell therapy
Iran	University of Tehran	University	CNCs from cotton linters, chemical pulps, local woody species, agro wastes, bagasse ,kenaf fibers, etc. using acid hydrolysis Surface modification, nanocomposites Food packaging nanocomposite films
	Amirkabir University of Technology	University	Isolation and characterization
	Gorgan University	University	Bacterial nanocellulose Bagasse, other CNCs for food packaging nanocomposite films Self-assembly behaviour
	Tarbiat Modares University	University	Isolation, characterization and nanocomposite films
	Department of Food Science, College of Agriculture, Islamic Azad University	University	CNCs conjugated with retinoic acid: its capability to adsorb aflatoxin B1; Antimicrobial activity of nanocellulose conjugated with allicin and lysozyme
	Caspian Nanocellulose Co.	Research Institute?	Not found

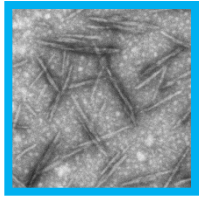
Cellulose Nanocrystals (CNCs)



Research activities

Middle East, Asia and Australia

Country	Institution	Type	Areas of interest
Malaysia	Universiti Teknologi Malaysia (UTM)	University	CNCs from: Oil palm empty fruit bunch fibres using acid hydrolysis method
	Universiti Kebangsaan Malaysia (UKM)	University	CNCs from: Mengkuang leaves, coconut fibers, Agave angustifolia fibres, kenaf core and oil palm empty fruit bunch fibres using acid hydrolysis method
	Universiti Sains Malaysia (USM)	University	CNCs from: Oil palm empty fruit bunch fibres using acid hydrolysis method
	Universiti Putra Malaysia	University	CNCs from kenaf bast
	Forest Research Institute Malaysia (FRIM)	Research Institute	CNCs from local forest pioneer species and industrial bio-residues (?) Surface modification of CNCs Interfacial micromechanics of CNCs Polymer nanocomposites

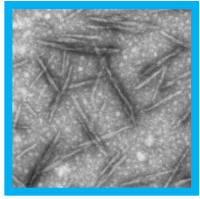


Cellulose Nanocrystals (CNCs)

Research activities

Middle East, Asia and Australia

Country	Institution	Type	Areas of interest
China	Chinese Academy of Sciences	University	Hydrophobic modification + grafting Production (alternate cellulose sources) Oxidation Thermal stability
	Nanjing University	University	Bacterial nanocellulose CNCs from cotton and waste tissue CNCs by mixed acid hydrolysis + sonication Thermal properties of CNCs
	Zhejiang Sci-Tech University	University	Not found
	South China University of Technology	University	Redispersible dried CNCs modified with CMC-Na Effects of various pretreatments + hydrolysis on CNC properties
	Chinese Academy of Tropical Agricultural Sciences	Research Institute	CNCs from crops and agriculcural residues, surface modification, nanocomposites

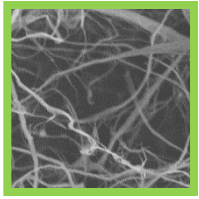


Cellulose Nanocrystals (CNCs)

Research activities

Middle East, Asia and Australia

Country	Institution	Type	Areas of interest
South Korea	Mokpo National University	University	CNCs from food waste (onion/garlic skins) Bionanocomposite films
	Korea Forest Research Institute KFRI	Research Institute	Preparation of nanocellulose from MCC for mixing with PVA
India	Indian Institute of Science	University	Development of nanocomposites for encapsulation
Australia	Several research groups are undertaking extensive research programs; a number of commissioned reports lend support to R&D related to technological applications using CNCs (e.g., ATSE report number 182, Feb 2014)		Producing CNCs via different mechanical and chemical methods Producing CNCs, nanocomposites from indigenous biomass (e.g. Spinifex) Spectroscopic and chromatographic measurements Mechanical, thermal and morphological analysis Green nanomaterials: cellulose nanofibres synthesis and applications

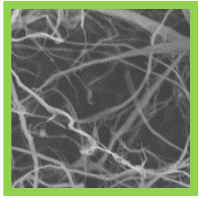


Cellulose Nanofibrils (CNFs)

Research activities

Americas

Country	Institution	Type	Areas of interest
Canada	University of Toronto	University	CNFs in biopolymer based nanocomposites (e.g. jute, aloe vera, cactus rind) Thermally stable optically transparent composites reinforced with nano-fibrillated pulp fibers
	Alberta Innovates Technology Futures	Research Institute	CNF extraction and characterization Standard tests development for characterization

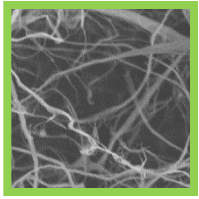


Cellulose Nanofibrils (CNFs)

Research activities

Americas

Country	Institution	Type	Areas of interest
USA	Georgia Tech (GaTech)/ Renewable Bioproducts Institute	University	Surfaces Fibers Composites
	North Carolina State (NCSU)	University	Surfaces Functionalization Hybrid composites, etc.
	Virginia Tech (Sustainable Nanotechnology)	University	Support for nanoparticles Life cycle assessment
	USDA-Forest Service-Forest Products Laboratory (FPL)	Research Institute	CNF extraction Characterization Composites (films, fibers, aerogels)
	US National Institute for Occupational Safety & Health (NIOSH)	Research Institute	Detection of dispersed CNFs in air
	US National Institute of Standards (NIST)	Research Institute	CNF characterization technique development
	US Army Research Laboratory (ARL)	Research Institute	Fibers Film transparency

