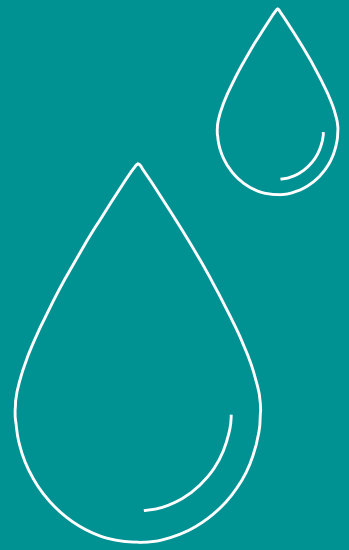
Capitalizing on Water Interactions

Tekla Tammelin

Industry meets FinnCERES

5th November, 2018



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Aalto University School of Chemical Engineering

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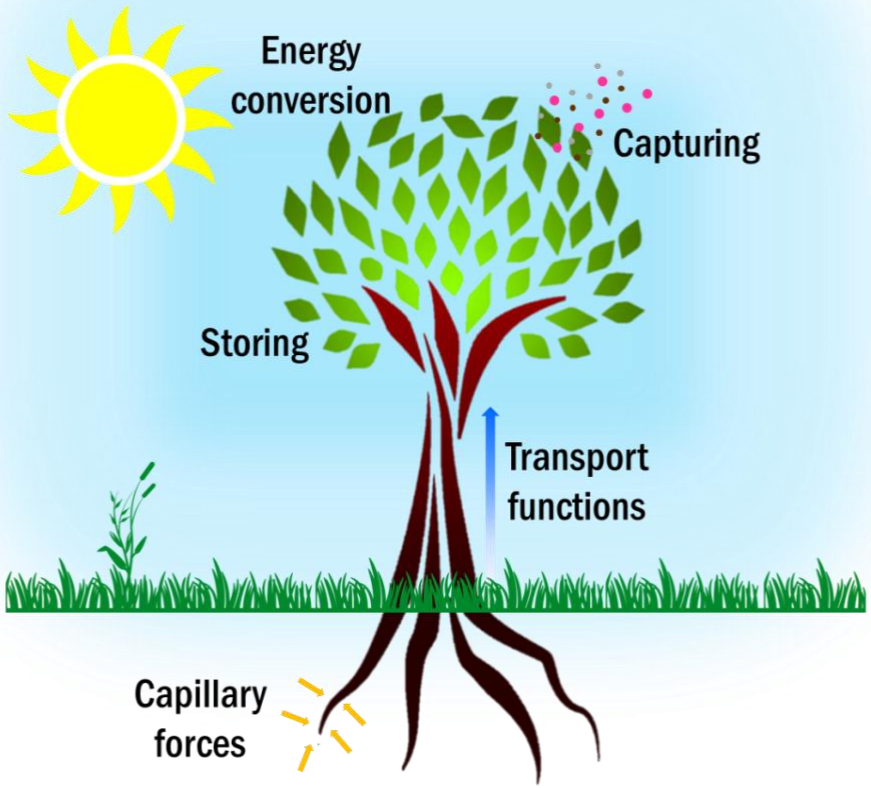
WATER INTERACTIONS ARE AT HEART OF BIOMATERIALS ENGINEERING



Plant cell wall functions based on water interactions

- *Hygroscopic, hydrophilic, fiber swelling*
- *In applications water usually seen as a detrimental feature*

Water interactions define behaviour and mechanisms

- *Biomass fractionation – isolation of the building blocks*
- *Reassembling structures – response to moisture and water*
- *Applications – draw inspiration from plant-based assemblies and functions*

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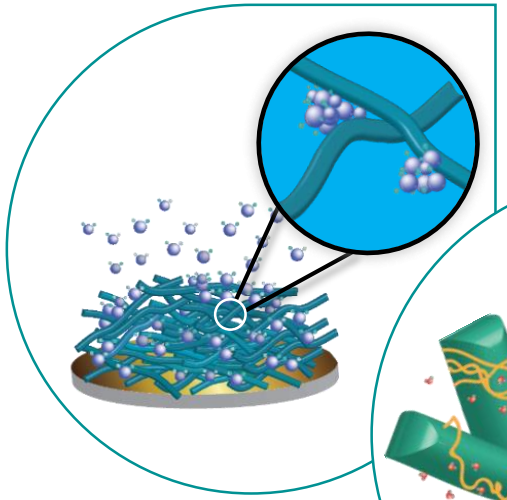
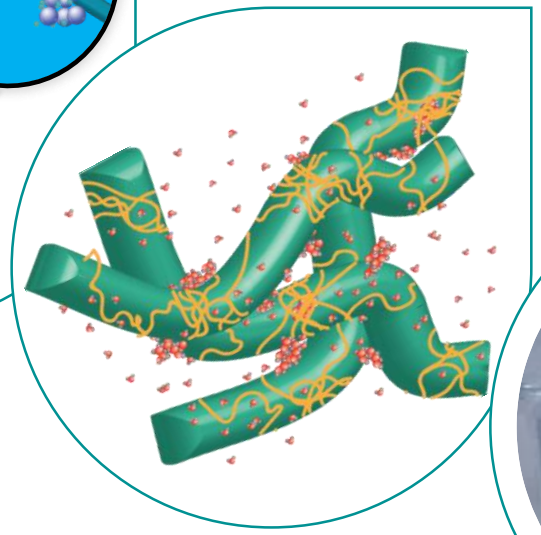
APPLICATIONS – Turning challenge to solution

