

Emerging materials from forest biomass feedstock

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FinnCERES Flagship

Redefining **Bioeconomy**

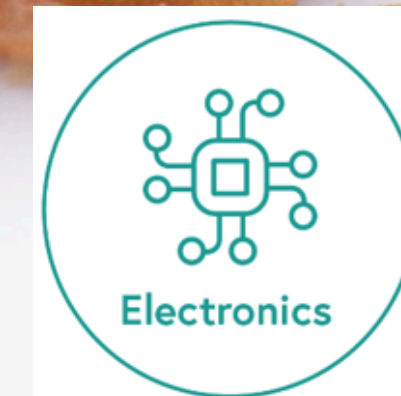
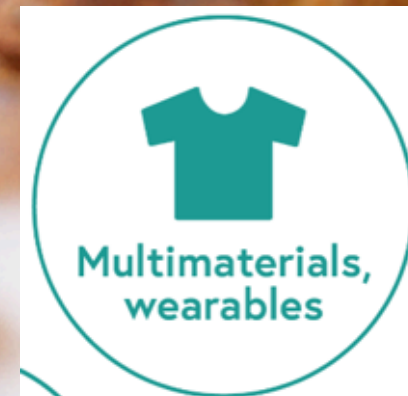
With advanced
bio-based materials

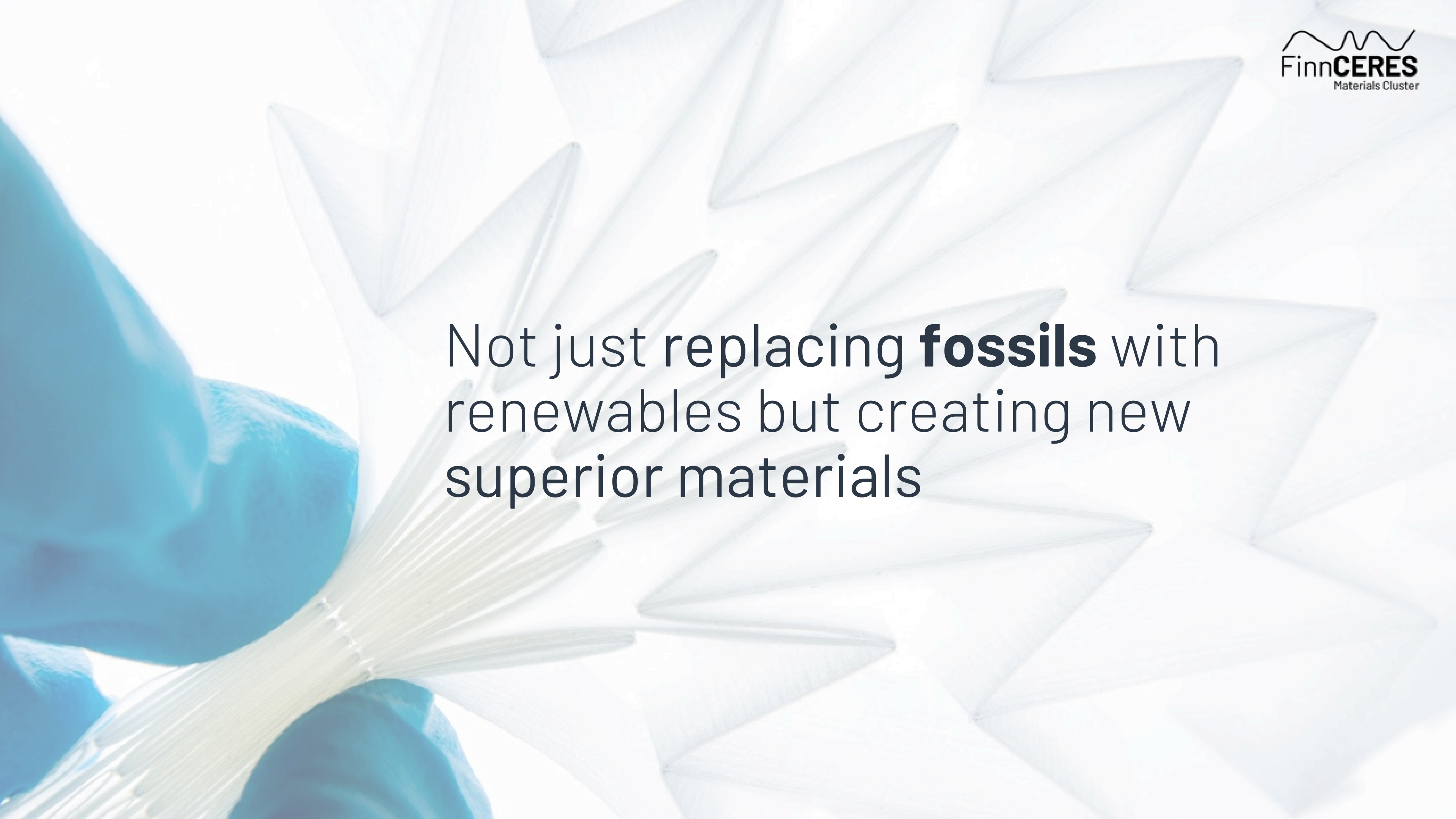
Global challenges

Urgent need to transform the existing materials paradigm

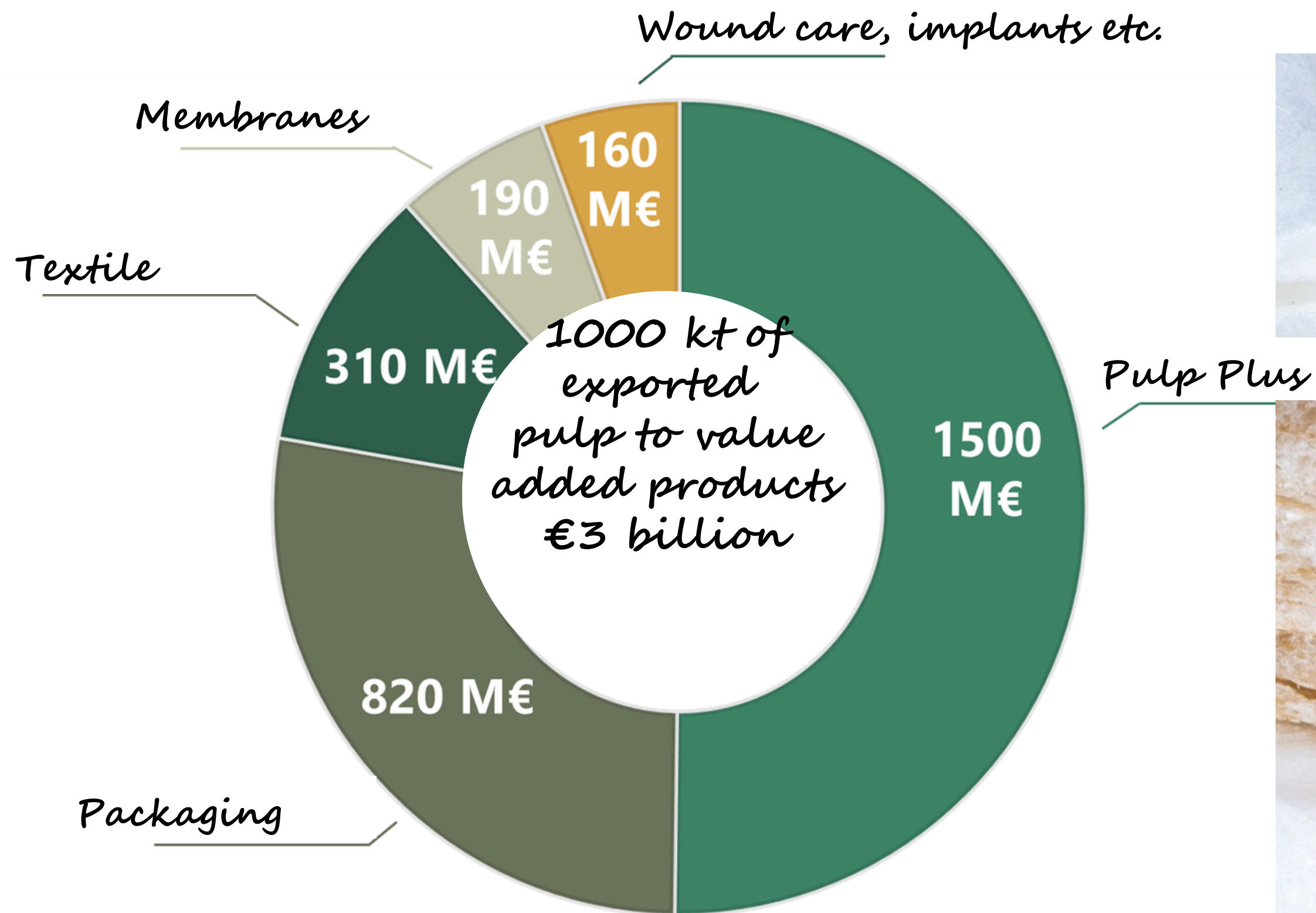
Over-reliance on fossil reserves
Resource insufficiency
Climate change