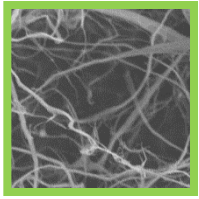


Cellulose Nanofibrils (CNFs)

Research activities

Americas

Country	Institution	Type	Areas of interest
USA	University of Texas at Austin	University	Genetically engineering *Acetobacter xylinum* into blue-green algae to secrete nanocellulose on a potentially industrial scale
	UMaine	University	CNF processing Composites
	Wisconsin-Madison	University	CNF biopolymers Injection molding Aerogels Flexible electronics
	Purdue	University	CNF characterization Composites (films, fibers, laminates) Cements Functionalization, Multiscale modeling
Brazil	São Paulo State University	University	CNFs from agricultural products/waste (banana peel, pineapple leaf) Nanocomposites (cars)
	Paper companies	Industry	Some experiments are being done with acquired CNFs

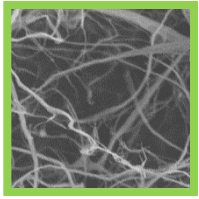


Cellulose Nanofibrils (CNFs)

Research activities

Nordic Countries

Country	Institution	Type	Areas of interest
Norway	Norwegian University of Science and Technology (NTNU)	University	TEMPO CNFs from spruce and eucalyptus CNF films therefrom
	Paper and Fiber Research Institute (PFI)	Research Institute	See Collaborations section
Sweden	Innventia	Research Institute	New pre-treatments for energy efficient production Scale-up issues Paper-making, composites, barrier film applications
	Wallenberg Wood Science Centre (WWSC) *collaboration between Chalmers and KTH*	Research Centre	CNFs in fibrous materials Biocomposites, nanostructured materials
	Luleå University of Technology	University	CNFs from wood residues Composites
	Uppsala	University	Energy storage, biocompatibility
	Karlstad	University	CNF-based packaging
Finland	VTT	Research Institute	High filler, NFC films Utilisation of nanocellulose as an additive in water-based polyurethane varnishes and paints
	Aalto University	University	NFC based papers, additives in paint

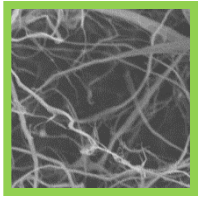


Cellulose Nanofibrils (CNFs)

Research activities

Europe

Country	Institution	Type	Areas of interest
UK	University of Bath	University	Partially oxidised CNF gels
	Queen Mary College, University of London	University	Cellulose nanofibres such as nanocellulose produced by bacteria are used to create fully biobased nanostructured materials with interesting mechanical and optical properties
	Brunel University London	University	Pilot scale nanocellulose and bio-composite manufacturing plants for construction applications
	University of Nottingham	University	Isolation, surface modification, composite films, aerogels, wound dressings, insulating materials, sensors (hydrogels) Surface modification, waste water treatment Biosynthesis of bacterial nanocellulose
	University of Exeter and Imperial College London	University	Preparation/ Nanocomposites
	Queen's University Belfast	University	Preparation, characterization, foam, Nanocomposites
	JCH Industrial Ecology Limited	Industry	Environmental impact associated with nanocellulose (all types) production-LCA (Life cycle assessment)

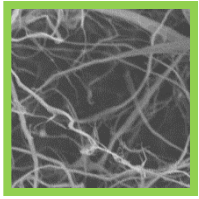


Cellulose Nanofibrils (CNFs)

Research activities

Europe

Country	Institution	Type	Areas of interest
Spain	Celbiotech Group, Universitat Politècnica de Catalunya	University	CNFs as reinforcement Modification of CMFs and CNFs by using biotechnological energy-efficient and environmentally benign processes
	Universidad del País Vasco	University	CNFs isolation from agricultural sources. CNF modification for reinforcing applications
	Universidad de Córdoba	University	CNFs isolation from agricultural sources
	LEPAMAP Group, Universitat de Girona	University	CNFs for paper and plastic reinforcement applications.
	ITENE	Research Institute	CNFs isolation and modification Bionanocomposites for packaging applications Nanosafety and food contact security assessment (EFSA, FDA)
	Novel Materials and Nanotechnology Group, IATA, CSIC, Valencia	Research Institute	Nanocomposites Environmentally friendly packaging materials Biopolymers and biodegradable materials
	Tecnalia	Research Institute	Paper recycling process oriented to low-energy MFC production Chemical modification of MFC Biocomposites for construction

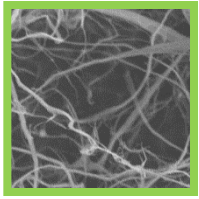


Cellulose Nanofibrils (CNFs)

Research activities

Europe

Country	Institution	Type	Areas of interest
France	Grenoble Institute of Technology (Pagora)	University/ Research Institute	Production of CNCs and CNFs/CMFs New approaches to functionalization Nanocomposite properties Specific surface of CNF suspensions
	CERMAV (SPG)	Research Institute	New processing methods for MFC, NFC Optimization of processing methods Nanocomposites, aerogels
	Centre Technique du Papier (CTP)	Research Institute	Production and functionalization of CNFs/CMFs New materials based on CNFs, composites CNFs in papermaking, inks and varnishes, electronics Transparent and barrier films and coatings Superabsorbent materials
	CEMEF	Research Institute	CNFs
	LCPO	Research Institute	CNFs
	FCBA	Research Institute	CNFs in glues, varnishes, paints, fibreboards, wood furniture, wood buildings
	INRA Nantes, Groupe BIA	Public Research Institute	MFC production and functionalization
	LRP – Laboratoire Rhéologie et Procédés	Research Institute (UMR 5520 – UJF – Grenoble INP – CNRS)	Rheology of CNF suspensions Drying of CNF suspensions Composites with CNFs