From basic discoveries towards applications

PRONOUNCED WATER UPTAKE ABILITY

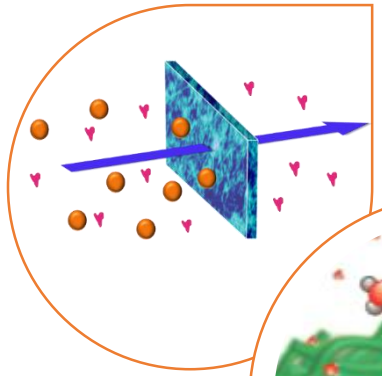


MOISTURE-RESPONSIVE STRUCTURES



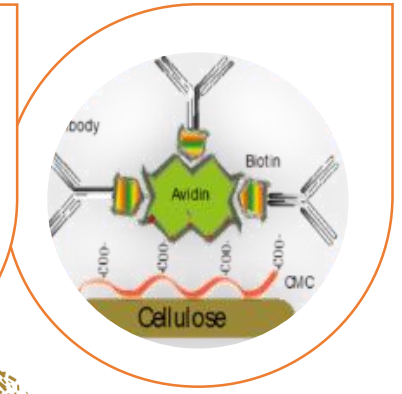
ENHANCED WET STRENGTH

BIOINSPIRED CONCEPTS FOR WATER PURIFICATION – Capturing microplastics



GAS AND VAPOUR CAPTURING MATERIALS

BIOBASED ELECTRONICS AND SENSOR ELEMENTS



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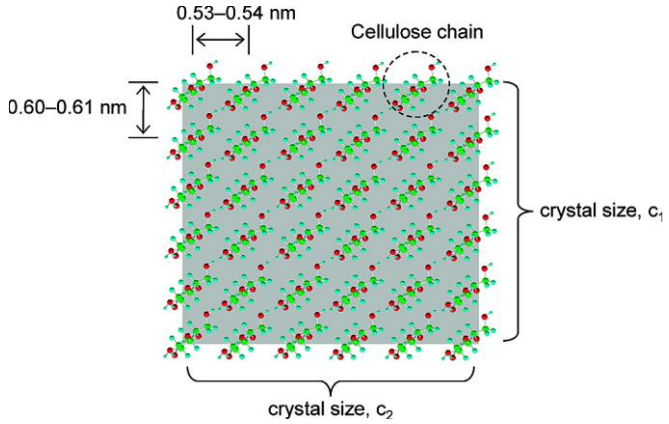
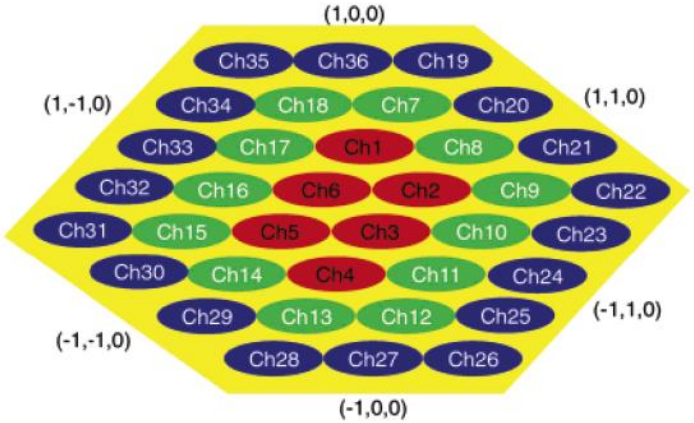
FUNDAMENTALS – Different models of cellulose microfibril structures under debate

