



Innovation Intelligence Sprint Report

Finding Plastic Free Coatings for Food
Contact Packaging

Prepared for Client X

Correct as of November 2025



An Introduction to Lumorro: What We Do

Lumorro is a one-stop-shop for consumer goods brands and manufacturers searching for more innovative, sustainable materials and technologies.

Launched by Rachel Myall after a decade developing technology innovation and investment events and ecosystems across materials, food, agriculture and water and with input from cross-industry advisors.

Combining human domain expertise and global networks with AI to accelerate discovery of viable alternatives across your business and value chain, and boost adoption through collaboration.

At our core is a proprietary intelligence and partnerships platform - think Pitchbook, but laser-focused on sustainable innovation for consumer goods and signals for successful technologies and collaborations. And we don't stop at data. We:

- ➔ **Map fragmented landscapes against real-world problems and growth opportunities:** from universities and research institutes, to start-ups and established technology providers; connecting the dots to identify trends and potential collaborations; and tracking commercialisation and industrialisation
- ➔ **Find technologies and solutions for any part of your business and value chain in one place -** from regenerative agriculture to plastic free and recycled materials
- ➔ **Introduce you directly to pre-vetted providers and partners we think are worth talking to -** that offer viable solutions, meet your specifications and align with priorities such as Scope 3 and EPR
- ➔ **Build successful collaborations with guided partnership development** to accelerate progress, improve outcomes and mitigate risks



What We Can Do For You

Lumorro is the gatekeeper to a world of alternatives and your fastest path from problem to partnership. We know where to look, where to focus and why - streamlining your efforts and accelerating outcomes.

Find Solutions

Innovation Intelligence Sprints & Introductions

Define your scope and find viable, compatible technology providers and partners - fast

- ✓ Deep research and viability assessments across our database + global networks
- ✓ 5 guaranteed email introductions to compatible, pre-qualified companies
- ✓ 15-page innovation intelligence report (landscape + rationale for recommendations)

We also offer extended and multi searches.

Meet Innovators

Innovation Tours & Networking Dinners

Build relationships with the right people - we identify innovators and bring them to you

- ✓ Small-group, invite-only, 1-day programmes
- ✓ Hosted on your own site with facilitated workshops / meetings / pitches / testing
- ✓ Networking dinner nearby (private or open for investors etc to join you)

We can also take your teams on innovation tours to visit hubs, labs and facilities around the world.

Build Partnerships

Collaboration Acceleration Programmes

Accelerate partnerships, improve outcomes and ROI, and mitigate risks with our support

- ✓ Partnership planning & roadmap
- ✓ Stakeholder engagement & management
- ✓ Objective setting & progress reporting
- ✓ Communication / negotiation / mediation

We also bring in additional expertise (e.g. technical, commercial, legal) from our networks as required.

Retained Services Also Available for ongoing trend tracking and partner/project management

Your Sprint Report



Executive Summary – Part 1

Your company faces a critical nine-month deadline to reformulate 200+ SKUs of packaging coatings worth EUR 69 million annually, driven by EU regulations and competitive pressure.

In response to your brief, this Innovation Intelligence Sprint identifies commercially viable cellulose-based alternatives that can replace current fossil-fuel based plastic formulations while maintaining performance.

Your team has acknowledged that there is no one silver bullet solution, that a mix of suppliers and solutions will need to be engaged in your major geographic markets, and that tests of recommended technologies will be required in addition to this research and due diligence.