We harness the natural properties of lignocellulose to create **high-value materials and products for our sustainable future**



The background of the slide is an abstract composition of overlapping, translucent geometric shapes. On the left side, there are solid blue shapes that resemble stylized leaves or petals. The rest of the background is filled with numerous white, translucent, star-like or crystalline shapes that overlap each other, creating a sense of depth and complexity.

Not just replacing **fossils** with
renewables but creating new
superior materials





BIOBASED COATINGS AND ADHESIVES FROM WOOD



IMPROVED DYEABILITY WITH WOOD-BASED TEXTILE FIBER



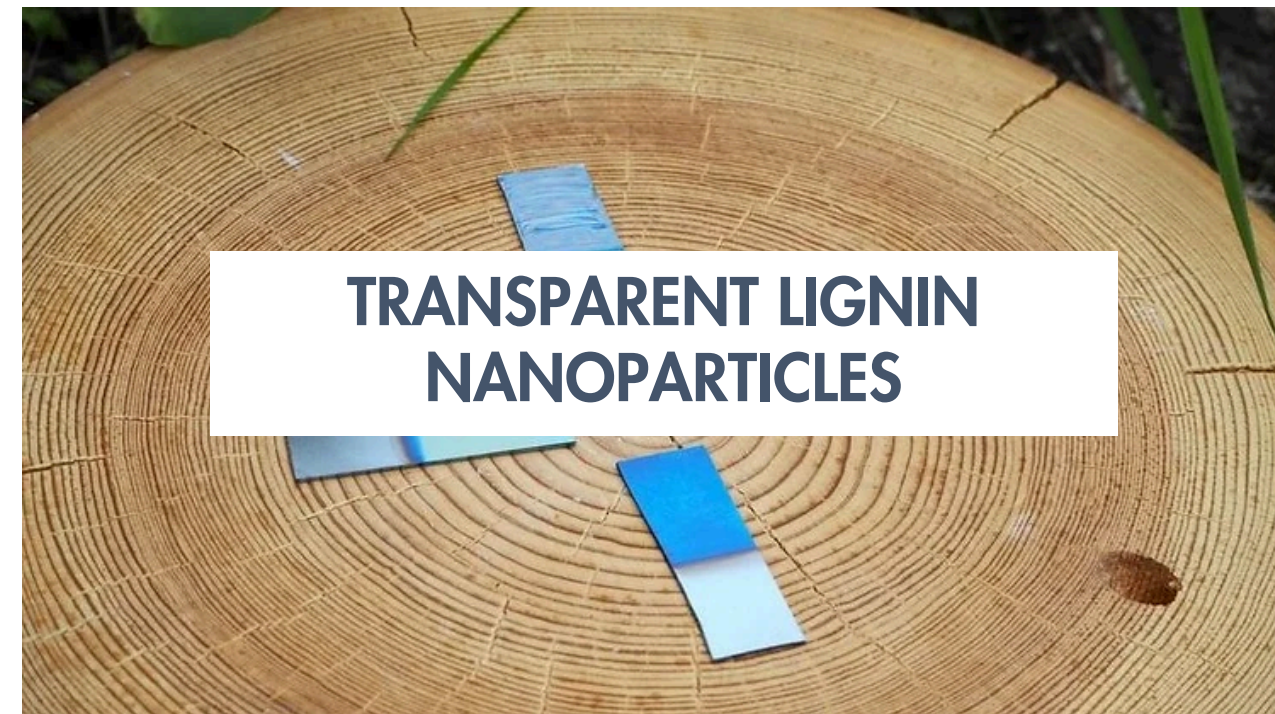
SUPERBLACK MATERIALS FROM WOOD



FOLDED PROTECTION



BIO-BASED FOAMS FOR PROTECTIVE PACKAGING



TRANSPARENT LIGNIN NANOPARTICLES



NEW TECHNOLOGY FOR FABRIC INDUSTRY



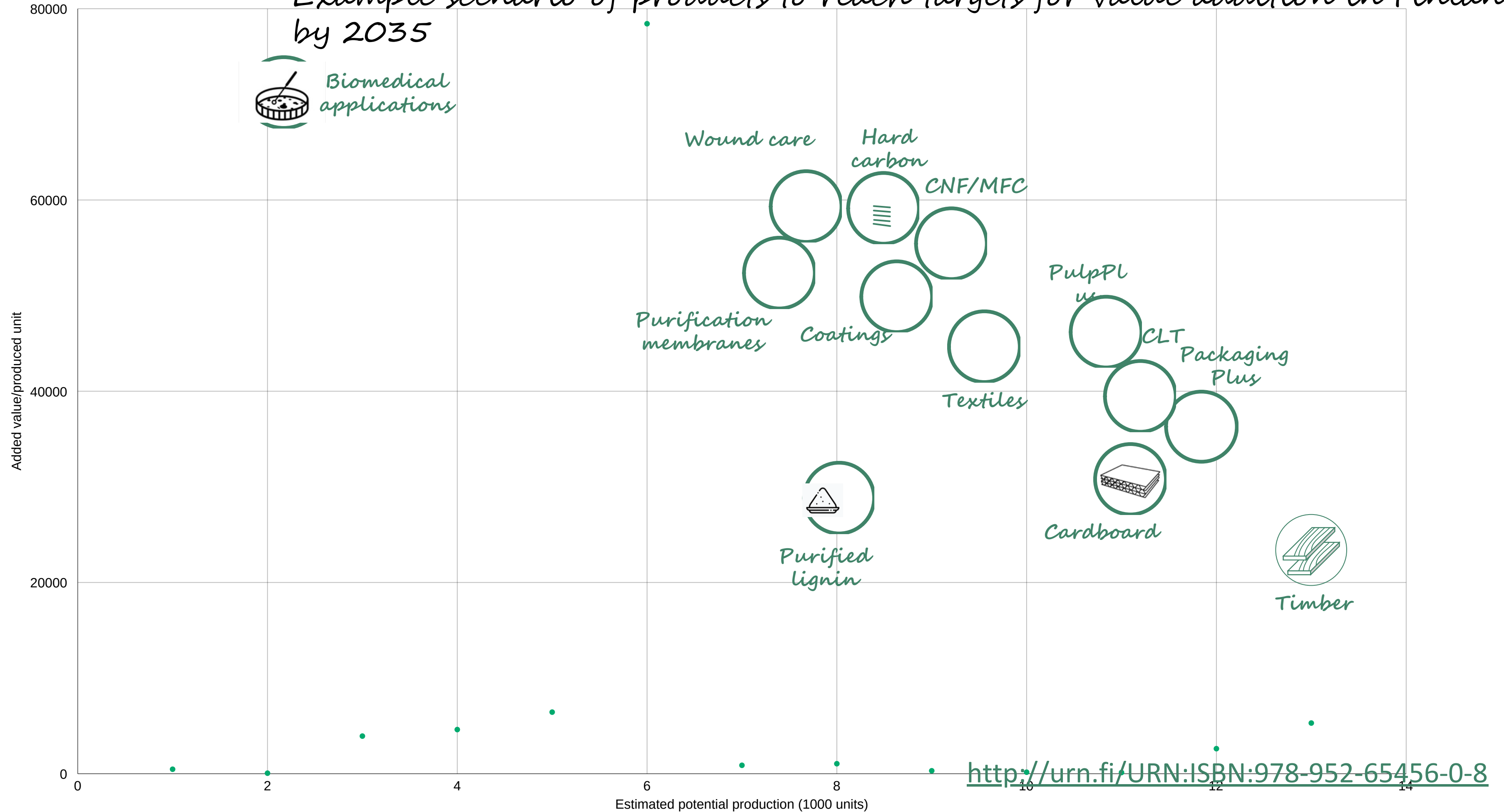
OPTICAL FIBRE FROM WOOD FOR SMART TEXTILES AND SENSING



SUSTAINABLE STRUCTURAL COLOUR FROM WOOD THAT DOES NOT FADE

Sustainable economic growth and competition for forest sector

Example scenario of products to reach targets for value addition in Finland by 2035



