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Cellulose Nano Crystals (CNC), Bio-building blocks for tomorrow's materials

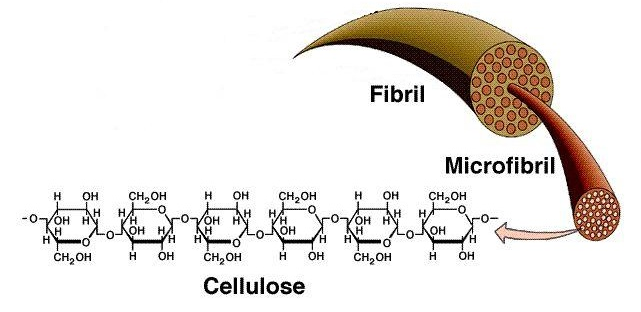
Tal Ben Shalom, senior researcher

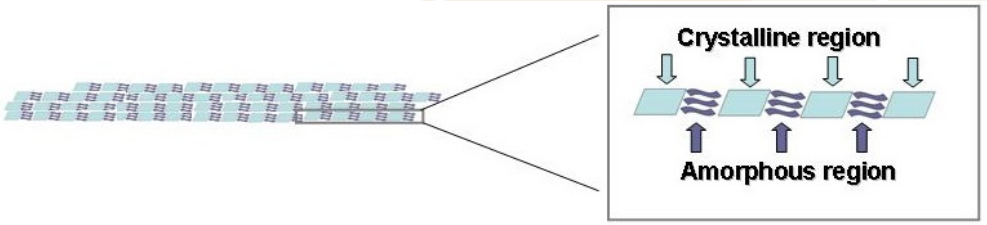
Melodea at a glance

- Founded in 2010 by researchers from the Hebrew University and Swedish industrialist from the composite industry
- Developed proprietary technology for CNC production and development of applications
- Investment and partnership with HOLMEN AB, Sweden. A large Pulp and Paper company
- Pilot production in Israel
- Semi industrial plant is being built in Sweden
- Granted above $1 million from the European Commission research funds (FP7)
- Strong IP portfolio

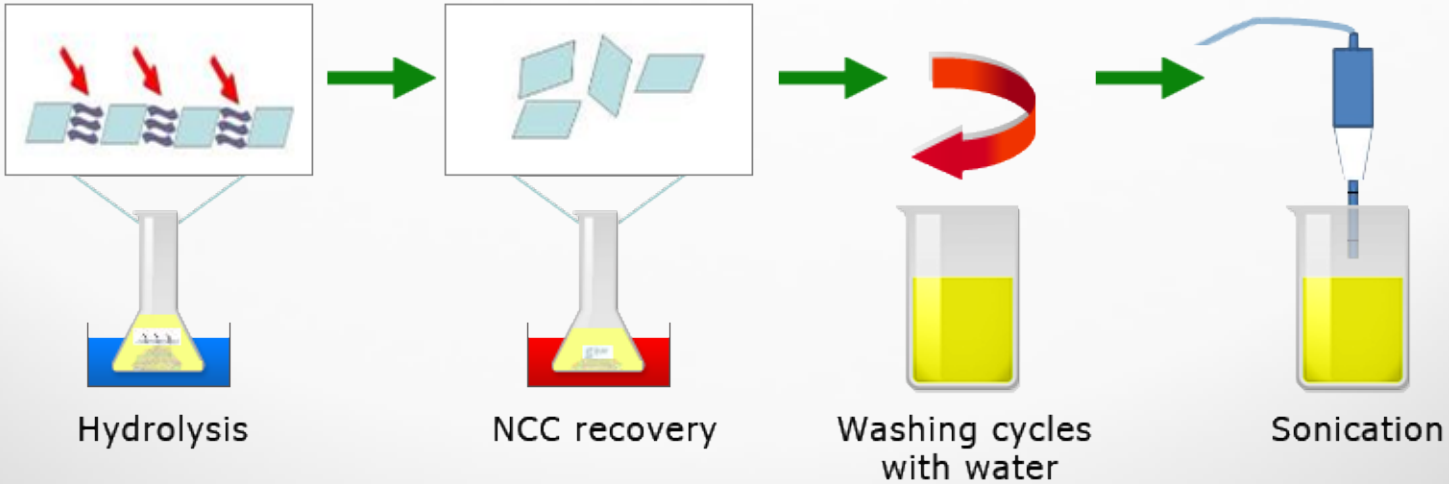
Cellulose Nanocrystals (CNCs)