Key Findings:

- Market momentum is accelerating - the cellulose-based barrier coatings sector has matured significantly in the past 18 months. Multiple technologies have progressed from pilot to commercial scale, with established production capacity and proven food contact compliance
- Nanocellulose leads the field - cellulose nanocrystals (CNC) and microfibrillated cellulose (MFC) technologies now achieve barrier performance matching or exceeding plastic and PFAS-based solutions, with OTR and WVTR approaching target specifications
- Drop-in compatibility verified – our research prioritised technologies that can integrate with standard industrial coating equipment (gravure, slot die, curtain coating) and minimise CapEx requirements - a critical factor for your reformulations
- Multiple partnership structures are available - companies range from acquisition targets (early-stage with strong IP) to licensing partners (established production) to ingredient suppliers (buy ready-to-use formulations), enabling your company to build a diversified supplier portfolio
- Volume capacity exists - combined production capacity should be sufficient to support your reformulation needs

Executive Summary – Part 2

Top 5 Recommended Companies

- 1. CelluForce (Canada)** - World leader in CNC production; recently launched CelluShield coating (Sept 2025); established commercial operation with 300 t/year capacity. Best near-term partner for immediate volume needs.
- 2. Borregaard (Norway)** - Exilva MFC is a commercially established, food-contact approved additive for barrier coating formulations. Available as 2% suspension or 10% paste for customers to incorporate into their own coating systems. Major global supplier with proven applications across Europe and US markets.
- 3. Sappi (South Africa/Global)** - mechanically fibrillated cellulose Valida functions as both a standalone barrier coating and additive to enhance other barrier systems. Large established company with operations in Europe, North America, and Africa. Demonstrated applications in food packaging with natural cellulosic structure for excellent substrate binding.
- 4. Melodea (Israel/Sweden)** - Two commercial barrier coatings (MelOx-NGen, VBseal) on the market with proven heat-sealing; traction with major CPG brands; Klabin strategic partnership; strong IP position and market validation.
- 5. CelluloTech (Canada/France)** - Breakthrough molecular-grafting technology; claims 50x cost advantage over traditional coatings; seed stage. High-risk, high-reward acquisition opportunity.

Strategic Implications

- Immediate action is required – with nine-month timeline in mind, competitors are already marketing alternative coatings and investors are watching closely
- A portfolio approach is essential - no single solution will serve all 200+ SKUs so a multi-supplier strategy is recommended combining established suppliers for mainstream volume with innovative technologies for competitive differentiation

Your Challenge

Your company is a global leader in specialty coatings and has built its reputation on innovation and sustainability. However, the food packaging coatings division faces urgent challenges driven by regulatory, competitor and investor pressures.

Regulatory Imperative

- EU PFAS restriction under REACH is expanding, with food contact packaging expected in 2026-2027 implementation wave
- Packaging and Packaging Waste Regulation (PPWR) mandates recyclability and reduces permissible material combinations
- Multiple member states (Denmark, Germany, Netherlands) advancing national plastic and PFAS bans ahead of EU timeline
- FDA also evaluating plastic and PFAS restrictions in food contact materials for US

Competitive Pressure

- Multiple competitors announced plastic-free and PFAS-free portfolios in past 12 months
- Industry peers securing strategic partnerships and exclusive supplier agreements
- Customer RFQs increasingly specify "plastic-free" as mandatory requirement
- Risk of market share loss as brands proactively reformulate ahead of regulations

Investor Scrutiny

- Board-level pressure to demonstrate progress on portfolio transformation
- ESG commitments include phasing out plastic and substances of concern
- Expectation of public announcement on plastic and PFAS alternatives by Q2 2026
- Recognition that delayed action creates reputational and financial risk

Operational Reality

- 200+ SKUs require reformulation across grease-resistant papers and heat-seal coatings
- Nine-month timeline from brief to commercial rollout (aggressive but necessary)
- Current formulations rely heavily on fluorinated chemicals and plastic-based binders
- Global customer base with varying performance requirements and regulatory contexts



Your Brief

Your company has already made several high-profile acquisitions and licensing agreements to add better, greener coating technologies to your portfolio.

However, there is recognition that not one silver bullet solution exists, so your company is expanding the search for plastic-free, PFAS-free, natural food packaging coatings that can be purchased, licensed or acquired from external suppliers and scale-ups in Europe and North America.

Innovation and sustainability are key points of differentiation, and there is particular interest in developments around cellulose - which has high potential and volume as the most abundant natural polymer on earth, but up to this point has known limitations for food contact packaging including poor tolerance against water vapor at high humidity.