Lignocellulose in Advanced Materials

Cellulose provides

- Extreme hygroscopicity
- Breathability & moisture binding
- Ion permeability
- Gas and liquid transport control
- Phonon blocking

Lignin provides

- Amphiphilicity
- Antimicrobial feature
- UV shielding

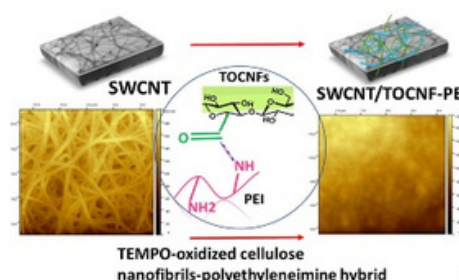
Biobased carbon provides

- Hydrophobicity
- Electrical conductivity
- Shielding electromagnetic radiation

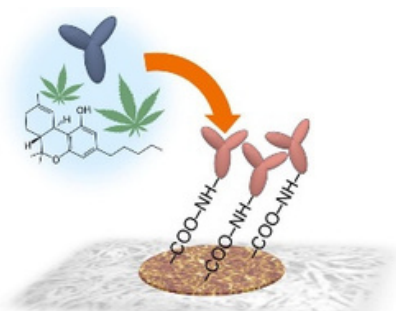
>600
publications
since 2018

Aalto & VTT
world leaders
in the field

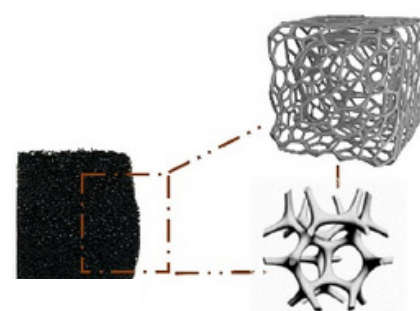
Detection & Recognition



Advanced nanocellulose-based **electrochemical sensor for antibiotics monitoring**¹



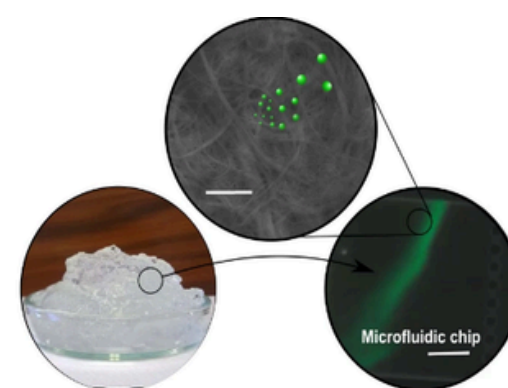
Cannabis detection by conjugating antibodies to nanocellulose²



Carbon foams for **electrochemical sensors**³

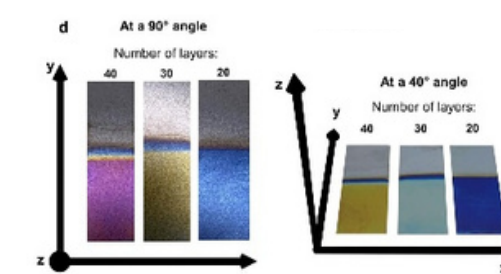
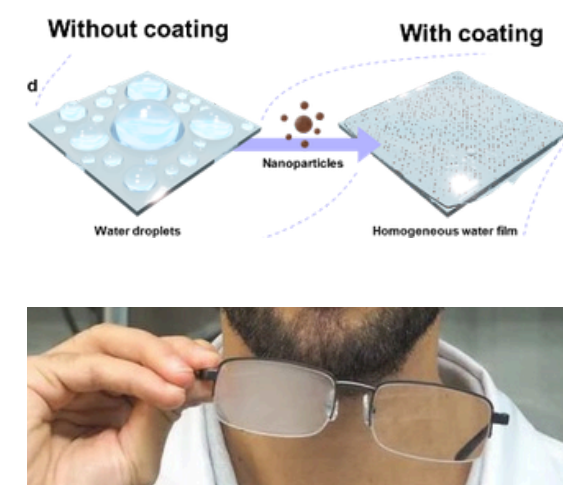
1. Nekoueian et al., *Electrochimica Acta* **2024**, 500, 144639, DOI: [10.1016/j.electacta.2024.144639](https://doi.org/10.1016/j.electacta.2024.144639)
2. Solin et al., *Carbohydrate Polymers* **2023**, 304, 120517, DOI: [10.1016/j.carbpol.2022.120517](https://doi.org/10.1016/j.carbpol.2022.120517)
3. Rodrigues et al., *Int. J. Biol. Macromol.* **2023**, 240, 124460, DOI: [10.1016/j.ijbiomac.2023.124460](https://doi.org/10.1016/j.ijbiomac.2023.124460)

