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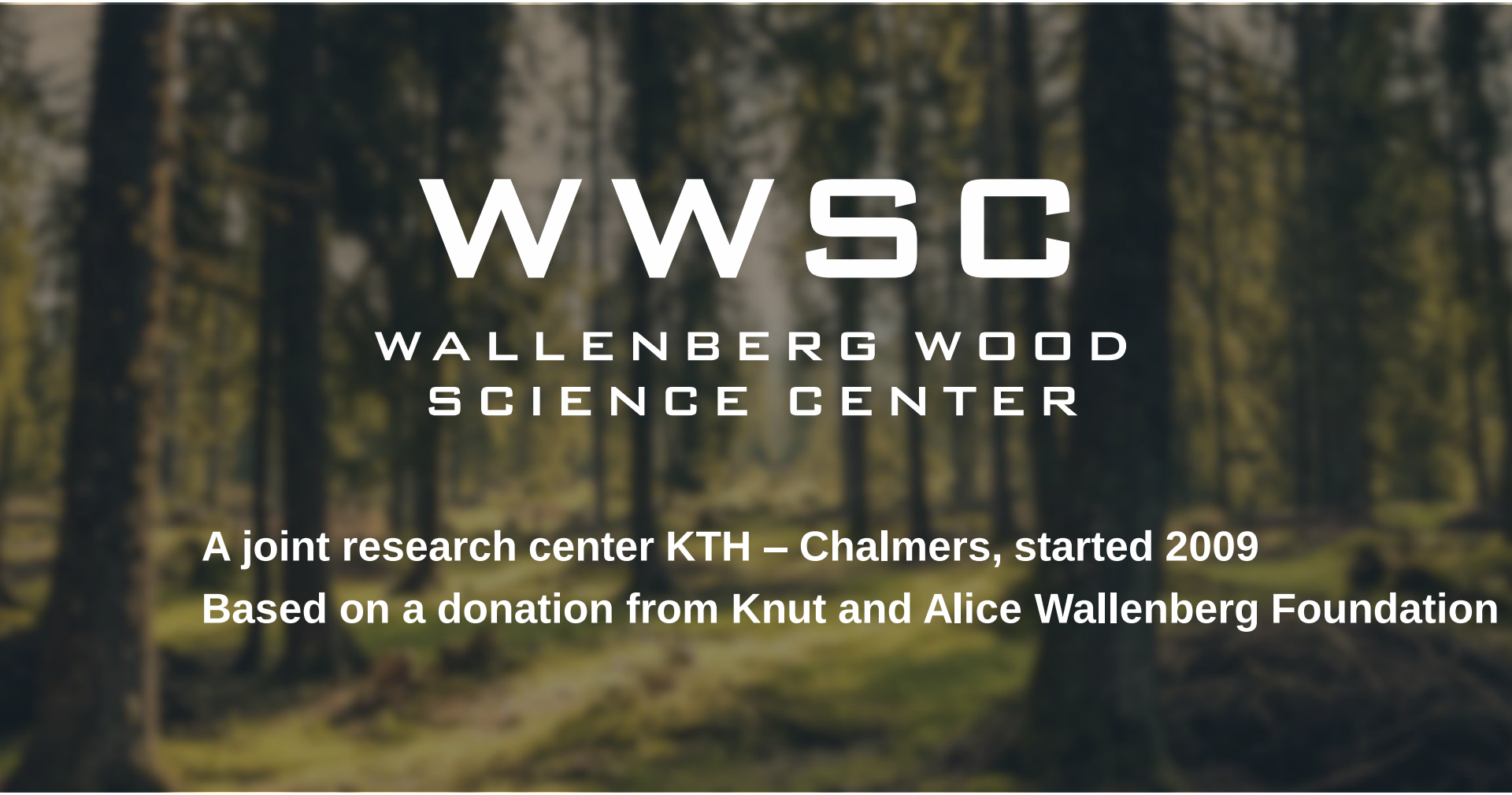
Wallenberg Wood Science Center

Research for new materials from wood

Professor Lisbeth Olsson
Co-director WWSC Chalmers

WWSC is a joint research center at KTH and Chalmers

Creating knowledge and building competence of innovative use of wood raw material



A joint research center KTH – Chalmers, started 2009

Based on a donation from Knut and Alice Wallenberg Foundation

Knut och Alice Wallenbergs Stiftelse

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New start for the research area: a new research culture

- A **multidisciplinary** competence platform
- Increased **internationalisation**
- **Scientific excellence**

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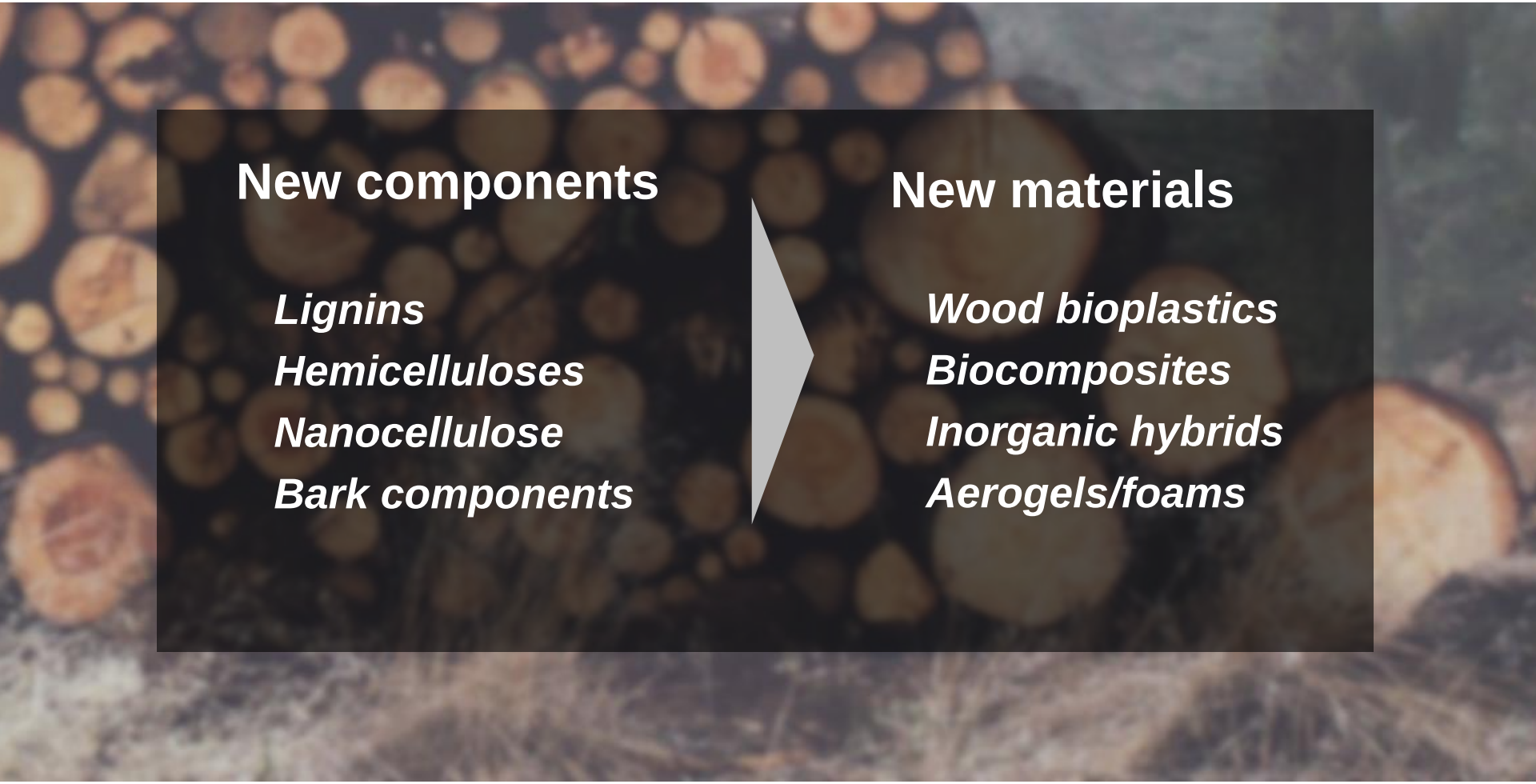
WWSC research: new components for new materials from wood



