News and Views

from Nordic Forest Research SNS

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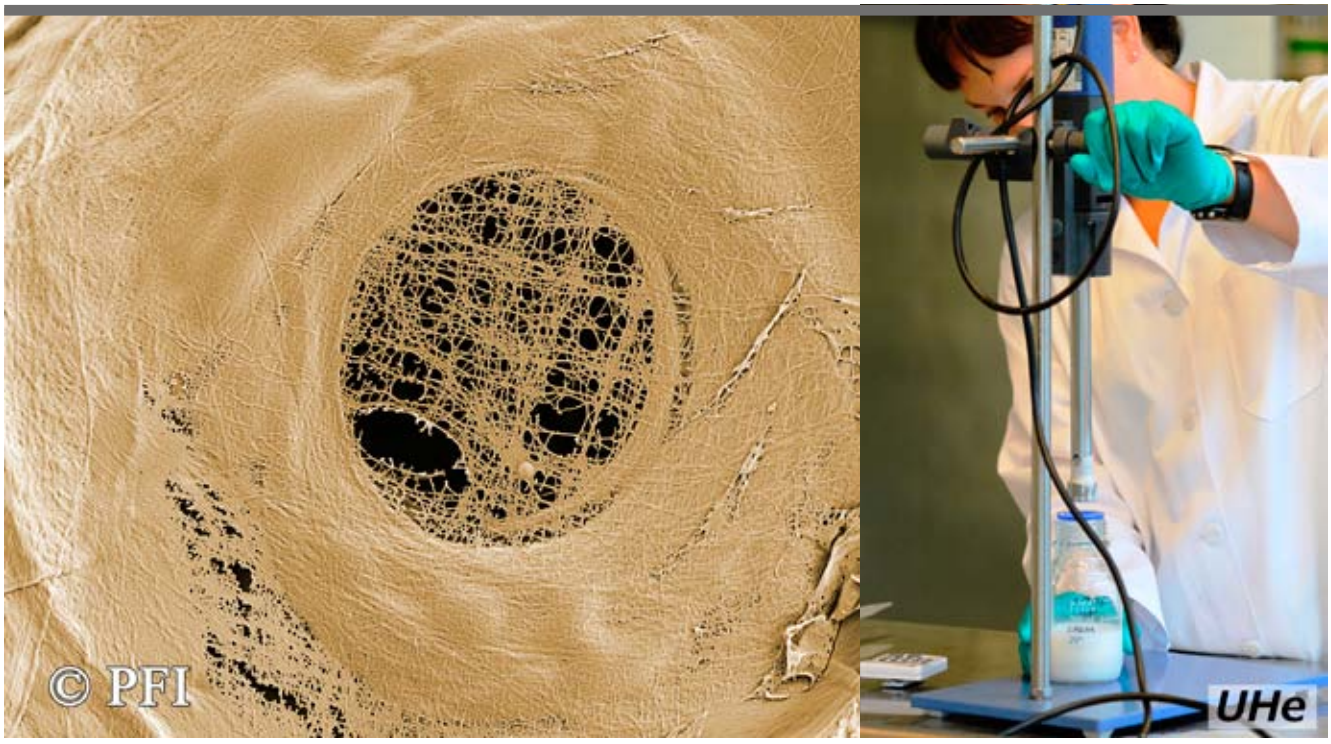

A magnified wood fibre from spruce, showing the cellulose nanofibrills and also a pore, covered by the fibrils (left), and emulsion preparation (right). Photo: Per Olav Johnsen, PFI (left) and Pia-Leena Heikkilä, University of Helsinki (right).

WOOD-PRO will add value to wood by-products

Will we find our new gels, packaging materials and food stabilisers in the forest? With the rapid advance of nanotechnology, we are likely to see many innovative uses of the carbon compounds produced by trees. Hemicellulose can, for example, be transformed from something of a waste product to a promising, environmentally friendly material with high value.

The SNS-supported project WOOD-PRO assembles some of the main competences in nanocellulose and hydrocolloid research in Finland, Sweden and Norway. Its purpose is to deepen our understanding of nanocelluloses and hemicelluloses as hydrocolloids. In the end, the project will have developed model applications, which could be exploited by the industry.