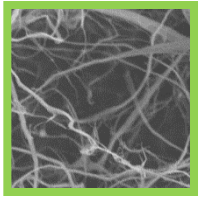


Cellulose Nanofibrils (CNFs)

Research activities

Europe

Country	Institution	Type	Areas of interest
Switzerland	Swiss Federal Laboratories for Materials Science and Technology (Empa)	Research Institute	Microfibrillated cellulose (MFC) Functionalization of MFC Elaboration of porous materials from MFC MFC as reinforcing agent in composite applications

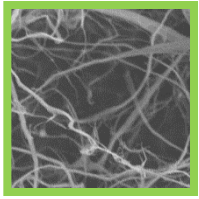


Cellulose Nanofibrils (CNFs)

Research activities

Middle East, Asia and Australia

Country	Institution	Type	Areas of interest
Iran	University of Tehran	University	Isolation and characterization Antimicrobial agents for food packaging, inside foodstuffs and textile materials CNF films and composites, Paper additives
	Amirkabir University of Technology	University	Production, Composites Bacterial cellulose production for drug delivery and wound care
	Gorgan University	University	Isolation and characterization Antimicrobial agents for food packaging, inside foodstuffs and textile materials CNF films and composites, Paper additives
	Department of Food Science, College of Agriculture, Islamic Azad University	University	Isolation and characterization Antimicrobial agents for food packaging, inside foodstuffs and textile materials
Japan	Osaka University *Laboratory of Cellulose Nanofiber Materials*	University Research Institute	Organic film solar cells with CNFs Printed electronics with CNFs CNF materials, physical properties
	Kyushu University	University	CNF manufacturing (aqueous counter collision method) CNF hybrids
	Tokushima University	University	CNFs from paper wastes, nanocomposites therefrom

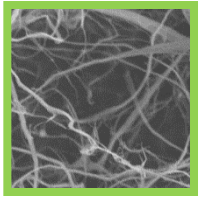


Cellulose Nanofibrils (CNFs)

Research activities

Middle East, Asia and Australia

Country	Institution	Type	Areas of interest
Japan	Kyoto University	University	CNF films and composites
	The University of Tokyo	University	TEMPO oxidized CNFs: production, characterization, films and networks
	AIST (National Institute)	University	Ligno-CNF composites
Malaysia	Universiti Putra Malaysia (UPM)	University	CNFs from Kenaf bast
	Universiti Kebangsaan Malaysia (UKM)	University	CNFs from: Kenaf core and oil palm empty fruit bunch fibres using high speed blender
China	Chinese Academy of Sciences	University	BC networks as drug carriers, nanocomposites
	Northeast Forestry University	University	CNFs from chemical-thermomechanical pulps for bio-composite making CNFs from bleached hardwood kraft pulp using high density ultrasonication + PVA composite film making

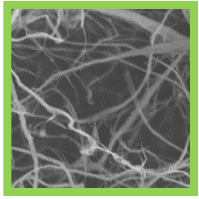


Cellulose Nanofibrils (CNFs)

Research activities

Middle East, Asia and Australia

Country	Institution	Type	Areas of interest
South Korea	Hansol Paper Co., Ltd.	Industry	Paper additives - wet end and coating
	Korea Forest Research Institute KFRI	Research Institute	Separator for lithium-ion battery Nanopaper Conductive films
	Kangwon National University	University	Effective manufacturing techniques Biocomposites
	Kyungpook National University	University	Hydrogels Nanocomposites
	Seoul National University	University	Characterization Nanofilters Aerogels
Singapore	National University of Singapore (NUS)	University	Nanocellulose composites

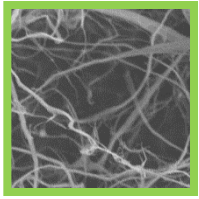


Cellulose Nanofibrils (CNFs)

Research activities

Middle East, Asia and Australia

Country	Institution	Type	Areas of interest
Australia	Bioresource Processing Research Institute of Australia (BioPRIA) at Monash University	University Research Institute	Characterisation Sheet manufacture Filtration Paper strength aids Hydrophobic surface applications
	Australian Institute for Bioengineering and Nanotechnology at University of Queensland	University Research Institute	CNFs from cotton and spinifex grass: Nanocomposites Carbon fibre precursors Filtration Propellant materials (nitrated)
	Australian National University	University	Sheets from CNFs prepared by ball milling: Water treatment Biomedical materials Nanocomposites Carbon fibre precursors
New Zealand	University of Auckland	University	CNFs in nanocomposites



Cellulose Nanofibrils (CNFs)

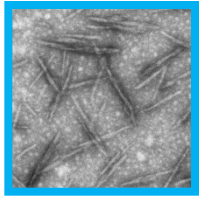
Research activities

Africa

Country	Institution	Type	Areas of interest
Tunisia	University of Sfax	University	CNFs from agricultural waste Nanocomposites (polymer, all cellulose)

Major Projects and Collaborations

- Major research collaborations between at least two large groups or universities/institutes/companies

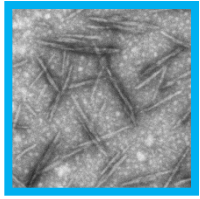


Cellulose Nanocrystals (CNCs)