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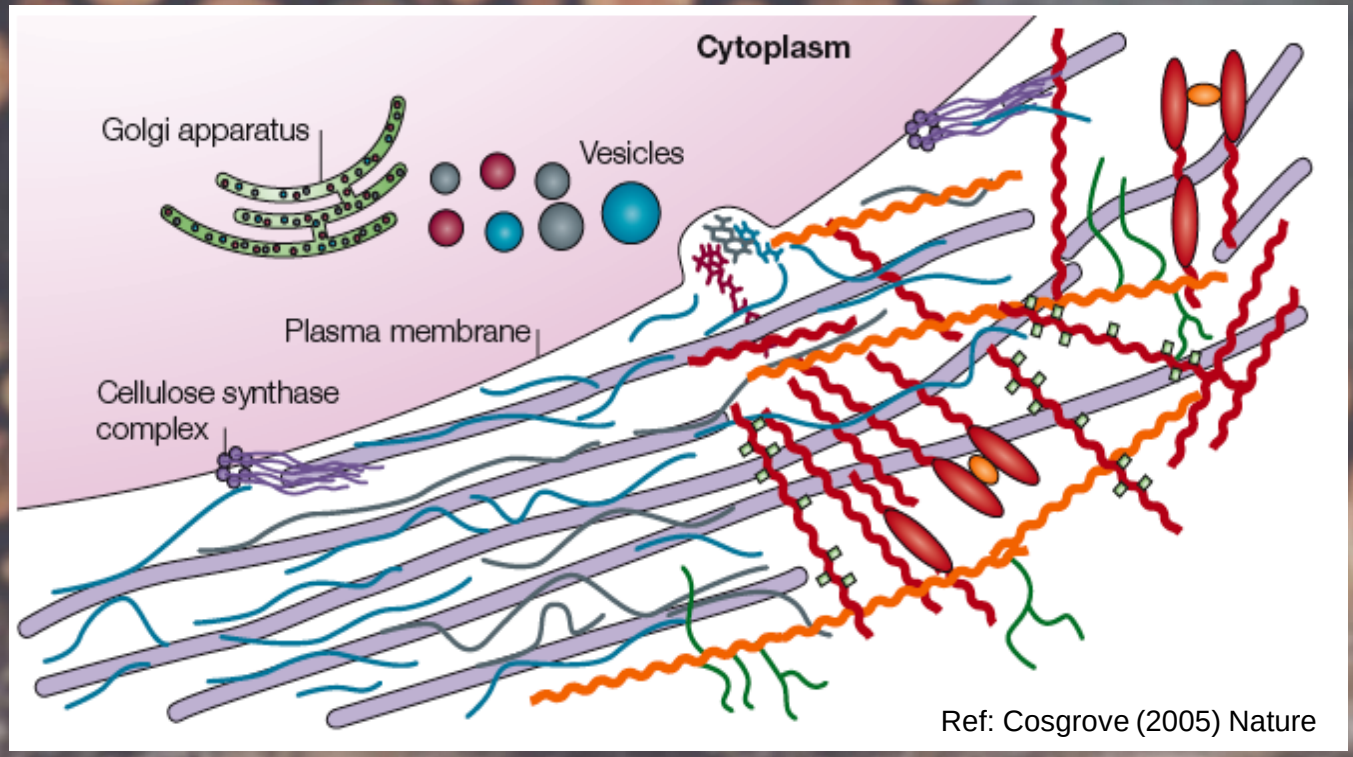
WWSC research starting point: understanding the cell wall and nanostructure



Ref: Cosgrove (2005) Nature

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WWSC research: three research themes

Materials biorefinery: Cell wall disintegration and fractionation
H. Theliander, M. Lindström, L. Olsson

Wood nanotechnology: Colloids and solutions
L. Wågberg, P. Gatenholm

Wood nanotechnology: Nanostructured materials
L. Berglund

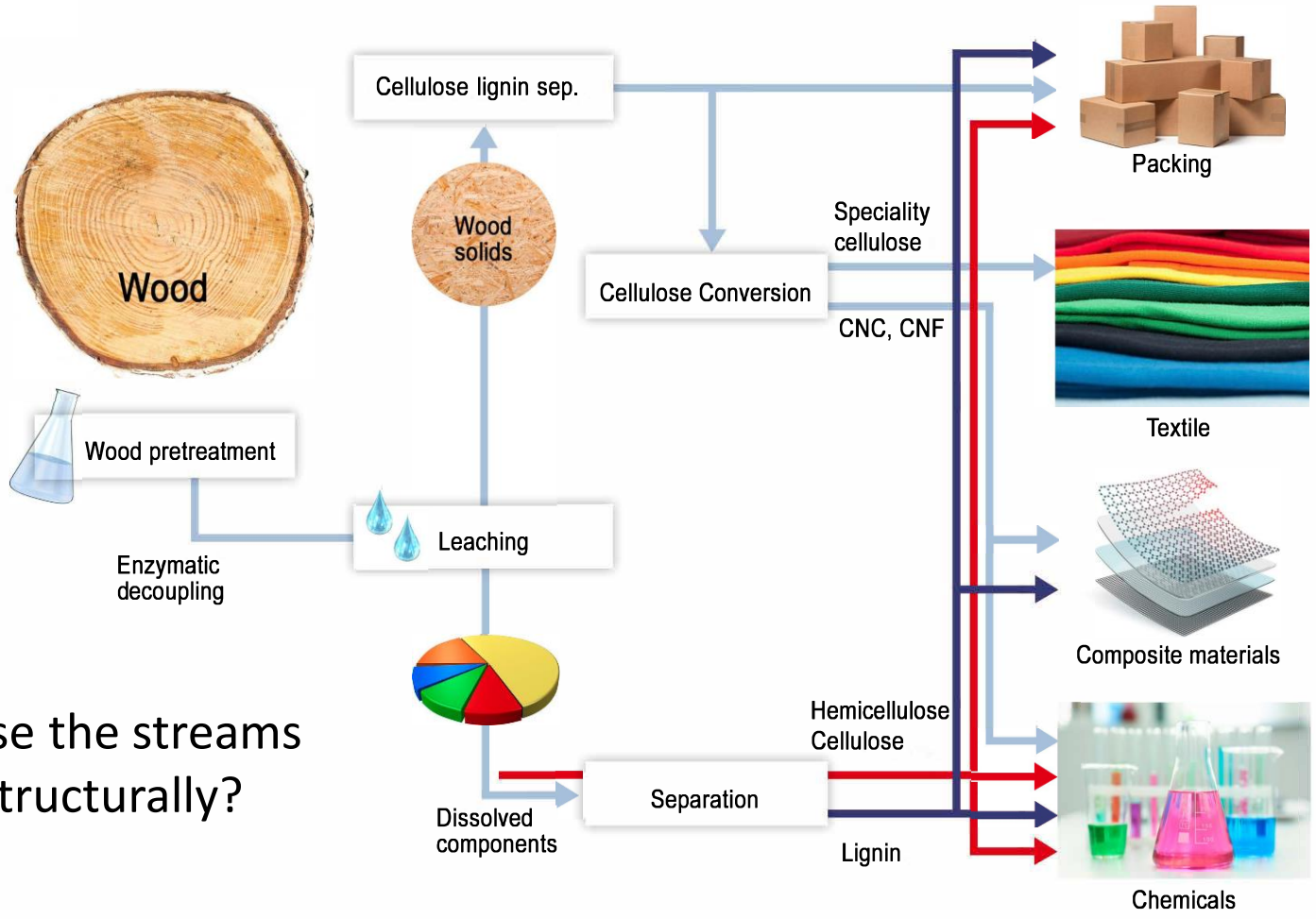
WWSC Research:
New material components from wood