Your Senior Leadership team has asked for updates and recommendations on nanocellulose-based products especially (CNC, CNF, MFC) given competitor portfolios.



Must Have Specifications						Nice To Have					
Commercially available cellulose-based coatings for flexible food contact packaging (TRL 7+)	Plastic-free and PFAS-free	Proven performance for grease-resistant papers and heat-seal coatings:				Recyclable in paper stream and Repulpable	Food Contact Compliant in EU and / or US	Drop In - or clear roadmap to becoming compatible or competitive with existing coating lines	Cost target: Within 15-25% of current coatings	Applicable for your other products & end markets (e.g. paint)	Open to investment or acquisition
		Grease resistance: Kit 10-12 minimum (fast food packaging)	Moisture barrier: WVTR below 1 g/m ² ·day at 1 gsm coat weight	Oxygen barrier: OTR below 1 cc/m ² ·day	Heat sealability: 120-180°C operational range						

Available Now: CelluForce (North America)

World Leader in Commercial CNC Production: TRL9

CelluForce is the world leader in the development, production and commercialisation of cellulose nanocrystals (CNC) and formulated CNC products.

The company was founded 2010 as a joint venture between private not-for-profit R&D organisation FPIInnovations and Resolute Forest Products and is headquartered in Montreal, Canada, employing more than 50 people and generating approximately CAD \$15-20M in annual revenue.

CelluForce operates the world's largest CNC plant, capable of producing 300 tonnes per year of high-quality sulfated cellulose nanocrystals, and launched its CelluShield barrier coating in September 2025 - a high-performance, bio-sourced, water-based CNC dispersion for recyclable flexible food and cosmetics packaging developed and tested with FPIInnovations.

Based on publicly available information and claims:

- Water-based, bio-based and free from plastic, PFAS, VOC, chlorine
- Excellent Performance: OTR below 1 cc/m²-day and WVTR below 1 g/m²-day at a target coat weight of 1 gsm
- Technology Maturity / Production Scale: Commercial production operational
- Sustainability Credentials: successfully passed biodegradability testing under aerobic, anaerobic, and marine conditions
- Recyclability: 100% recyclable and re-pulpable with mono-material design enabling PE, PP, or PET structures to meet EPR and PPWR
- Integration: Drop-in for existing production lines, applied using reverse gravure coating and compatible with standard lamination technology for PE, PP, and PET films, available as a ready-to-use coating for in-house application, or as a precoated film
- Compliant with FDA and Health Canada regulations

Rationale: addresses the majority of your SKU reformulation needs, with largest capacity and immediate availability

Consideration: Best for dry/frozen goods – may require hybrid approach for high-humidity applications and an additional layer for heat sealing requirements

Recommendation: explore a partnership – an ingredient supplier / straight forward purchasing agreement would be the fastest route. Alternatively, a licensing agreement to produce CNC coatings using CelluForce IP or co-development agreement to progress joint formulation for heat-seal applications within six-to-nine-month timeframe

Top 5 Recommendation

Firsthand Insight & Verification From Call with X

Including:

- Commercial Traction / Growth Plans for CelluShield
- EU Food Contact Compliance Timeline
- Supply Chain Security & Sustainability
- Available Capacity / Volume
- Indicative Pricing
- Investment / Acquisition Opportunities

Available Now: Borregaard (Europe)

Producer of the World's First Commercially Available Cellulose Fibril Product: TRL 9

Borregaard is a Norwegian company established in 1889, primarily known for its production of cellulose, lignin and other biochemicals derived from wood. The company operates one of the world's most advanced and sustainable biorefineries, manufacturing a range of products, including specialty cellulose, used in various applications such as food packaging and personal care.

Borregaard's Exilva® microfibrillated cellulose (MFC) is food contact approved, sustainable, multifunctional additive for improving the performance of water-based dispersion barrier coatings and would be an 'add-on-top' additive for your existing formulations.