Major Projects and Collaborations

Americas

Country	Partners		Project/Collaboration
Canada	FPInnovations	CelluForce	Production, next-generation CNCs, applications and standards development
	FPInnovations	AITF	Characterization of CNCs Standards development for CNCs

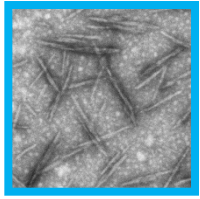


Cellulose Nanocrystals (CNCs)

Major Projects and Collaborations

Nordic Countries

Country	Coordinator	Partners	Project/Collaboration
Sweden	Innventia	39 European companies, institutes and universities	SustainPack - Development of sustainable fiber-based packaging European commission projects (FP6)

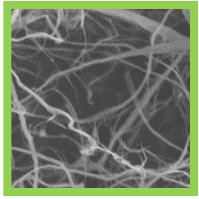


Cellulose Nanocrystals (CNCs)

Major Projects and Collaborations

Europe

Country	Coordinator	Partners	Project/Collaboration
Italy	D'Appolonia SPA	14 European companies, institutes and universities	**BRIMEE** - Development and application of foams in construction applications European commission projects (FP7)
Spain	Termoformas de Levante SL/ ITENE	10 European companies, institutes and universities	**TRAYSRENEW** - Development of innovative renewable trays for poultry products European commission projects (FP7)
	Melodea/ ITENE	7 European companies, institutes and universities	**FLHEA** - Flax and hemp advanced fiber based composites European commission projects (FP7)
UK	Netcomposites Limited	11 European companies, institutes and universities	**NCC-FOAM** - Development and application of foams in composites European commission projects (FP7)

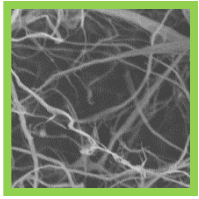


Cellulose Nanofibrils (CNFs)

Major Projects and Collaborations

Americas

Country	Partners		Project
USA	The National Institute of Standards and Technology (NIST), USDA Forest Products Laboratory (FPL)	American Forest and Paper Association	CNCs as reinforcing materials
	Universities	Other Federal laboratories such as the USDA Forest Products Laboratory (FPL)	Key collaborations have been 1) FPL-Purdue University 2) FPL-GaTech (and the Renewable Bioproducts Institute)
USA-Australia	American Process, Inc. Futuris Automotive	Georgia Institute of Technology Clark Atlanta University Swinburne University of Technology Forest Products Laboratory	Developing ultra-strong, lightweight automotive components using nanotechnology from nature

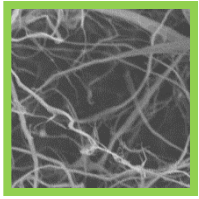


Cellulose Nanofibrils (CNFs)

Major Projects and Collaborations

Nordic Countries

Country	Partners		Project
Norway	Paper and Fibre Research Institute (PFI)		
	Treklyngen Holding AS (project owner)	Elkem AS	NaProBio - Innovative process for production of nanofibrillated cellulose from chemical pulp, with focus on optimizing all steps from wood chips to CNFs
	Funded by Research Council of Norway (RCN), group of industry partners	PETROMAKS project Elkem AS (project owner)	Waterflu - Extend the area of application of environmentally friendly drilling fluids by use of novel viscosifiers based on cellulose
	Partly funded by RCN Cooperation among industry, institutes and universities	NTNU SINTEF Materials and Chemistry	STEM - Functionality of CMFs to stabilize emulsions (water-in-oil and oil-in-water)
	4 research partners		Nanofilter - Obtain fundamental knowledge in nanopollution, toxicology and environment; develop new solutions for nanoparticle filtration based on CMFs

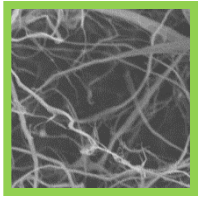


Cellulose Nanofibrils (CNFs)

Major Projects and Collaborations

Nordic Countries

Country	Partners		Project
Norway	Funded by RCN	Nofima Østfoldforskning Wageningen Universitet Federation of Norwegian Bakers and Confectioners The Norwegian Packaging Assoc'n.	BreadPack - Development and testing of innovative, functional and environmentally friendly packaging materials based on structures combining fibres and CNFs
	Partly funded by RCN	NTNU (Norwegian University of Science and Technology) SINTEF Materials and Chemistry	SustainBarrier - Innovative fibre-based packaging and multilayer concepts with step change in barrier properties, flexibility and environmental profile
	Funded by RCN/ NANO2021 (2012-2016)	NTNU Faculty of medicine Cardiff, Swansea, Lund Universities AlgiPharma	NanoHeal - Novel material solutions for use in advanced wound healing based on CNF structures
	Stiftelsen Sintef	17 European institutes, universities, and companies	NanoBarrier - Development of biopolymers for sustainable and multifunctional food packaging European commission projects (FP7)
Finland	Elastopoli/ ITENE	5 other European institutes and companies	FUNKIFIBRE - Cereal waste valorization through development of functional key fibers for packaging applications European commission projects (FP7)

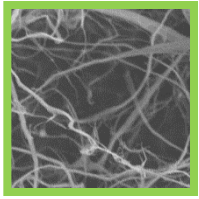


Cellulose Nanofibrils (CNFs)