New components

Lignins
Hemicelluloses
Nanocellulose
Bark components

How can biomass be treated chemically, physically and enzymatically to decompose wood into new components?

Materials biorefinery



What characterise the streams chemically and structurally?

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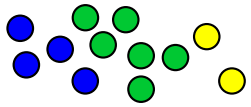
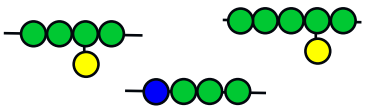
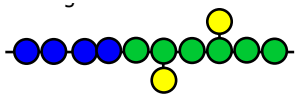
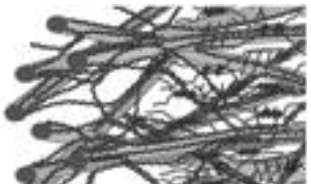
Analytical toolbox for wood structure and pretreatment

Constituent sugars	Intramolecular Substitution Pattern	Macromolecular architecture	Supramolecular organization
			

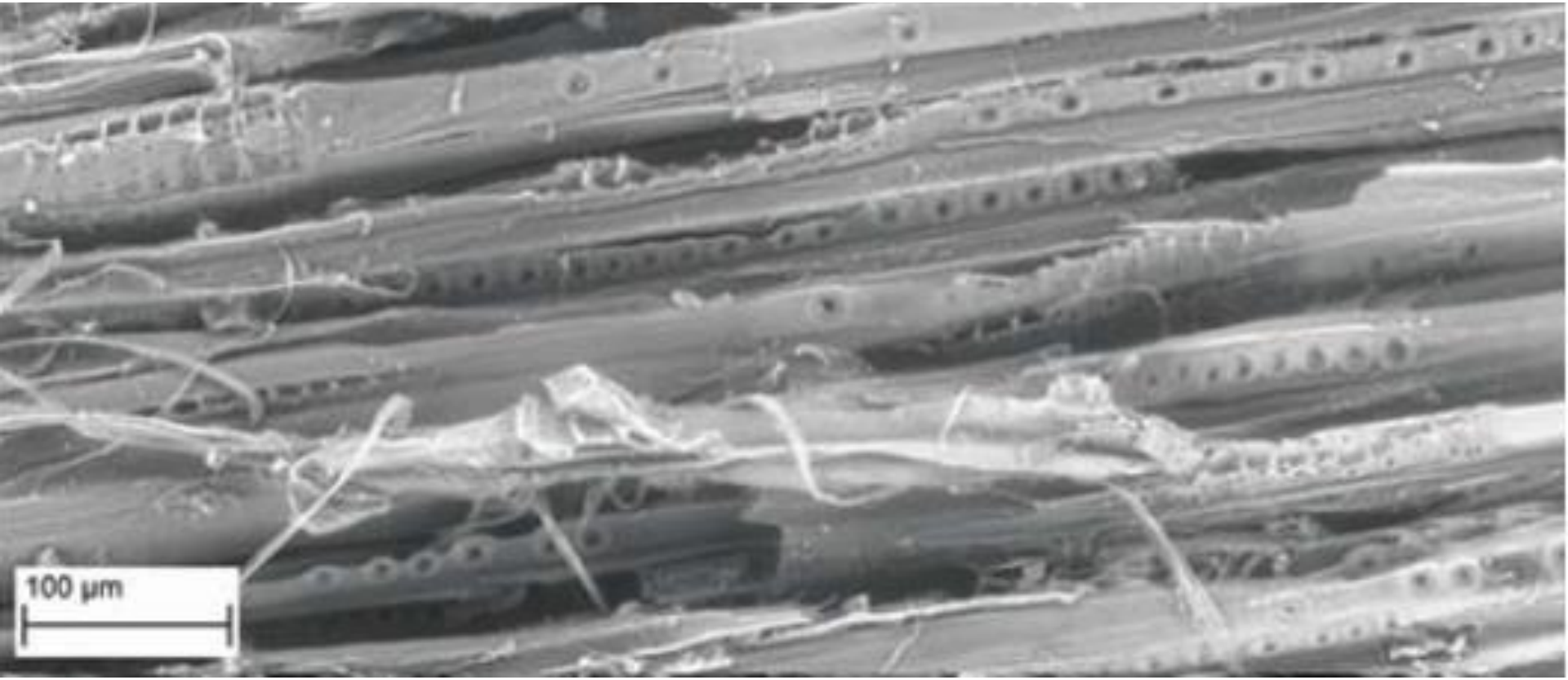
Mass spectrometry (GC-MS, ESI, MALDI)

Liquid Chromatography (HPAEC, HPLC, SEC)

Spectroscopy and Scattering (NMR, IR, MALLS, DLS, X-ray)