It was the world's first commercially available cellulose fibril product. Development began in 2005 and the commercial production facility was opened in 2016, funded by Bio-based Industries Joint Undertaking under the EU framework programme Horizon 2020.

Based on publicly available information and claims:

- Innovation driven by the EU single-use plastic directive and PFAS bans
- Plastic-free, PFAS-free, biocide-free, USDA BioPreferred solution made from wood from Norwegian and Swedish forests
- Improves rheology, stability and water retention of barrier coatings, making it suitable for various substrates
- Helps to overcome challenges such as product strength, lightweighting, and achieving better surface smoothness and enhanced barrier properties without plastic liners
- For applications including adhesives, cosmetics household cleaning products and composites as well as coatings and packaging materials

Rationale: an established multinational with proven production capabilities and solutions ready to deploy now

Consideration: Borregaard provides the raw cellulose fibril material – your company would need to formulate it into your own complete cellulose-based barrier coating system

Recommendation: Borregaard offers free samples to try out fibrillated cellulose products in your formulations so these should be requested as a priority

Top 5 Recommendation

Firsthand Insight & Verification From Call with X

Including:

- Growth Plans
- Technical Data and Proof Points
- Food Contact Compliance
- Recyclability & Re-Pulpability
- Supply Chain Security & Sustainability
- Available Capacity / Volume
- Indicative Pricing
- Partnership Opportunities

Available Now: Sappi (Europe)

Global Pulp and Paper Company with Commercial Scale MFC: TRL 7 - 8

Top 5 Recommendation

Sappi is a global pulp and paper company with a diverse portfolio and established nanocellulose production.

The company was founded in 1936, with HQ in South Africa and production facilities in the Netherlands, and €10+ billion annual revenue for the group.

Markets and applications are diverse: dissolving pulp, specialty papers and biomaterials for packaging, coatings, cosmetics, homecare and more.

Its mechanically fibrillated cellulose - branded as Valida - is a natural cellulose product that offers robust barrier performance as a stand-alone application by filling macropores and coating surfaces and also to enhance the barrier performance of other barrier additives.

Based on publicly available information and claims:

- Performance: Excellent oxygen barrier and grease resistance properties
- Technology Maturity: 8+ years development (2016 pilot to 2024+ commercial)
- Production Scale: Commercial production operational - pilot plant for R&D and scale-up
- Sustainability: 100% natural, biodegradable, FSC-certified wood fiber
- Integration: Part of wider division (Sappi Biotech) focusing on biomaterials commercialisation
- Infrastructure: established supply chain with integrated pulp mills providing consistent feedstock

Rationale: an established multinational with proven production capabilities and solutions ready to deploy now

Consideration: barrier coating for food packaging is not a primary commercial focus so may require validation / pilot – potentially impacting your nine-month timeline

Recommendation: explore a partnership asap – either ingredient supplier (your company purchases Valida MFC as raw material for coating formulation), technology transfer (your company licenses Sappi's fibrillation technology for in-house production) or co-development of food packaging barrier formulations. Consider doing so alongside CelluForce and/or Melodea for a diversified strategy and both short and mid term solutions

Firsthand Insight & Verification

From Call with X

Including:

- Technical Data and Proof Points
- Food Contact Compliance
- Recyclability & Re-Pulpability
- Available Capacity / Volume
- Indicative Pricing
- R&D / Growth Plans
- Investment / Acquisition Opportunities

Available Now: Melodea (Europe)

Early Commercial & Scaling: TRL 7 - 8

Melodea is a leader in the sustainable industrial production of Cellulose Nano Crystals (CNC) from forestry by-products and has two plastic-free, PFAS-free, recyclable barrier coatings - MelOx-NGen (oxygen barrier) and VBseal (vapor barrier + heat-seal).