An unexploited component

Wood is mainly composed of cellulose, hemicellulose and lignin. While the long-chained cellulose polymer is an important raw material for pulp and paper, hemicellulose is mostly a by-product with limited value.

– Hemicelluloses make up some 30% of conifer wood, but are largely unexploited. In pulp making, hemicelluloses are sometimes washed out along with the process water. Althoug being a source of energy, there is potential to raise the value of hemicelluloses through new industrial applications, says Kirsi Mikkonen, who is coordinating WOOD-PRO.

Kirsi Mikkonen and her co-workers engineer the compounds found in trees to develop new products of value. Nanotechnology allows them to create thin but strong materials with unique characteristics to be used, for example, as films or gels in the food industry.

Hydrocolloids important in the food industry

The WOOD-PRO project will exploit the potential for cellulose and hemicellulose to be converted to hydrocolloids. Hydrocolloids are hydrophilic colloid particles dispersed in water. Depending on the amount of water, a hydrocolloid can take the form of either a gel or a liquid. Polysaccharides that are hydrocolloids can be used as thickeners, gelling agents, encapsulating agents, adhesives, fat replacers and emulsifiers in food, cosmetics and pharmaceutical products.

Plant-based hydrocolloids have great potential in many applications.

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Currently, the food industry is an important target, in which hydrocolloids are used to stabilise dairy products, replace fat and make beverages more cloudy.

– We have for example shown that galactoglucomannan, the main hemicellulose in softwood, is an efficient emulsifier and stabiliser of oil in water, and that it can prevent oxidation of lipids in emulsions. This is a remarkable advance for food applications. Currently, several other food additives are used to obtain the desired physical and chemical stability. These will be further developed in the project, says Kirsi Mikkonen.

Are wood nanofibres different?

The project will start with preparing emulsions and gels, the properties of which will be carefully evaluated. The most suitable candidates will be selected for the preparation of emulgels, in which the emulsion is gelated to form an elastic network of hydrocolloids, which can surround, for example, oil droplets.

The project will continue with testing selected nanocelluloses and hemicelluloses under varying conditions such as different pH levels and temperatures. The long-term stability will be tested under selected storage conditions. Finally, the project will develop model applications, such as food pastes, dressings, and beverages.

Kirsi Mikkonen is curious to learn more about the functioning of nanocelluloses and hemicelluloses.

– For example, Luleå Technical University has previously shown that nanocellulose from vegetable sources is re-dispersible even after drying. This is not the case of nanocellulose from wood, and the project will investigate the reason for this difference. Do vegetable nanofibres have surface characteristics that wood nanofibres lack, she asks?

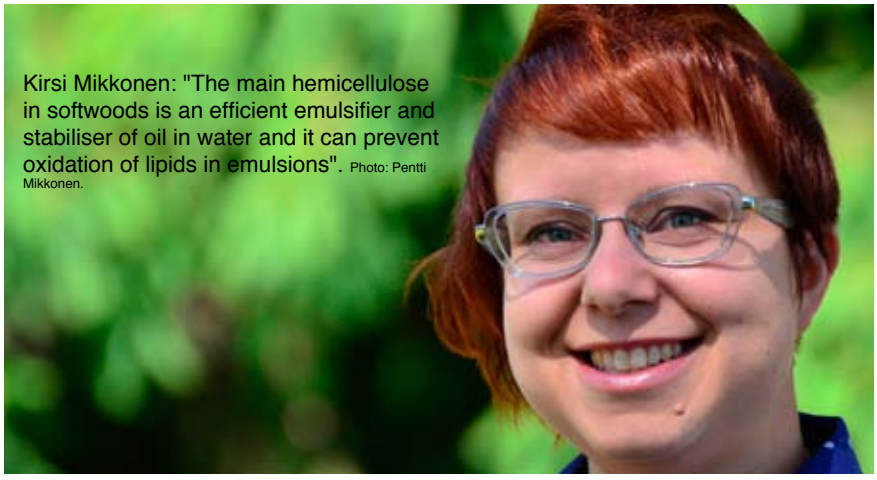
Biorefineries

The development of biorefineries has potential to revolutionise the manufacturing of new advanced products of the forest industry. New methods make it possible to separate and isolate the wood components into pure fractions.