Capture & Protection



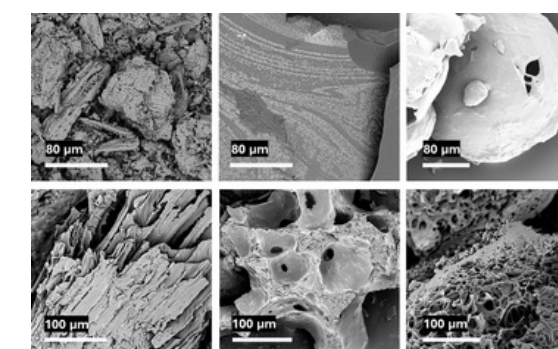
Capturing colloidal nano- and microplastics with nanocellulose networks¹

1. Leppänen et al., *Nat. Commun.* **2022**, 13, 1814, DOI: [10.1038/s41467-022-29446-7](https://doi.org/10.1038/s41467-022-29446-7)
2. Henn et al., *Chem. Eng J.* **2023**, 475, 145965, DOI: [10.1016/j.cej.2023.145965](https://doi.org/10.1016/j.cej.2023.145965)



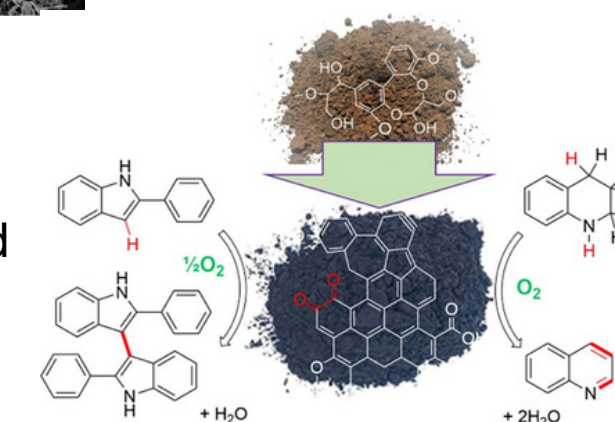
Lignin nanoparticles for **invisible antifogging and photonic films**²

Conversion & Storage



Lignin-derived carbon materials with **controlled nano-architecture**¹

Catalysis of (electro-) chemical reactions for material synthesis and energy management²



1. Robertson et al. *J. Anal. Appl. Pyrolysis*, **2024**, 183, 106811, DOI: [10.1016/j.jaap.2024.106811](https://doi.org/10.1016/j.jaap.2024.106811)
2. Lenarda et al. *ACS Catalysis*, **2023**, 13, 11362–11375, DOI: [10.1021/acscatal.3c02735](https://doi.org/10.1021/acscatal.3c02735)

MICROPLASTIC MANAGEMENT



Nanocellulose network collects colloidal plastic particles



Blue Sky Young Researcher
Award



Dr. Ilona Leppänen, VTT

**The
Guardian**

**Magnets, vacuums and tiny nets: the
new fight against microplastics**

18 Feb 2021



PROF. G. CEDER, UNIVERSITY OF CALIFORNIA AT BERKELEY:

"We will not develop novel materials without AI interactions with the physical world.
We are in the transformative time for science"

Berkeley Lab's A-Lab uses AI and robotics to synthesize new materials 24/7 without human intervention

MRS2026 presentation of Dr. Neethu Thomas on CO₂ capturing using polysaccharides

2026 MRS SPRING MEETING & EXHIBIT
April 26-May 1, 2026 | Honolulu, Hawai'i

MT02

Automated Materials Discovery in the Big Data Era

^MRS Communications Early Career Distinguished Presenters:
Yongtao Liu, Oak Ridge National Laboratory
Yumin Zhang, SES AI Corporation