These offer advanced oxygen and moisture barrier technology for plastic, paper or molded pulp plus heat-sealing properties on a par with EVOH and metallised materials and enable manufacturers to replace multi-layered packaging with a single material. The company was founded by materials scientist Dr. Shaul Lapidot in 2010 with headquarters in Israel and production facility in Sweden. It is early commercial stage (TRL 7-8), with funding from VCs and Brazilian paper/packaging producer Klabin, and current capacity of dozens of tons of CNC, on dry basis, per year with plans to increase to hundreds of tonnes a year.

Based on publicly available information and claims:

- Water-based and free from plastic, phthalates, PFAS, BPA and other harmful ingredients
- Excellent Performance: OTR <0.5 cc/m²·day (MelOx) and WVTR 2-5 g/m²·day estimated (VBseal)
- Technology Maturity: TRL 7 - 8
- Capacity: Dozens of tonnes currently - scaling to 500 t/y by 2026-2027 with Klabin partnership
- Sustainability: efficient and sustainable extraction method that enables recovery of chemicals used in production process
- 100% recyclable (PTS and CEPI certified) and re-pulpable
- Integration: drop-in for plastic, metallised films and paper-based materials and can be applied using standard industrial machines to lower CapEx (printed using commonly available equipment like gravure machines, slot dies, and curtain coating)
- Food contact compliant: BfR approved (Germany) and FDA due Q1 2026
- Also offers renewable paint additive formulations

Rationale: Dual-product portfolio directly addressing two of your primary coating categories, while VBseal's unique heat-sealing capability eliminates the need for additional layers. Scaled-up European production and early CPG validation too

Consideration: Your company may need a hybrid approach to achieve a higher barrier specification

Recommendation: Explore a partnership asap – an ingredient supplier / straight forward purchasing agreement would be the fastest route, or a licensing agreement to produce CNC coatings using Melodea IP. Also opportunity for strategic investment with a Series C round likely in 2026.

Top 5 Recommendation

Firsthand Insight & Verification From Call with X

Including:

- Technical Data and Proof Points
- Commercial Traction / Growth Plans
- Vbseal heat-sealing specs
- Shelf-life extension specs
- EU Food Contact Compliance Timeline
- Supply Chain Security & Sustainability
- Indicative Pricing
- Investment / Acquisition Opportunities

Available Next: Cellulotech (North America)

High-Risk, High-Reward Investment or Acquisition Opportunity: TRL 5 - 6

Cellulotech offers a proprietary, patented, bio-based, solvent-free, breakthrough green chemistry process that brings hydrophobicity to hydrophilic reactive substrates.

Chief Scientist Daniel Samain has developed a unique molecular-grafting process for cellulose modification to replace plastic, PFAS and other harmful incumbents across packaging, hygiene, textiles and construction - enabling protection from grease, oxygen and vapour while preserving the recyclability and biodegradability properties of the initial substrate.

The company is headquartered in Canada with an office in France, is pre-revenue (TRL 5-6), with a small team of 8 people (mostly R&D specialists) who raised a Seed Round this year.

Based on publicly available information and claims:

- Patented, bio-based, solvent-free, plastic-free, PFAS-free breakthrough chemical reaction that suppresses capillarity and creates high-performance barriers
- Bespoke: the right combination is developed at the lowest cost possible to achieve the required performances for each application's needs
- Cost Competitive: up to 95% cheaper than current solutions due to much less material intensity per sqm, and the cost of specific equipment depending on the required specs is estimated to be similar to a coating machine
- Fast: with 0.1 second process suited for 2D and 3D substrates
- Sustainable: up to 92% less CO2 emissions than current materials
- Repulpable, compostable, biodegradable: if substrate such as paper is so before treatment, it will remain so afterwards
- Compliance: the fatty acids that are grafted are molecules consumed everyday in food so are safe, but Cellulotech has proactively secured approval from the FDA and EU for PVOH coated paper for example
- Gaining early traction with 60+ customers leads with NDAs in place, paid research projects with fortune 500 companies, and validated samples