Major Projects and Collaborations

Nordic Countries

Country	Partners		Project
Sweden	ACREO Innventia	Linköping University KTH	Application of CNFs in printed electronics
	Innventia	Billerudkorsnäs	Mobile demonstration plant (100 kg CNFs/h)
	Innventia	9 international companies	Large scale production of various nanocellulose applications (energy efficiency): nanocomposites, films, foams, nanofilaments, rheological applications, new CNF generations for electronic applications Characterization, alleviation of hornification during drying, etc.
	Innventia	14 European companies, institutes and universities	SUSTAINCOMP - Development of sustainable composite materials using CNFs European commission projects (FP7)
	Funded by The Swedish Research Council Formas	Innventia, Uppsala University, Stockholm University, KTH (Royal Institute of Technology), and SwedNanoTech	Collaboration work on method development for understanding of environmental, health and safety aspects of CNF

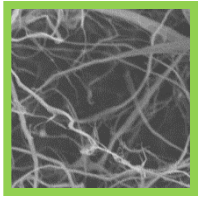


Cellulose Nanofibrils (CNFs)

Major Projects and Collaborations

Europe

Country	Partners		Project
France	CERMAV LGP2 (INPG) 3SR (INPG)	CTP LRP	Institut Carnot PolyNat - Different national projects dedicated to CNF production and uses (films, biomaterials, etc.)
	CTP	10 European companies, institutes and universities	FLEXPACKRENEW - Design and development of an innovative ecoefficient low-substrate flexible paper packaging from renewable resources European commission projects (FP7)
	Centre National de la Recherche Scientifique	9 European companies, institutes and universties	GREENANOFILMS - Development and application of ultra-high resolution nano-organized films by self-assembly of plant-based materials for next generation opto- and bio-electronics European commission projects (FP7)
Spain	Acondicionamiento Tarrasense Asociación	26 participants	GUIDEnano - Development of innovative methodologies to evaluate and manage human and environmental health risks of nano-enabled products. European commission projects (FP7)
Switzerland	Empa	9 European companies and institutes	INNOBITE - Transforming urban and agricultural residues into high performance biomaterials for green construction European commission projects (FP7)
UK	Sheffield Hallam University	11 European companies, institutes and universities	NEWGENPAK - Functional cellulose fibre based packaging materials for sustainability European commission projects (FP7)



Cellulose Nanofibrils (CNFs)

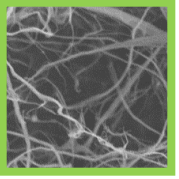
Major Projects and Collaborations

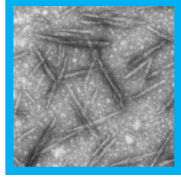
Middle East, Asia and Australia

Country	Partners		Project
Malaysia	Universiti Kebangsaan Malaysia (UKM)	Local company	Production of electrical and thermal conducting CNF films for electronic packaging applications
Japan	Kyoto University Kyoto Municipal Institute of Industrial Technology and Culture	Oji Holdings Corporation Mitsubishi Chemical Seiko PMC DIC (CNF-reinforced plastics)	CNF composites for automobiles (2010-2012)
	The University of Tokyo	Nippon Paper Industries Kao Corporation Toppan Printing	Gas barrier CNF films for packaging (2007-2012)
	AIST (National Institute, Ligno-CNF) Shizuoka University Okayama University Kurashiki University of Science and The Arts	TOCLAS MORI Machinery (providing Ligno-CNF)	Ligno-CNF composites (2010-?)
	Kyoto University Kyoto Municipal Institute of Industrial Technology and Culture The University of Tokyo	Oji Holdings Corporation Nippon Paper Industries Seiko PMC	Production of lignocellulose nanofibers and their composites (2013-2019)

Programs, Networks and Entities

- Larger research programs or networks, generally having government and/or big industry funding



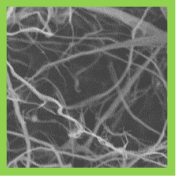


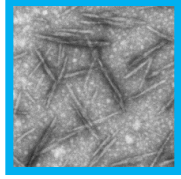
Cellulosic Nanomaterials (CNMs)

Programs, Networks and Entities

Worldwide

Country	Institute(s)	Program/ Entity	Mandate/Focus
Canada	NRCan (Federal government) FPInnovations	Transformative technologies	To bring together governments, industry and academia to conduct research along the forest value chain (including CNMs) in order to create innovative products and increase investment in a higher-value-added forest sector
USA	U.S. Endowment for Forestry & Communities, Inc.	P3Nano Public-Private Partnership for Nanotechnology	P3Nano is a public-private partnership designed to help keep America's forests and forest-based economy healthy and sustainable through the development and use of wood-based nanomaterial for a wide-range of commercial products.
Norway	PFI NTNU Biorefinery and fibre technology NTNU Ugelstadlaboratory UoS Department of Petroleum Engineering UoB Department of Clinical Dentistry Østfoldforskning CNR-ISTEC Norut Research Council of Norway Innventia NorFab-node Nanolab	NORCEL NORwegian nanoCELlulose Technology Platform	Internationally leading research platform for production, modification and control of morphology, chemistry and three-dimensional structures of nanocellulose at a fundamental level The project will explore this generic knowledge in the following three application areas: 1) Use of nanocellulose in paper and packaging 2) Applications of nanocellulose within petroleum industry 3) Use of nanocellulose as scaffold in bone tissue engineering



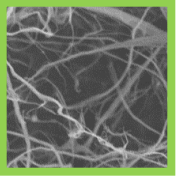


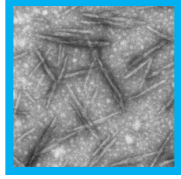
Cellulosic Nanomaterials (CNMs)