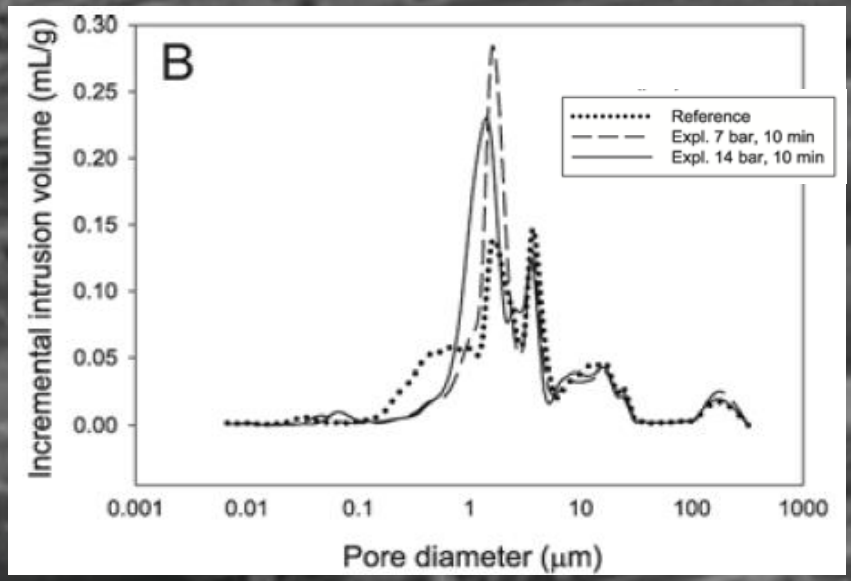
Thermo-Mechanical and Imaging (EM, AFM, tensile testing, DMA, rheometry)

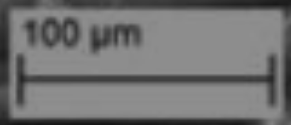
Mild steam pretreatment can positively affect chemical and structural material modification



Mild steam pretreatment can positively affect chemical and structural material modification

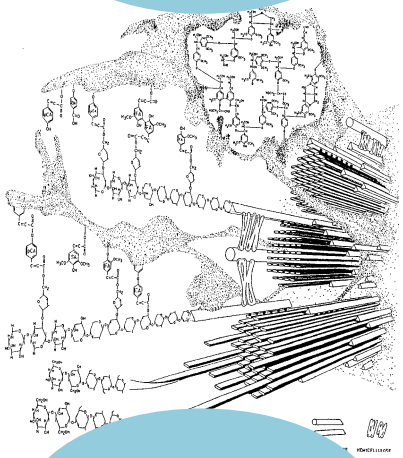
Effect on the pore volumes





Enzymes, nature's scissors, cleave ester bonds between hemicellulose and lignin

LCC structure

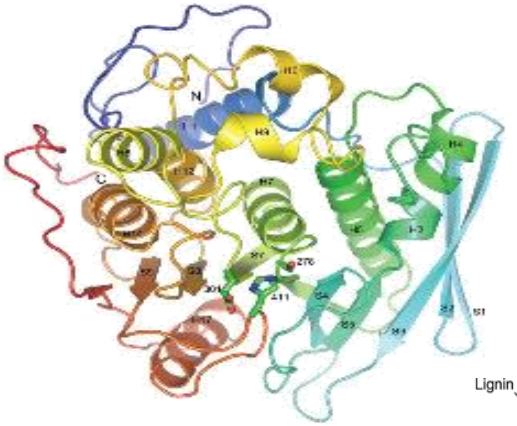


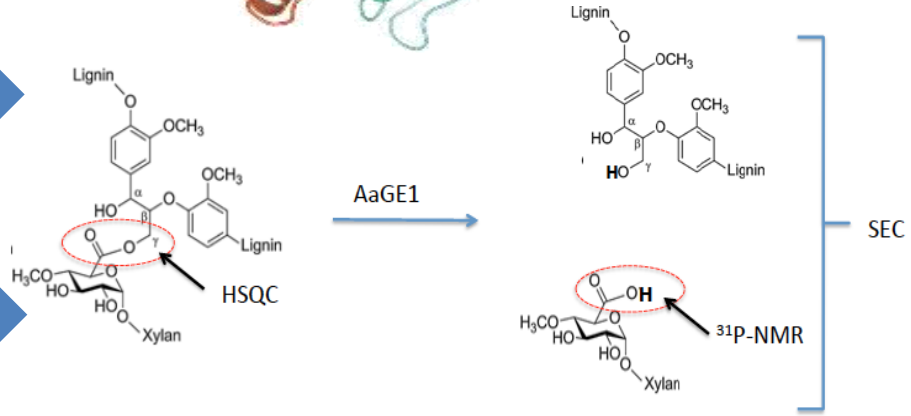
Enzymatic treatment

Cloning and expression

Enzyme production

LCC model compounds





Sunner, H., M.-D. *et al* (2015) *Molecules* **20:** 17807-17817;
Nylander F., H. *et al* (2016) Holzforschung. 70: 385-391
Arnling Bååth, J., N. et al (2016) *FEBS Letters,* **590:**2611-2618

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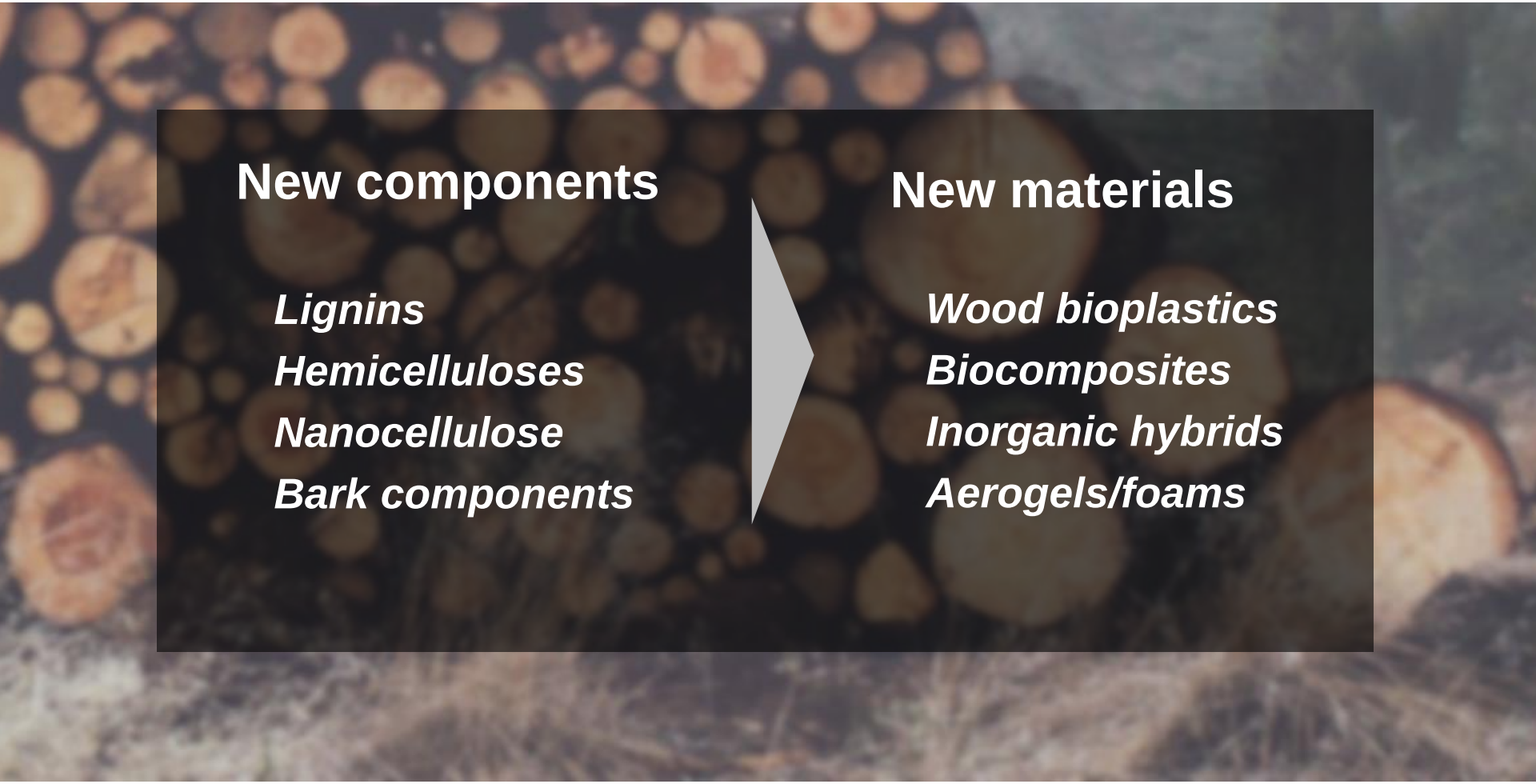