Cellulose fibers contain amorphous and crystalline areas





Controlled acid hydrolysis of cellulose results in degradation of the amorphous regions and release of the crystals termed **"CNC"**



Method For Production Of Cellulose Nano Crystals From Cellulose-Containing Waste Materials PCT/IL2011/000613

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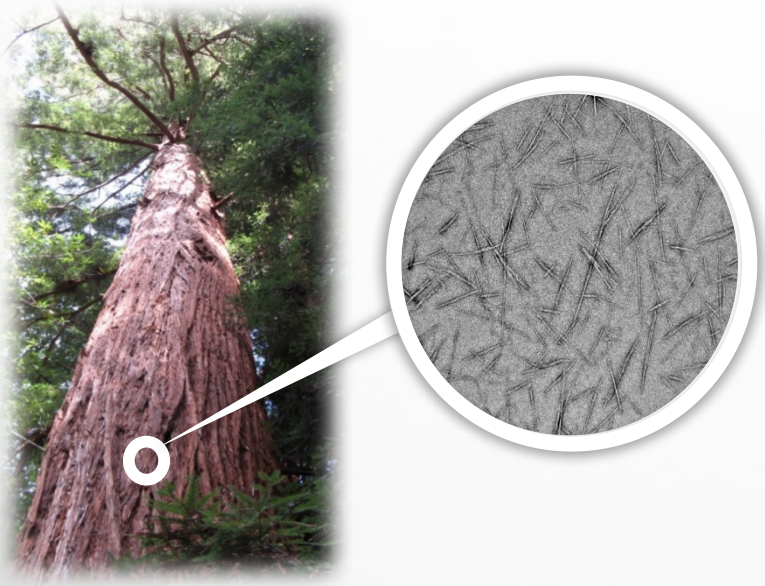
Cellulose Nano Crystalline (CNC)

- Stronger than steel!
- Excellent for production of novel eco-friendly materials
- CNCs are a promising candidate for enhancing mechanical properties of composites



Estimated CNC mechanical properties

Material	Elastic Modulus [GPa]	Tensile strength [GPa]
CNC	~150	~10

Moduli of engineering materials compared to cellulose

Material	Modulus (GPa)	Density (Mg m^{-3})	Specific modulus (GPa Mg^{-1} m^3)
Aluminium	69	2.7	26
Steel	200	7.8	26
Glass	69	2.5	28
Crystalline cellulose	138	1.5	92

Eichhorn *et al.* J Mater Sci (2010)

*CNC is also termed NCC

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CNC production technology

Melodea's unique technology allows efficient and sustainable extraction of CNC from cellulosic materials

Cellulosic raw materials; wood pulp, paper waste, flax, cotton and more

Chemical processing

CNC product → applications

Melodea's process is unique to include recycling of up to 95% of the chemicals, saving costs, and minimizing the environmental production impact

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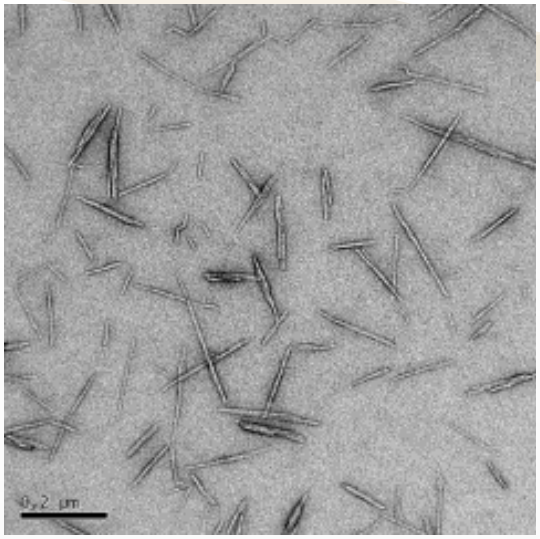
CNC Product Properties