Programs, Networks and Entities

Worldwide

Country	Institute(s)	Program	Mandate/Focus
Finland	VTT Technical Research Centre of Finland Aalto University UPM-Kymmene	Finnish Centre for Nanocellulosic Technologies	To create new applications for cellulose as a raw material, substance and end product
France	Free membership to individuals, companies and institutes	Club Nanométrologie	Contact between industry and research centres in nanotechnology field
Spain **Finland** **Switzerland** **Germany** **France** **Finland**	Tecnalia VTT EMPA CIMV Advance Composite Fibers exergy Vertech Group TECNARO ecoPULP	**INNOBITE** http://www.innobite.eu/#&panel1-1	INNOBITE contributes to the development of sustainable consumption and production patterns through the development of new technological solutions based on the efficient use of natural resources. The INNOBITE project will transform urban and agricultural residues into high performing, resource efficient products for the emerging Green Construction sector. The project is supported by two innovative ideas: (1) Adding value to the inorganic fraction of wheat straw (2) **Obtaining cellulose nanofibres (MFC) from highly recycled paper**



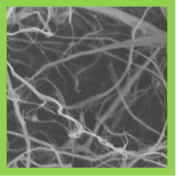


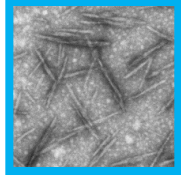
Cellulosic Nanomaterials (CNMs)

Programs, Networks and Entities

Worldwide

Countries	Institute(s)	Program	Mandate/Focus
France Finland Sweden Germany Netherlands	CERMAV (coordinator) CTP VTT University of Lund Produits Chimiques Auxiliaires et de Synthèse,SA (PCAS) University of Bremen Disa Solar, SAS obducat technologies, AB TNO	**GreeNanoFilms** European Project	To develop and apply ultra-high resolution nano-organized films by self-assembly of plant-based materials for opto- and bio-electronics. Life cycle assessment, risk assessment and validation of the industrial feasibility will be performed. (2014-?)
Europe	BIO-based Industry Consortium	BBI	BBI is a public-private partnership aiming at increasing investment in the development of a sustainable bio-based industry sector in Europe



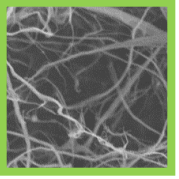


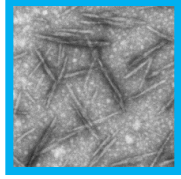
Cellulosic Nanomaterials (CNMs)

Programs, Networks and Entities

Worldwide

Countries	Institute(s)	Program	Mandate/Focus
Japan	AIST consortium – as of May 11, 2015, the council consists of: Ministry of Economy, Trade and Industry (METI) Ministry of Agriculture, Forestry and Fisheries Forestry Agency – Ministry of Agriculture, Forestry and Fisheries Ministry of the Environment The University of Tokyo Kyoto University Kyushu University Hitotsubashi University Japan TAPPI Oji Holdings Corporation Nippon Paper Industries (150 companies, 54 researchers, 33 public authorities)	Nanocellulose Forum https://unit.aist.go.jp/brrc/ncf/eng/index.html	▪ Facilitate practical uses of nanocellulose by Japanese companies ▪ Provide research trends, collaboration opportunities, programs to develop human resources, and information about standardization and safety/risk issues ▪ Share information and opinions and enhancing cooperation among R&D organizations and enterprising bodies in the field of materials, processing, and manufacturing equipment, and also between supply and demand sides
Malaysia	Countrywide	Consortium for nanocrystalline cellulose research	Initiated in 2013 with initial funding of RM 1.978 million by the government of Malaysia 3 research programs: (1) CNC production process (2) CNC applications (3) Novel CNC applications





Cellulosic Nanomaterials (CNMs)

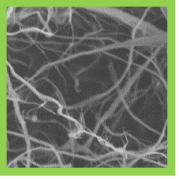
Programs, Networks and Entities

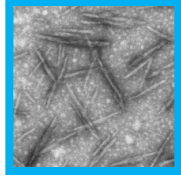
Worldwide

Countries	Institute(s)	Program	Mandate/Focus
Australia New Zealand	Australian Research Council Industry Transformation Research Hub; co-funded by Federal Australian Government, pulp and paper industry in Australia and New Zealand	BioProcessing Advanced Manufacturing Initiative (BAMI)	Transform the Australian Bioresource processing industry, by developing new products and materials from existing biomass resources Includes nanocellulose projects on membranes and barriers

Conferences

- Conferences at which cellulosic nanomaterials are the main topic or form a significant portion of the material



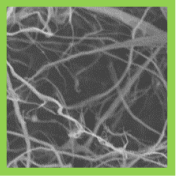


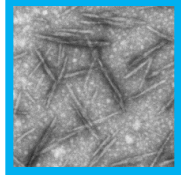
Cellulosic Nanomaterials (CNMs)

Conferences in 2015-2016

Worldwide

Country	Conference	Organizer(s)	Focus/Topics
USA	Division of Cellulose and Renewable Materials Symposia 249th ACS National Meeting & Exposition March 22-26, 2015	ACS	▪ Functional lignocellulosics and nanotechnology
	Renewable Bioproducts Institute 2015 Executive Conference March 10, 2015	Georgia Tech	▪ Annual RBI industry executive conference addresses challenges in strategic areas of the bioeconomy, including: ▪ Biocomposites and Nanocellulose
	SWST 2015 International Convention June 7-12, 2015	Society of Wood Science and Technology	▪ "Renewable Materials and the Bio-Economy" ▪ Nanotechnology of Lignocellulosics session
	69th FPS International Convention June 10-12, 2015	Forest Products Society	▪ "The Convention is a showcase for ideas: research, development, philosophy, technology. The boundaries between industry sectors are gone. Cross-pollination is the goal." ▪ The theme is "Unlocking the Potential of Forest Products" and includes a session targeting advances in technology, including nanotechnology
	2015 TAPPI International Conference on Nanotechnology for Renewable Nanomaterials June 22-25, 2015	TAPPI	▪ Multi-disciplinary exploration of how nanotechnology can transform biomaterials into high-value products that expand and transcend traditional forest products ▪ Fundamental Research: characterization, isolation, functionalities ▪ Industry Applications: manufacturing applications, new markets, other end user issues ▪ Research perspectives and business acumen ▪ Leading researchers, industry experts, government representatives and other stakeholders