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Light-weight nanocellulose foams

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N Cervin, L Andersson, J Boon Sing Ng, P Olin, L Bergström, L Wågberg (2013) Biomacromolecules, 14 (2)

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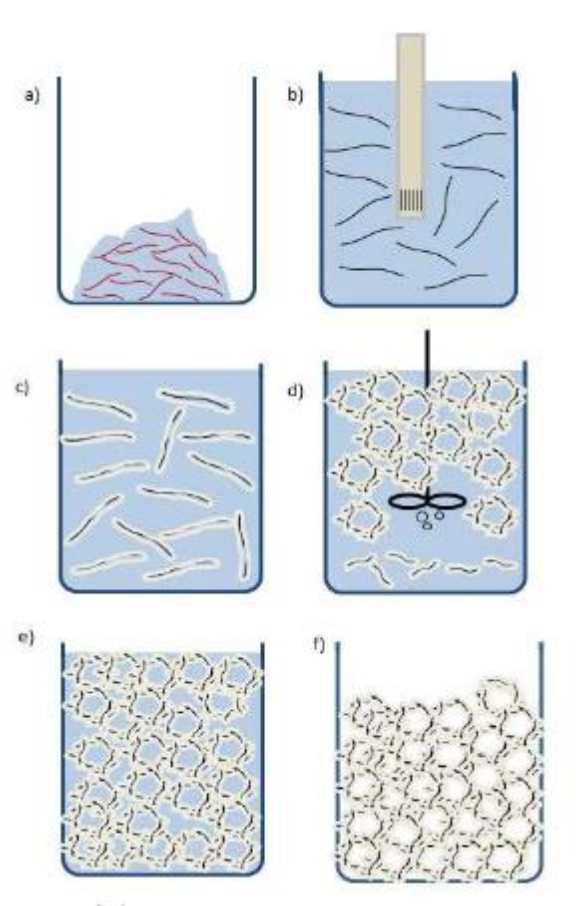
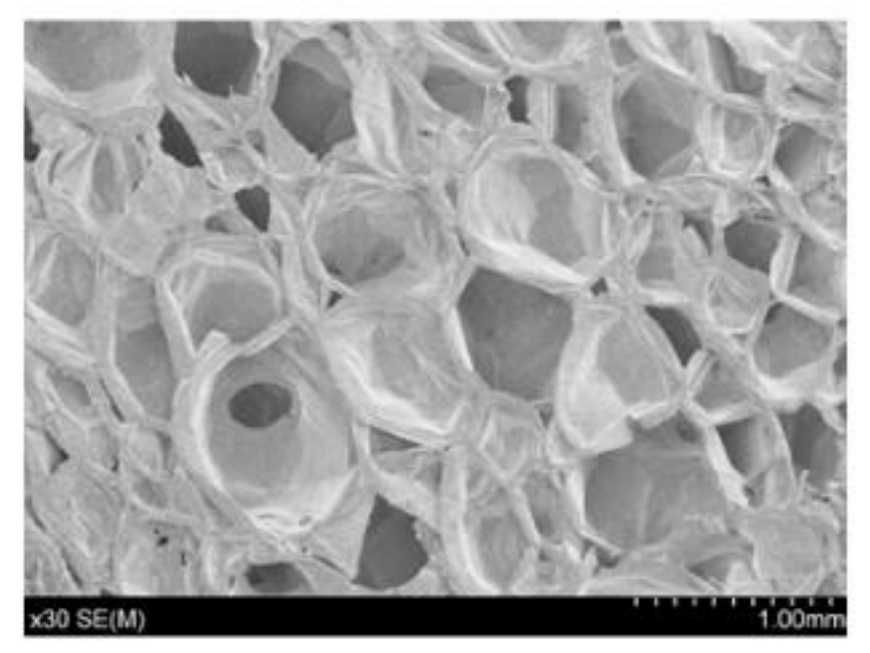
Light-weight nanocellulose foams