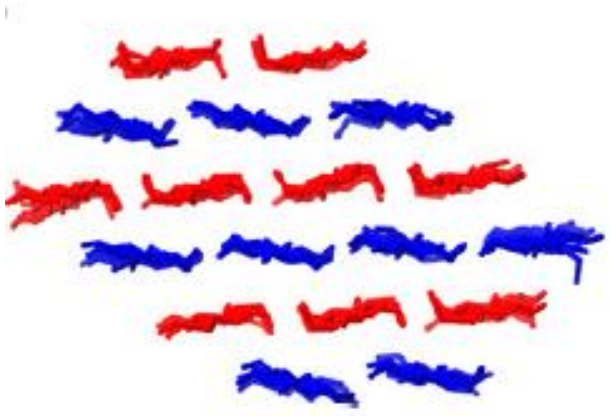
CLASSIC 6×6 MODEL



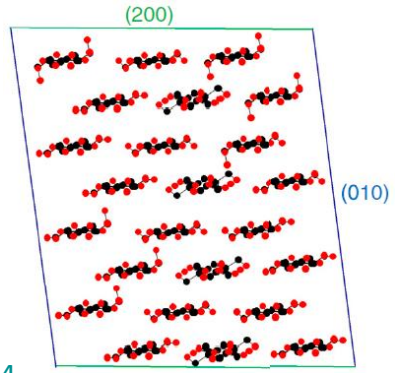
ALTERNATIVE 6×6 MODEL

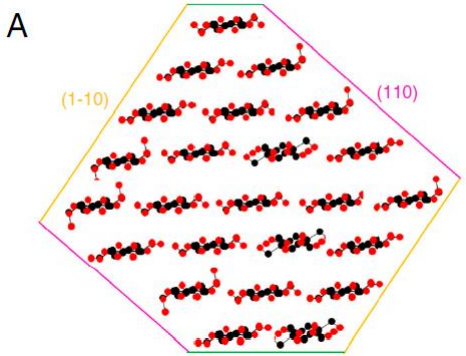


18 CHAIN MODEL



24 CHAIN MODELS





Ding and Himmel *J. Agric. Food Chem.* 2006, *54*, 597

Fernandes et al. *PNAS* 2011, *108*, E1195

Oehme et al. *Plant Physiol.* 2015, *168*, 3

Endler and Persson *Mol. Plant.* 2011, *4*, 199

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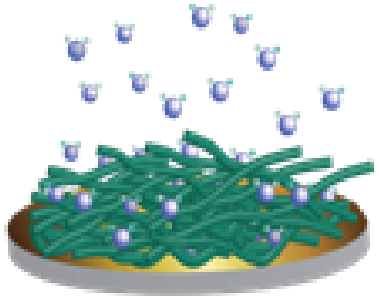
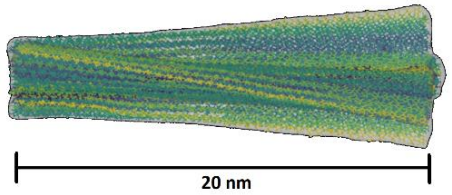
OUR APPROACH: MAPPING THE DIMENSIONS VIA WATER SORPTION

- *We can probe water interactions at interfaces with nanosensitivity and molecular level preciseness – Surface sensitive methods*



[Hakalahti et al., Biomacromolecules (2017)]

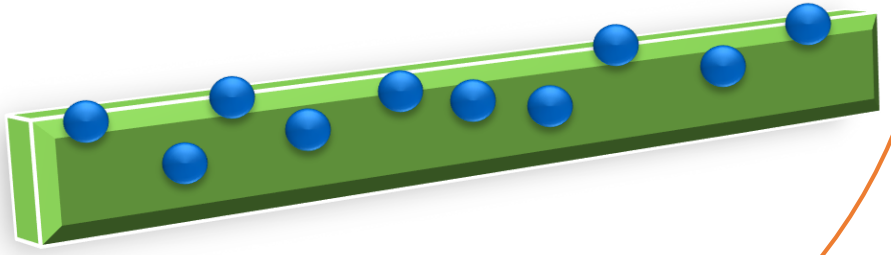
- *We can model the amount and location of water as well as structure of cellulose crystallites – Molecular simulations*



[Ketoja et al., VTT-Aalto unpublished results (2018)]

IDEA: specific sites for water adsorption reveal details about the dimensions of cellulose crystal/microfibril

Can we use water molecules to probe exact size and structure of the elementary microfibril?



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THANK YOU!

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Eero Kontturi
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Professor
Internationally awarded expert in cellulose-based materials, particularly within the fundamental aspects of interfacial and surface-related phenomena.

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Leading nanobiomaterial scientist with expertise in wide range of applications-related solutions rooted in science

Zhuojun Meng
Joint post-doctoral researcher
Experienced scientist with strong background in biobased materials