Rationale: CelluloTech is the only viable acquisition target in this report. A Seed stage company with a breakthrough patented technology, founder ownership, and funding urgency create an opportunity to secure potentially lucrative IP and exclusive access to flexible, scalable molecular grafting solution

Consideration: Very much an early-stage company so not ready for nine-month timeline but worth consideration for longer term competitiveness and differentiation

Recommendation: Conduct additional due diligence and testing with a view to acquiring or investing

Top 5 Recommendation

Firsthand Insight & Verification From Call with X

Including:

- Commercial Traction / Growth Plans
- Series A Fundraising Plans & Runway
- Technical Data for OTR, WVTR, Heat-Sealing as depend on applications
- Available Capacity / Volume
- Indicative Pricing
- Investment / Acquisition Opportunities

Additional Options

Impermea Materials offers BIO-PAK - a next-generation suite of bio-based, plastic-free, PFAS-free, recyclable, compostable, repulpable, compliant barrier coatings engineered for paper and paperboard packaging and outperforming traditional plastic and polyethylene coatings on moisture, grease, oxygen barrier properties and operational efficiency. However, Impermea Materials has an exclusive strategic partnership with INX International Ink Co to accelerate commercialisation that may prevent a collaboration with your company.

MakeGrowLab produces an innovative, tree free cellulose ('SPM Nanocellulose') derived from biowaste through microbial fermentation. Non-toxic and home-compostable with enhanced barrier properties and improved mechanical strength. Founded in 2016 in Poland, with notable backing from the likes of Plug & Play and EIT Food, although still at Accelerator / Incubator stage so an option for co-development rather than a commercially available drop-in.

Finecell produces high-performance, sustainable materials from natural, bio-based cellulose nanofibers with a scalability first approach - ensuring compatibility with standard industrial equipment, no hazardous chemicals or solvents, waste-free with over 95% material yield, and ability to operate at low temperatures. The company can produce modified cellulose pulp, cellulose hydrogels and dry and redispersible flakes of cellulose nanofibers for use in cosmetics and personal care, paper packaging, paints and coatings, and water cleaning. Early stage but fundraising now for EUR 1.5 Million so could be a strategic investment opportunity.

VTT Technical Research Centre of Finland is a state-owned and controlled non-profit limited liability company. It is one of Europe's leading research and innovation institutions and provides services and information for domestic and international customers and partners in private and public sectors. The organisation led the ZeroF Project in 2023 to develop safe and sustainable coating alternatives to replace PFAS compounds in food packaging and upholstery textile value chains. So, may be worth contacting for advice and support during this transition – or potentially to develop your own solution.

Wildcard: GO-Eco's Graphene-Oxide Nanomaterial

Northwestern University researchers led by Adjunct Professor of Mechanical Engineering Timothy Wei and Professor of Chemistry SonBinh Nguyen recently announced the development of a new water- and oil-resistant material derived from graphene oxide that could become a safe, viable replacement for harmful plastics and toxic PFAS in food packaging. GO-Eco — a subsidiary of Chang Robotics and a resident startup at Northwestern's Querrey InQbation Lab (The Q) — is now commercialising the patent-pending product. Independent, third-party industry-standard evaluations have shown that Northwestern's material significantly improves strength and barrier properties compared to current commercially available solutions so this could be an investment or acquisition opportunity in your North America market.



Next Steps

- Schedule a video meeting to discuss findings and rationale behind the recommendations, and share additional insights from firsthand calls
- Confirm which companies you would like to be introduced to
- Confirm if follow on services are needed – tours to company labs and facilities, networking dinners and collaboration acceleration programmes

“Rachel has a track record of connecting the dots between companies and technologies, and opening up opportunities for commercial collaborations. We met Xampla at the Rethinking Materials Summit in 2022, have been working together ever since to bring their biomaterials to market, and are now exclusive European manufacturing partner.”

Business Director, 2M Group of Companies

Appendix



Methodology & Sources

Our searches combine proprietary database access, trained AI tools and direct conversations with technology innovators to surface intelligence unavailable through desk research alone.