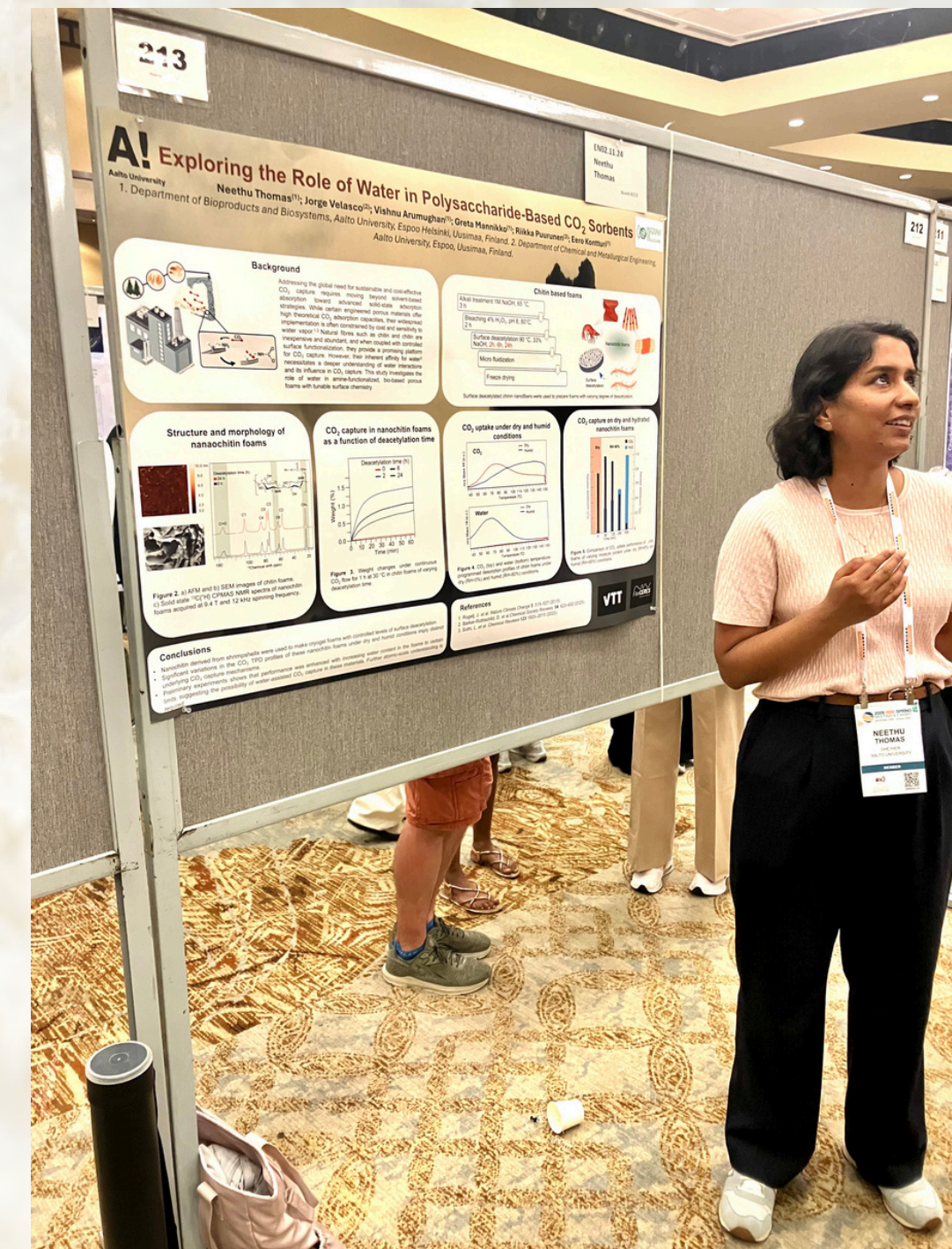
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APL Machine Learning



Adaptive forest management enhances bioeconomy to mitigate climate change, safeguard biodiversity and carbon stocks

Clearcutting after the attack of bark beetles



Thinning promotes the forest growth



Mixed-tree plantation boosts forest ecosystems



Concluding remarks: Bioeconomy for resilience

- **No biomass – no bioeconomy**
- **Sustainable competitiveness** should steer industrial policy towards biobased production
- **From lab to fab:** AI-driven material design as a continuous engine for breakthrough discoveries will enable the birth of new growth companies
- **Significant value added** with resource sufficient utilisation of forest biomass feedstocks
 - Bioenergy vs. added value materials vs. advanced materials vs long-lasting wood products



The new era of biobased materials

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