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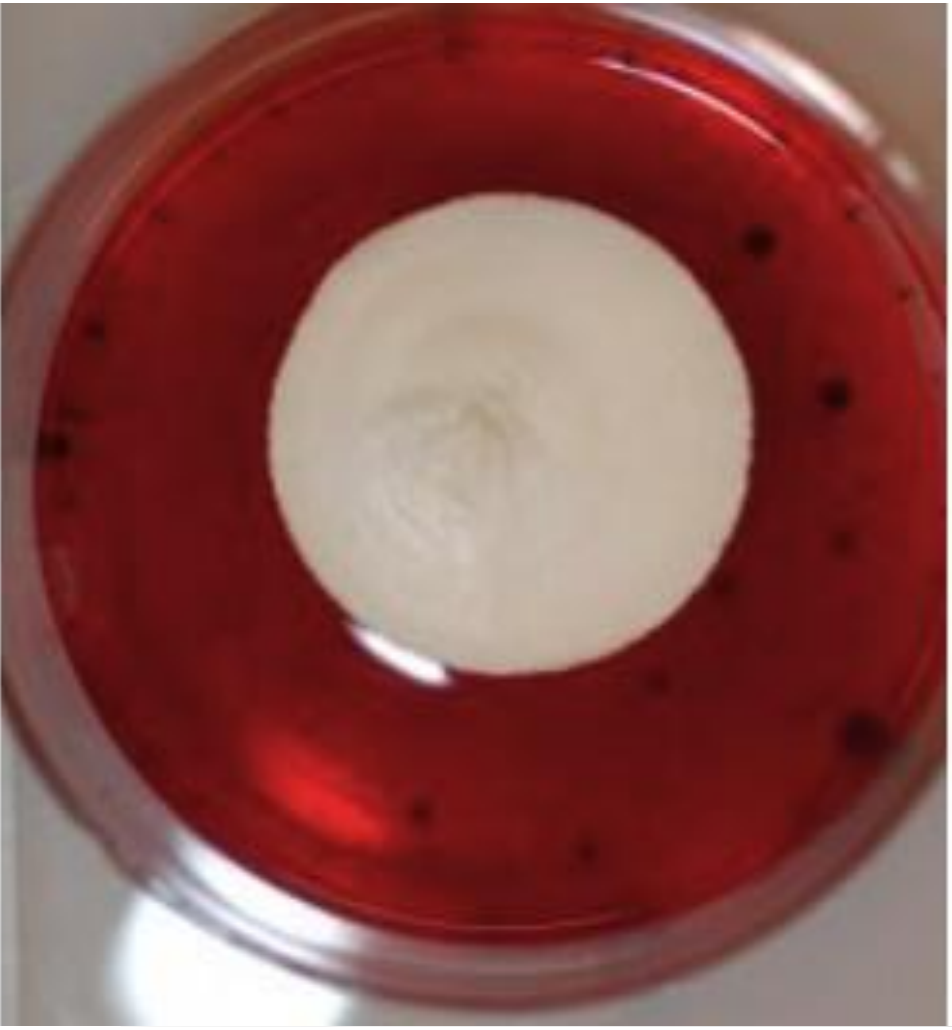
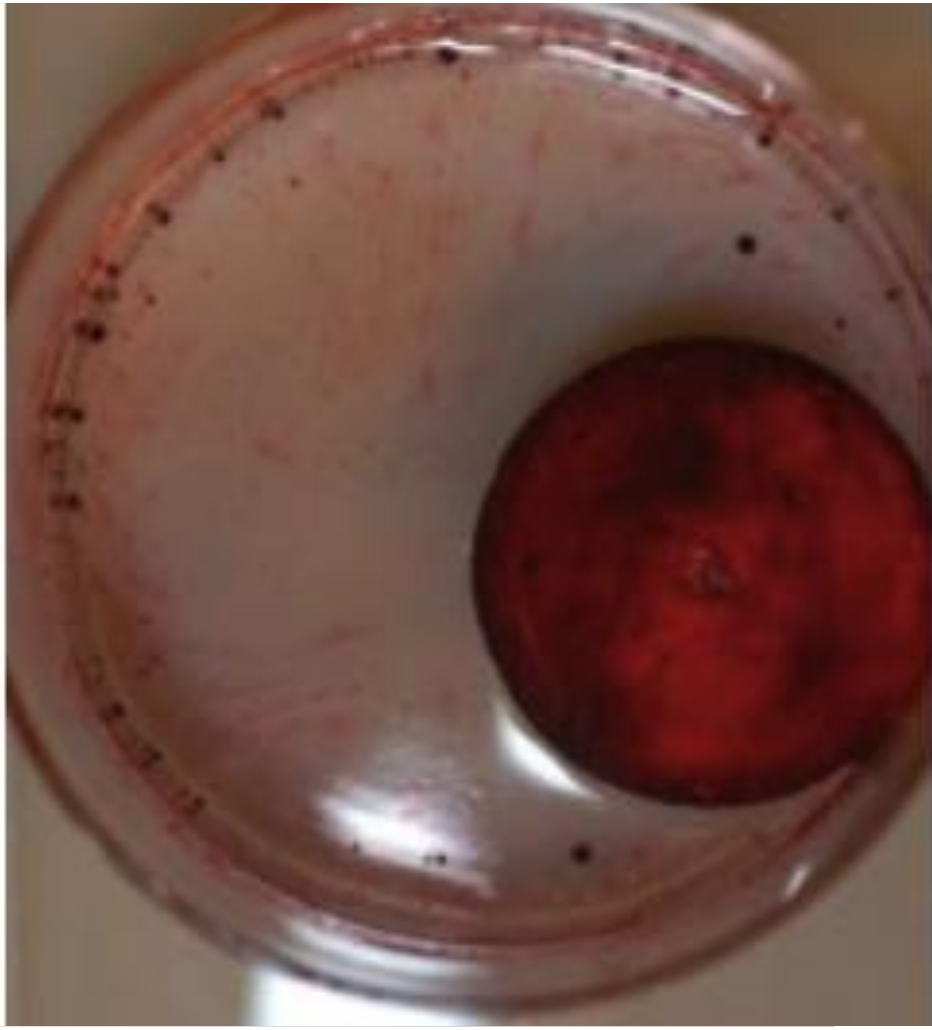
Application: oil-absorbing foam





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Soft batteries of nanocellulose foam

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G Nyström, A Marais, E Karabulut,
L Wågberg, Y Cui, M Hamedi (2015)
Nature communications 6

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WWSC foam in the wood bicycle helmet

Cellufoam™

Research from WWSC further developed by Cellutech

CELLUTECH

Photo: Skogsindustrierna

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Transparent wood

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Y Li, Q Fu, S Yu, M Yan, L Berglund (2016)
Biomacromolecules 17 (4), pp 1358–1364

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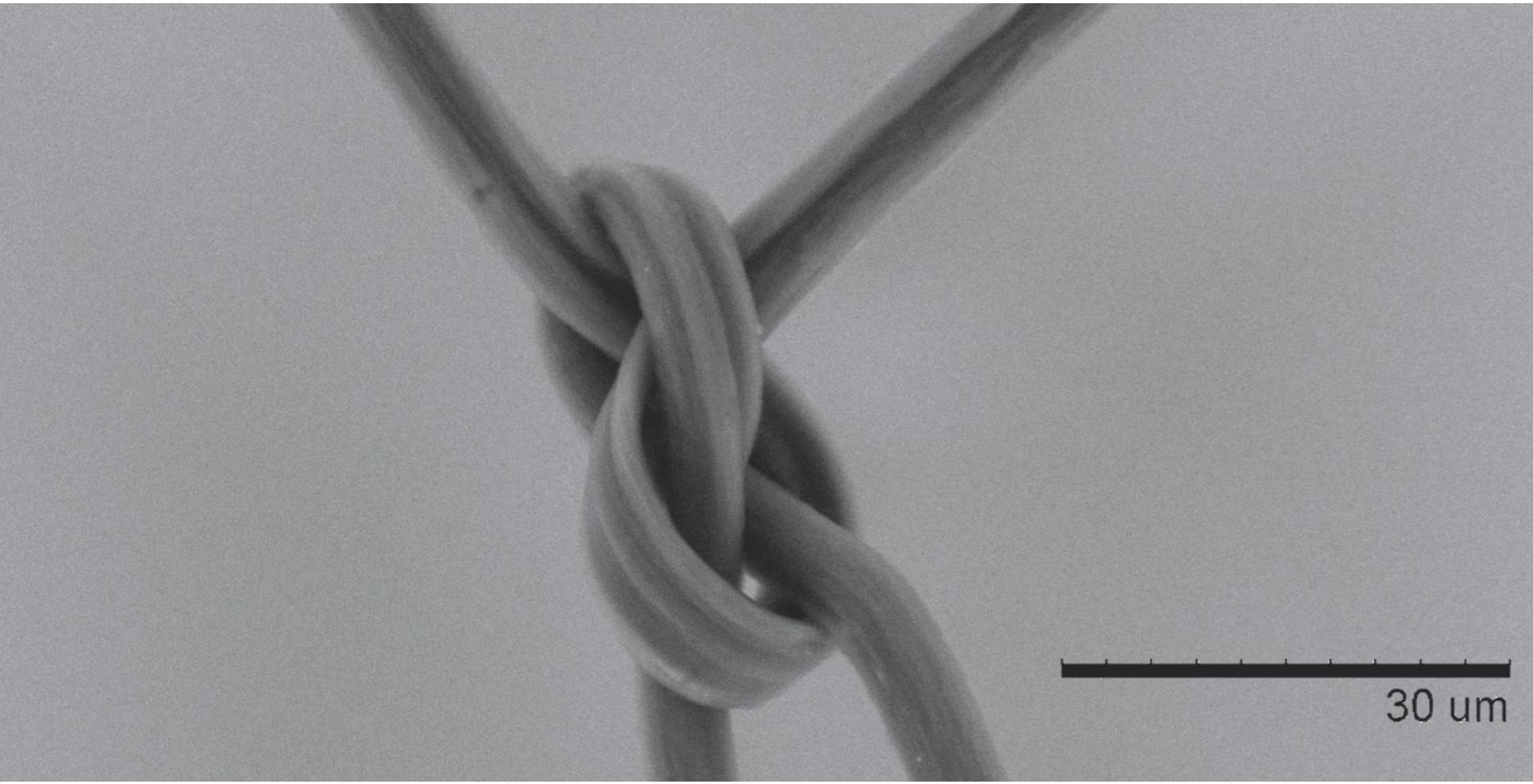
Nanocellulose fibres: strongest biobased material ever