Following an in-depth briefing to define your requirements, we search Lumorro's proprietary platform and wider innovation ecosystem to identify compatible providers and partners.

For this cellulose-based barrier coating brief, we identified 20 potential companies and organisations.

We evaluate and score each against your specific criteria to create a vetted shortlist of 10, then conduct 30-minute verification calls with senior leaders at each company to confirm capabilities, assess commercial readiness and uncover additional insights.

This process results in our top 5 recommendations - compatible companies that we will personally introduce you to in line with your priorities.



Market Landscape

The cellulose-based barrier coatings market has reached a critical inflection point in 2025, transitioning from research projects to commercially viability technologies. Multiple factors have converged to accelerate adoption:

Regulatory Push

- EU PFAS restrictions are creating multi-billion EUR replacement market
- EU PPWR is driving demand for mono-material, recyclable packaging
- Some individual national governments are moving faster than EU timeline
- FDA scrutiny on fluorochemicals in US food packaging

Customer Pull

- Many CPG brands still have goals of achieving fully recyclable, reusable and compostable packaging despite some revisions to targets and timelines
- Retailers (especially in Europe) are mandating plastic and PFAS elimination from private label products
- Consumer awareness increasing, especially around health risks, leading to willingness to pay premium for non-toxic alternatives
- Packaging converters seeking differentiation as well as regulatory compliance

Technology Maturation

- First-generation cellulose coatings achieved oxygen barrier but failed on moisture
- Second-generation nanocellulose formulations are now approaching plastic and PFAS-level performance
- Industrial-scale production facilities commissioned (CelluForce 300 t/y)
- Equipment manufacturers adapting standard coating lines for bio-based formulations



Technology Landscape: Availability

Three primary cellulose nanostructures dominate the barrier coatings space:

Cellulose Nanocrystals (CNC)

- Structure: Rod-like crystalline structures, 5-20 nm diameter, 100-200 nm length
- Production: Produced via acid hydrolysis of cellulose pulp
- Advantages: Excellent oxygen barrier, high surface area, well-characterized production
- Leading Companies: CelluForce, Melodea, CelluloTech
- Status: Commercial production established; food contact approved
- Barrier Performance: OTR consistently <1 cc/m²·day; WVTR 1-5 g/m²·day depending on formulation

Cellulose Nanofibrils (CNF) / Microfibrillated Cellulose (MFC)

- Structure: Long, flexible fiber structures, 5-30 nm diameter, micrometers length
- Production: Produced via mechanical fibrillation (high-pressure homogenization, grinding)
- Advantages: Excellent mechanical strength, good oxygen barrier, higher yield than CNC
- Leading Companies: Borregaard, Sappi
- Status: Commercial and pilot scale; food contact pathways established
- Barrier Performance: OTR <5 cc/m²·day typically; WVTR variable