- Transparent dispersions of nano particles in water
- Dimensions: 5-20 nm width, 150-400 nm length
- Self assembly to gels, films and foams
- Additive for enhancement of various materials

Semi industrial plant being built in Sweden

- First CNC plant in Europe, capacity of 100 kg/day under construction
- Being built at MoRe research in Örnsköldsvik, Sweden
- Collaboration between Melodea, Holmen, MoRe research and SP Sweden.
- Launch is expected at Q4 of 2016

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What can CNC be used for?

Foams for composites and insulation panels

Reinforcing of paper and paperboard

Solid lubricant friction reduction in seals

Coatings and barrier materials

Reinforcement of cement and mortars

Additive to plastics (bio-based and synthetic)

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CNC coatings and films

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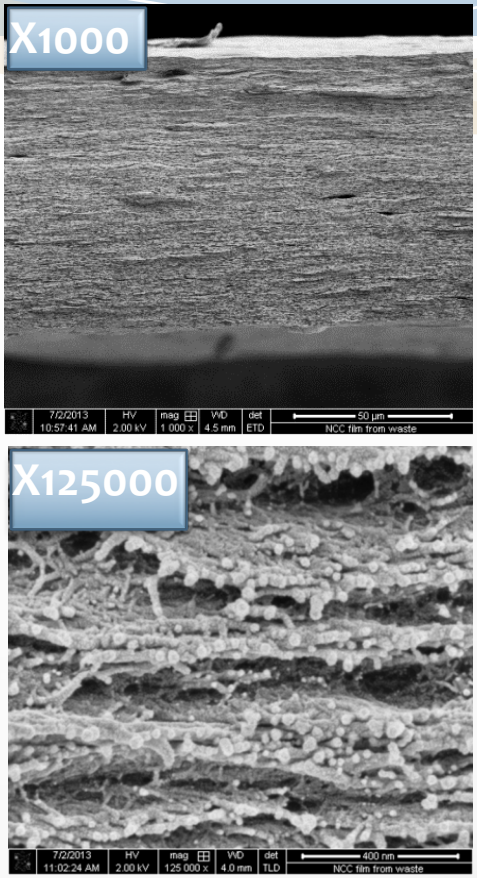
CNC self-assemble to highly ordered transparent films

CNC film



Ordered layered structure viewed by SEM

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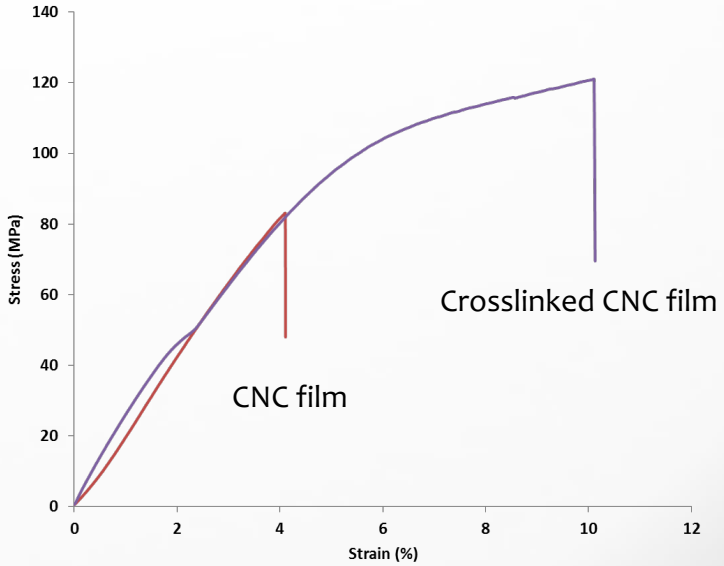
New development, high strength transparent CNC films



100% CNC film, no plastic support!