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K. Håkansson, A. Fall, F. Lundell, S. Yu, C. Krywka, S. Roth, G. Santoro, M. Kvick, L. Prahl Wittberg, L. Wågberg & D. Söderberg (2014) Nature Communications 5:4018

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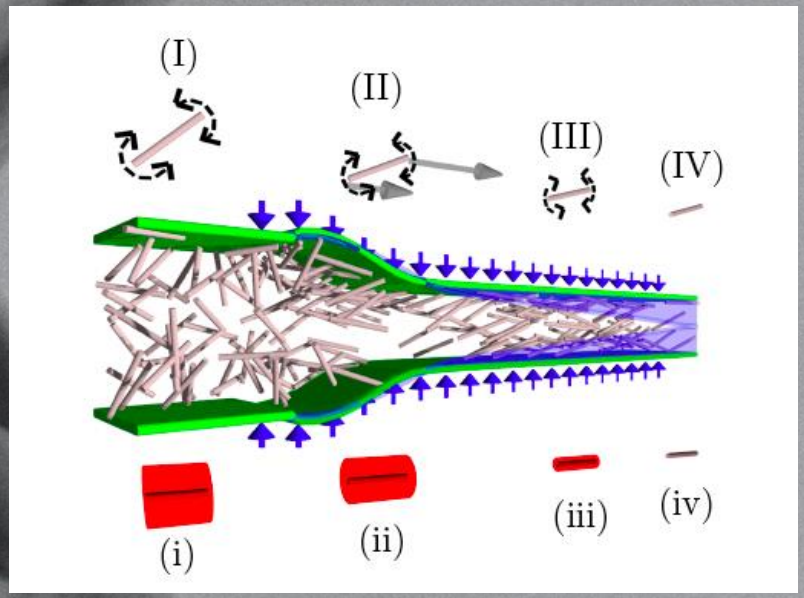
Nanocellulose fibres: strongest biobased material ever

Hydrodynamic alignment of nanocellulose fibrils



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3D-printing nanocellulose

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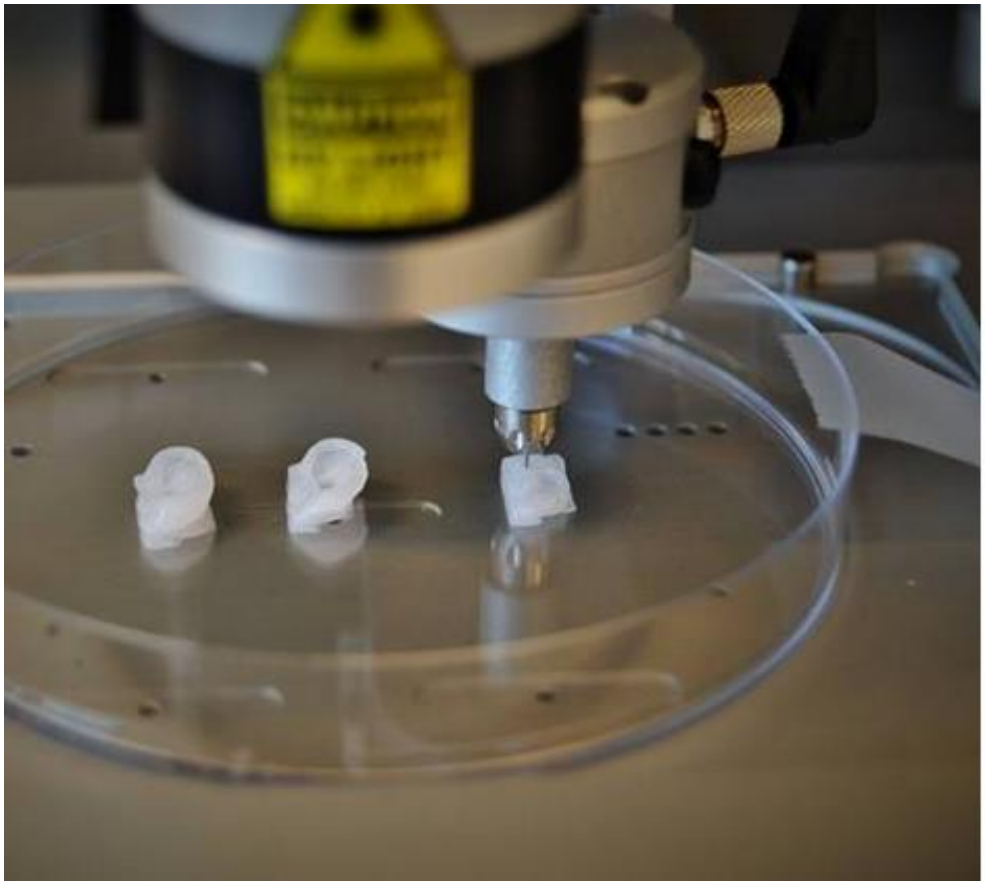
3D Bioprinting nanocellulose and cells for tissue engineering



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K. Markstedt, A. Mantas, I. Tournier, H. Martínez Ávila, D. Hägg, P. Gatenholm (2015) Biomacromolecules 16 (5)

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Thin speakers with magnetic cellulose gel

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S Galland, RL Andersson, M Salajková, V Ström, RT Olsson, LA Berglund (2013)
Journal of Materials Chemistry C 1 (47)