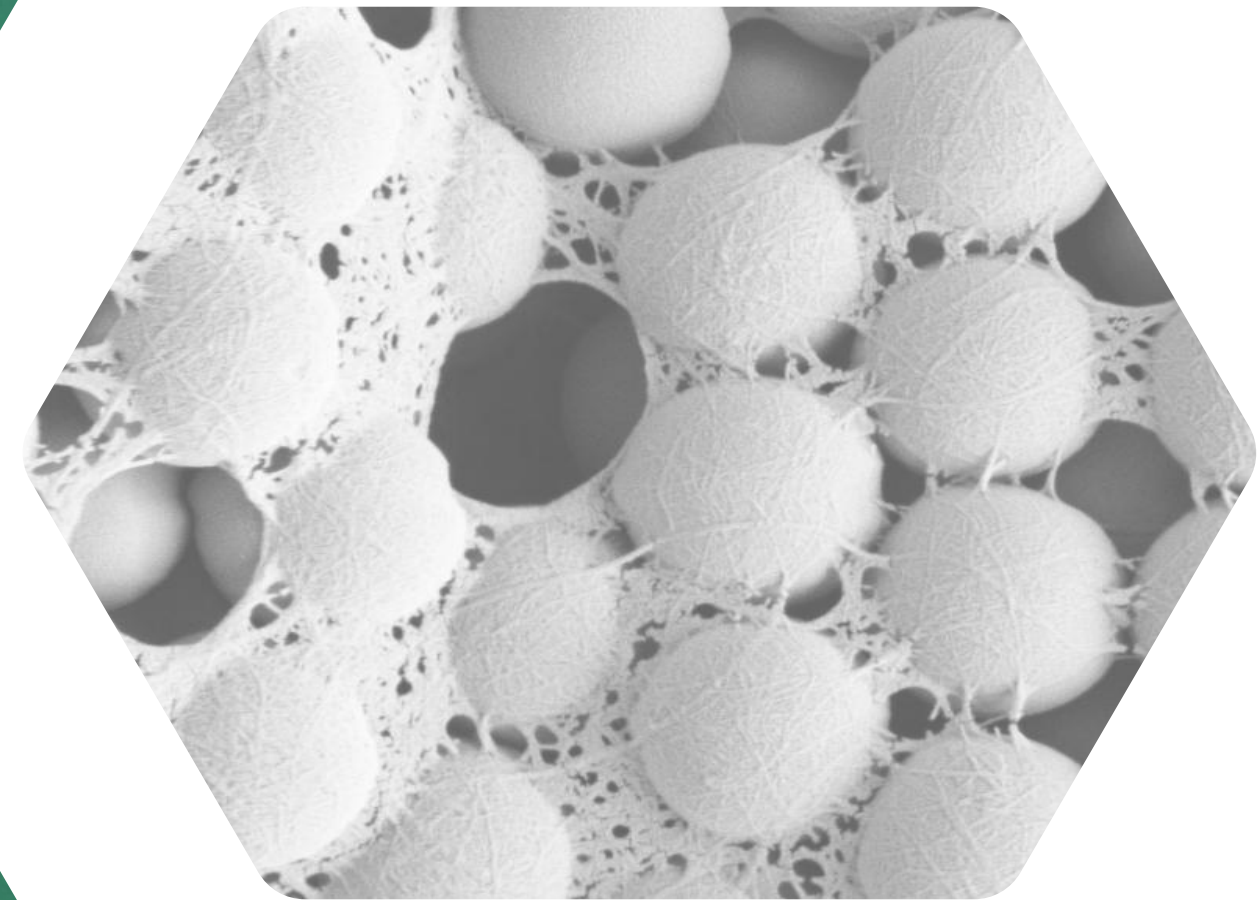
Feedstock Diversity – enabling your company to craft differentiated narratives for different customer segments:

Wood-Based (Traditional)

- Examples: CelluForce (Canadian kraft pulp)
- Advantages: Established supply chains, consistent quality, regulatory history
- Challenges: Deforestation concerns (though most are FSC-certified sustainable)

Agricultural Waste

- Examples: MakeGrowLab (bio-waste fermentation)
- Advantages: Circular economy; valorises waste; avoids forestry concerns
- Challenges: Supply chain complexity; seasonal availability; purity/consistency



Technology Landscape: Performance

Performance Benchmarks

Based on calls and technical data shared by companies, the oxygen barrier (OTR) offered by nanocellulose coatings is approaching performance parity with plastic and PFAS -based incumbents, while the moisture barrier (WVTR) is dependent on the formulation as the range can be significant.

Indeed, the WVTR challenge remains the primary technical hurdle for nanocellulose coatings, as cellulose is inherently hydrophilic and water vapor uptake at high humidity degrades barrier performance.

Companies are addressing this through:

- Chemical modifications (grafting hydrophobic groups - CelluloTech approach)
- Hybrid formulations (combining CNC/CNF with other bio-based barriers)
- Multilayer structures (cellulose for oxygen + thin biopolymer for vapor)
- Process optimisation (alignment, density, coating weight)