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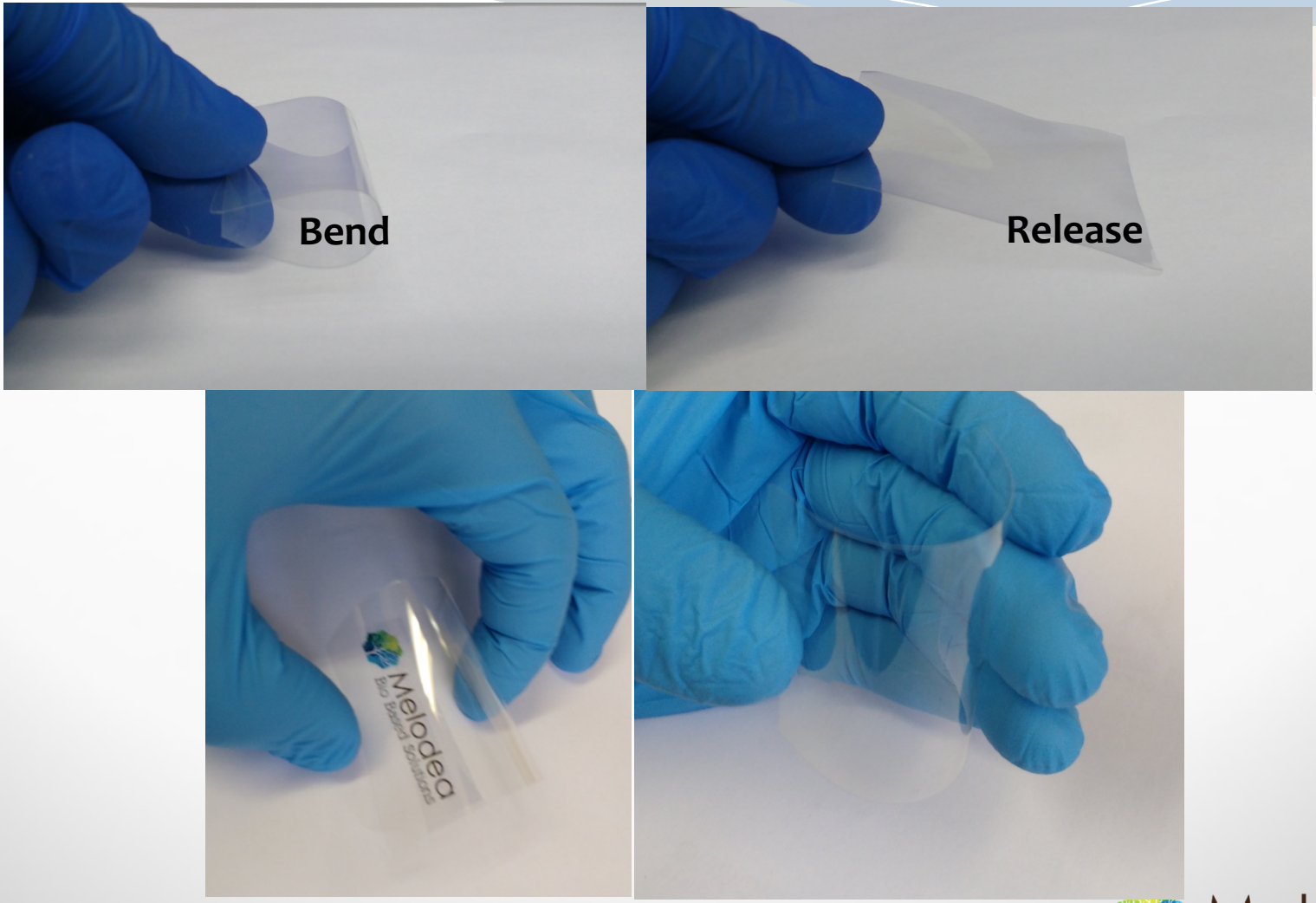
Crosslinked CNC films are transparent and flexible