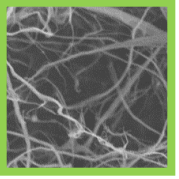


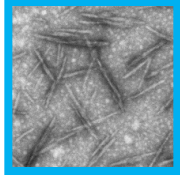
Cellulosic Nanomaterials (CNMs)

Conferences in 2015-2016

Worldwide

Country	Conference	Organizer(s)	Focus/Topics
USA	Symposium at the 2015 MRS Fall Meeting & Exhibit November 29 - December 4, 2015	Materials Research Society	▪ "Nanocellulose Materials and Beyond: Nanoscience, Structures, Devices and Nanomanufacturing" ▪ Topics addressed in this symposium include • Nanocellulose and other biomaterials • Nanocellulose-based functional structures and nanomanufacturing such as 2D/3D structures and hierarchical assembly
	Pacifichem 2015 December 15-20, 2015	ACS, CSC, CSJ, NZIC, RACI, KCS, CCS	▪ Decreasing demands in printing and writing papers over the last decade has led to significant efforts worldwide in the development of new products including MFC or NFC, also known as cellulose nanofibrils (CNF). ▪ The focus of this symposium will be on the dissertation of advanced products from lignin and MFC or NFC, innovative processes for their production, and their potential applications.
Portugal	ICNF2015 – From Nature to Market *2nd International Conference on Natural Fibers* April 27-29, 2015	Fibrenamics TecMinho Universidade do Minho	▪ Turn scientific knowledge into natural fiber-based innovative products ▪ Nanodimensional natural fibers (nanocellulose), among other topics ▪ Keynote: *Biomimetic functional materials based on cellulose and chitin nanofibers*, Qi Zhou, KTH
France	ICBPE 2015 : XIII International Conference on Bioenvironmental Polymer Engineering May 18-19, 2015	WASET World Academy of Science, Engineering and Technology	▪ New advances and research results in the fields of Bioenvironmental Polymer Engineering ▪ Nanocellulose composites, among other topics
	2016 TAPPI International Conference on Nanotechnology for Renewable Nanomaterials June 13-16, 2016 (Grenoble)	TAPPI	▪ Fundamental Research: characterization, isolation, functionalities ▪ Industry Applications: manufacturing, new markets, etc. ▪ Research perspectives and business acumen ▪ Leading researchers, industry experts, government representatives and other stakeholders



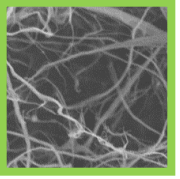


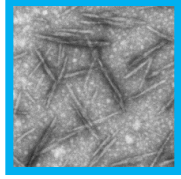
Cellulosic Nanomaterials (CNMs)

Conferences in 2015-2016

Worldwide

Country	Conference	Organizer(s)	Focus/Topics
Poland	2nd International Symposium on Bacterial NanoCellulose September 9-11, 2015	Lodz University of Technology GCK	▪ Accelerate scientific and technological development to lead to innovative BNC products ▪ Biosynthesis, modifications and industrial production of BNC ▪ Molecular, economical, legal aspects of BNC
Spain	5th International Conference on Biobased and Biodegradable Polymers (BIOPOL-2015) October 6-9, 2015	ECNP Universidad de Alicante Università degli studi di Perugia Universidad del País Vasco	▪ Bioplastics from natural polymers, directly extracted from biomass ▪ Thermoplastic and thermosetting bioplastics, indirectly produced from biomass ▪ Bioproduction, biotech & biodegradability ▪ Multiphase systems ▪ Industrial applications ▪ Valorization of agro-residues and wastes for synthesis of monomers and chemicals
	European Workshop on Lignocellulosics and Pulp (EWLP 2016) June 28-30, 2016	To be confirmed	▪ New lignocellulose-based materials ▪ Chemistry of biomass deconstruction ▪ Pulping and bleaching processes ▪ Biotechnological approaches ▪ Lignocellulose bio-refinery ▪ Chemistry of the fiber cell wall
United Arab Emirates (Dubai)	Global Experts Meeting & Expo on Nanomaterials and Nanotechnology April 25-27, 2016	OMICS International	▪ Lignocellulosic Biomass is one focus: ▪ Nanocellulose can play a vital role in developing the existing healthcare products ▪ As more and more research activities are carried out across the globe, the market will be seeded with newer products and acceptance of nanocellulose based products is bound to increase ▪ As the nanocellulose industry prospers, the need for industrial production will bring in new manufacturing processes





Cellulosic Nanomaterials (CNMs)