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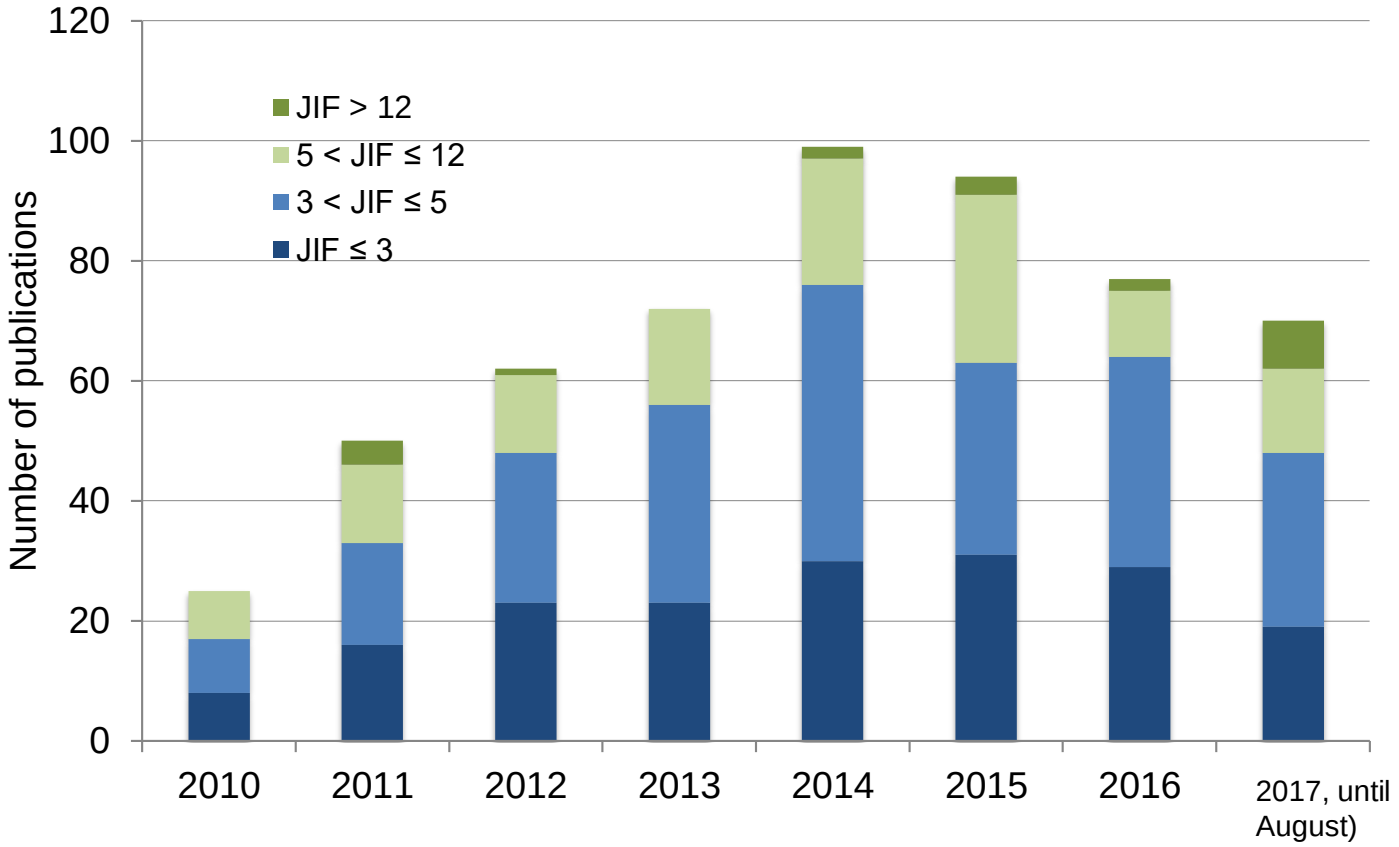
WWSC research has led to excellence



based on the 2015 journal impact factor (JIF)

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WWSC Academy: Multidisciplinary education and a strong network

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WWSC Alumni: unique competence for academia and industry

30 PhD

50 / 50 men / women

1/3 postdocs

1/5 research institutes

1/5 start-ups

1/5 companies

> 2/3 in Sweden

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WWSC almuni

“The skills acquired from WWSC and contacts have been of great value for me in my work “

Mikaela Helander
scientist, Cellutech

Photo: Cellutech

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Next step: **WWSC 2.0** (2019 – 2028)

Knut and Alice Wallenberg Foundation: up to 400 MSEK

Industrial co-funding: 100 MSEK

Co-funding from the Universities: 160 MSEK

Knut och Alice Wallenbergs Stiftelse

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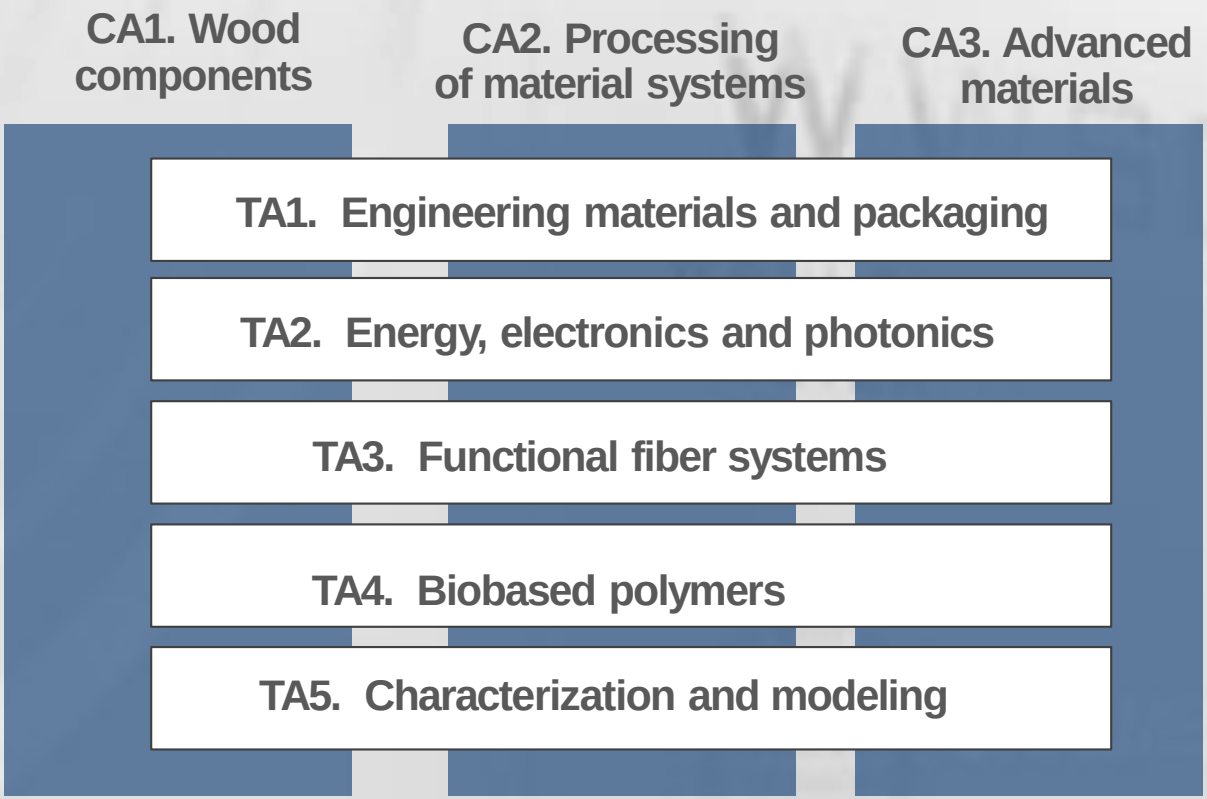
LINKÖPINGS UNIVERSITET

TREESEARCH

WWSC 2.0 work areas



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