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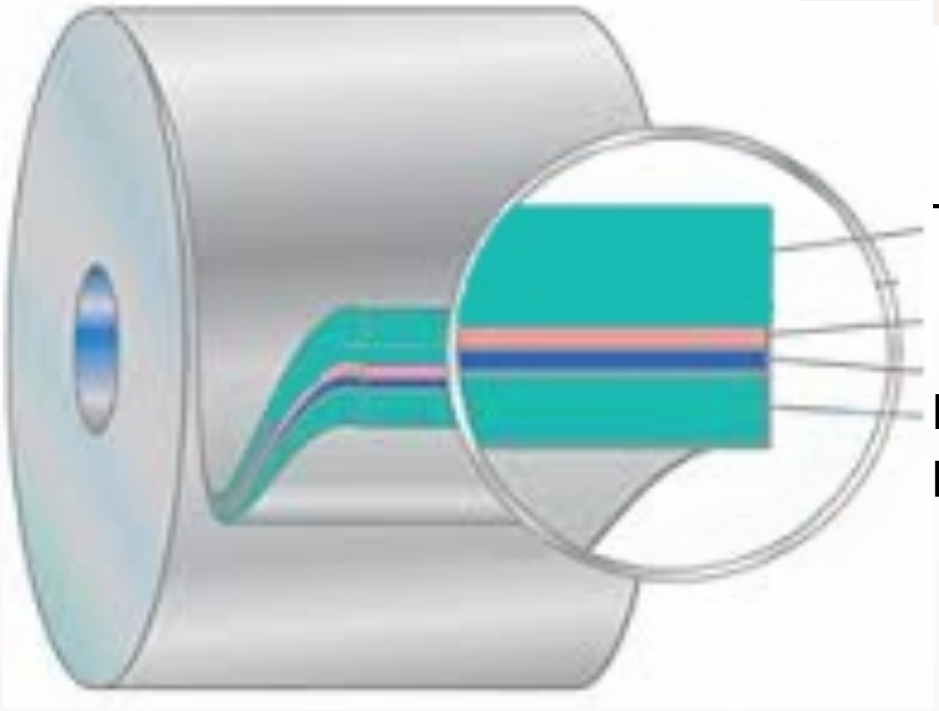
CNC films applications

- 100% biodegradable films for packaging
- Films for flexible electronics
- Carrier for other components e.g. nano-particles, fibers etc.
- Combination with conductive layers → flexible batteries

CNC coating solution for flexible films & paper board packaging



Cost effective, sustainable solution

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CNC film coatings for food packaging

- Reduction of BOPP oxygen permeability from 1580 to ≤ 1 cc /(m^2.day.atm)
- Similar results with other films (PET, PLA and more)

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Intermediate products, Hybrid CNC– metalized PET films

Coatings of metalized sheet OTR results:

- Metalized PET sheet control, **0.5** cc/(m^2.day.atm)
- Metalized PET sheet coated with CNC OTR <**0.002** cc/(m^2.day.atm)*
- Cost effective competition to current high cost barriers

*below the detection rate

Market demands

- High oxygen and mineral oil barrier
- Transparency
- Printability
- Recycling and sustainability
- Environmental awareness
- Biodegradable, compostable

*information based on Smithers Pira market research

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CNC barrier product technical goals

- Humidity Stability
- Higher barrier: <1 cc/(m^2·day·atm)
- Pilot coating trials
- Commercialization

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Our management team

Major General (res) Ilan Biran Chairman, wealth of experience in business management from the financial, telecom and defence industries

Dr. Shaul Lapidot Co-founder, CEO extensive leadership and experience in the field of nano-cellulose and bio-composites

Prof. Oded Shoseyov Co-Founder Prolific inventor, extensive experience in nano-biotechnology

Tord Gustafsson Co-founder, well known expert in composite materials

- Melodea development team is dynamic and experienced including 3 PhD's in Chemistry, plastics and polymer engineer, process engineer and chemists

Winner of Israeli Ministry of Economics Nanotechnology Innovation of the Year Award

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Ways to collaborate with us

- Joint product development
- Open for licensing our CNC production technology
- Investment

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Thank You

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