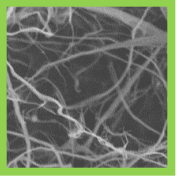
Major Conferences in 2015-2016

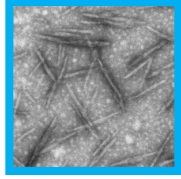
Worldwide

Country	Conference	Organizer(s)	Focus/Topics
Malaysia	Conference on Nanotechnology and Bioresource Technology (NBT2015) March 28-29, 2015	Universiti Kebangsaan Malaysia (UKM)	▪ Bio-polymers & bio-composites ▪ Advanced bio-composite materials ▪ Sustainable materials for manufacturing ▪ Paper and pulp ▪ Nanocellulose ▪ Natural fibres modification and applications ▪ Nanocomposites, nanoparticles, nanocrystalline material
Japan	International Symposium on Wood Science and Technology 2015 March 15-17, 2015 in Tokyo	Japan Wood Research Society	▪ No information on cellulosic nanomaterials
	Nanocellulose Symposium March 20, 2015	Nanocellulose Forum and Research Institute for Sustainable Humanosphere, Kyoto University	▪ No information on cellulosic nanomaterials
	Pulp and Paper Research Conference June 4-5, 2015 in Tokyo	Japan TAPPI	▪ Session on Nanocellulose
Canada	CSC 2015, 98th Canadian Chemistry Conference and Exhibition June 13-17 2015	Canadian Society for Chemistry	▪ Symposium entitled "Frontiers of Cellulosic Materials" organized by Wadood Hamad (FPInnovations) and Mark McLachlan (UBC)
Australia	Fibre Value Chain Conference & Expo 2015 November 11-12, 2015	Appita	▪ One day workshop on cellulosic nanomaterials

Standards Development and Regulations

- Published standards for CNMs
- Ongoing work items
- Regulations affecting CNM trade



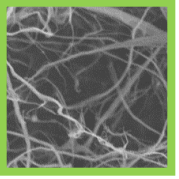


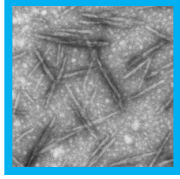
Cellulosic Nanomaterials (CNMs)

Standards Development

Worldwide

Standards Organization/ Committee(s)	Project Type	Details
ISO/TC 229 Nanotechnologies	Technical Report	**TR19716** – *Characterization of Cellulose Nanocrystals: Particle Morphology, Purity and Surface Properties* **Status:** Out for ballot (July 2015) **Contact:** Linda Johnston, NRC Linda.Johnston@nrc-cnrc.gc.ca
	New Work Item Proposal	**N 1235** – *Standard Terms and their Definition for Cellulose Nanomaterials* **Status:** Reviewed at Paris meeting (April 2015), in progress **Contact:** Your national member body – see www.iso.org
ISO/TC 229 Nanotechnologies **CEN/TC 352** Nanotechnology	Mandate	**Mandate M/461** identifies 45 standardization projects (TS or TR) on nanomaterials in the field of "characterization of and exposure to nanomaterials" and "health, safety and environment" **Status:** As of September 2011, many subjects accepted, e.g.: ▪ Identification and definition of measurands required for characterizing, evaluating functional properties and performance of materials at the nanoscale ▪ Protocols for whole life cycle assessment of nanoscale materials, devices and products



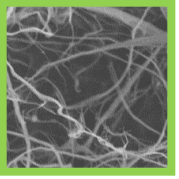


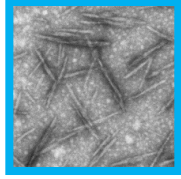
Cellulosic Nanomaterials (CNMs)

Standards Development

Worldwide

Standards Organization/ Committee	Project Type	Details
ISO/TC 6 Paper, board and pulps (cellulosic nanomaterials to be added)	Task Group	**TG 1** – Cellulosic nanomaterials **Status:** In progress **Convener:** Jean Bouchard, FPInnovations jean.bouchard@fpinnovations.ca
	New Work Item Proposal	**Proposed Draft** – *Determination of Cellulose Nanocrystal Sulfur and Sulfate Half-Ester Content* **Status:** In progress **Contact:** Stephanie Beck, FPInnovations stephanie.beck@fpinnovations.ca
CSA Group TC on Cellulosic Nanomaterials	CSA Standard	**CSA Z5100-14** – *Cellulosic nanomaterials – Test methods for characterization* **Status:** Completed, available for purchase **Contact:** Brian Haydon, Senior Project Manager, Canadian Standards Association brian.haydon@csagroup.org
TAPPI	TAPPI Standard	**WI-3021** – *Standard terms and their definitions for cellulose nanomaterials* **Status:** Transferred to ISO/TC 229
	Roadmap	**Roadmap for the Development of International Standards for Nanocellulose** **Status:** In progress, available for viewing **Contact:** World Nieh, US Forest Service wnieh@fs.fed.us





Cellulosic Nanomaterials (CNMs)

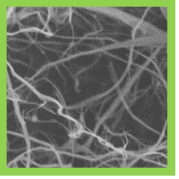
Regulations

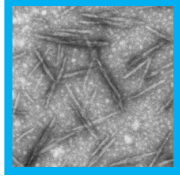
Worldwide

Organization/ Committee	Project Type	Details
National Agency for Food, Safety, Environment and Work (ANSES)	Regulation (France)	Entities must declare to ANSES when more than 100 g of nanoparticles are produced, imported or distributed

Summary of International Cellulosic Nanomaterials Activities

- Production and research as of July 15, 2015
- Confirmed companies, institutes, universities, etc. only





Cellulosic Nanomaterials (CNMs)

Production and Research Activities

Worldwide

		CNC	CNF
Production	Commercial or ≥ 100 kg/day	4	17+
	Pilot plant scale	5	8
	Total	**9**	**25+**
Research	Universities	52+	44+
	Institutes	22+	22+
	Industry	7+	4+
	Total	**81+**	**70+**