– The techniques for the preparation of nanocelluloses and the isolation of hemicelluloses from wood or pulp already exist, but it depends on the application potential whether their recovery is worthy of industrial investments, she says.

Once the technique is ready and the industry is prepared to invest, she thinks that there is great potential to use more constituents of trees.

– We are experiencing decreased consumption of printing paper, and this has created a need for new types of industrial processes utilising all components of wood, she says.



Kirsi Mikkonen: "The main hemicellulose in softwoods is an efficient emulsifier and stabiliser of oil in water and it can prevent oxidation of lipids in emulsions". Photo: Pentti Mikkonen.

About WOOD-PRO

- "Valorization of **WOOD** biorefinery **PRO**ducts into novel functional hydrocolloids" runs over the period 2016-2018 with funding amounting to 500 000 SEK/year from SNS.
- WOOD-PRO is a cooperation between University of Helsinki, Luleå University of Technology and Paper and Fibre Research Institute (Norway) in collaboration with Åbo Akademi University, BLN Woods Ltd, the Natural Resources Institute Finland (Luke) and Stora Enso.

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Nanocellulose hydrogel. Photo: Kristiina Oksman.

About polysaccharides

Wood consists of long carbon chains, **polysaccharides**, which make up the wood fibres and give it its strength.

Cellulose forms the major part of the wood, amounting to over 40%. Cellulose consists of linear chains of several hundred to many thousands of glucose units, and is likely the most abundant organic polymer on Earth.

Hemicelluloses are the second-most abundant polysaccharides in wood, making up some 30% of conifer wood and somewhat less in deciduous trees. Hemicelluloses are shorter polysaccharide chains, some 200 sugar units long. Besides glucose, hemicellulose can contain xylose, mannose, galactose and arabinose. Hemicelluloses are more randomly organized compared with cellulose and have much less strength.

Dr. Hans Verkerk (left), Professor Gert-Jan Nabuurs (2nd from left) and Dr. Mart-Jan Schelhaas (right) are part of the team of developers and have used the EFISCEN model in their doctoral studies. Professor Timo Pukkala (2nd from right) was their supervisor. Photo: Niina Verkerk.

Forest resource model free for all

The well-established forest resource model EFISCEN is made open source and the model and source code are now free for anyone to use.

The European Forest Information SCENario model (EFISCEN) is a leading forest resource model to describe the structure and composition of European forest resources. EFISCEN uses national forest inventory data as its main source of input, and the model can project the development of forest resources at various scenarios. These are mainly determined by management actions, but the model can also consider changes in forest area and growth rates.

The outputs are basic forest inventory data (species, area, growing stock, volume, increment, mortality, age-structure), as well as information on harvest potential and on important forest ecosystem services. The latter may be carbon sequestration, biodiversity, recreation, or moderation of wind and fire risk.

Carbon accounting

Several European countries have relied on projections by EFISCEN (along with the G4M model) for estimating their Forest Management Reference Levels in the context of carbon accounting rules in the Land Use, Land-Use Change and Forestry sector. These reference levels were adopted during the UNFCCC conference of parties in Cancun.

EFISCEN has also been used in the IPCC 4th assessment report on mitigation of climate change.

Used for over 20 years

The core of what is now the EFISCEN model was developed in the late 1980s for Sweden by Professor Ola Sallnäs at the Swedish University of Agricultural Sciences. The first European application of the model was carried out by the International Institute for Applied Systems Analysis (IIASA) in the early 1990s. With help from the original developers, the model was transferred to the European Forest Institute (EFI) in 1996, and given the name EFISCEN. Since then, the model has been further developed both by EFI and Alterra.

The model has thus been in use for over 20 years. Gert-Jan Nabuurs, now Professor at Wageningen University, was one of those who started EFISCEN development, and he notes:

– We have used EFISCEN in numerous studies to assess impacts of policy and management strategies and environmental change on forest resources at the national and European level.

Open source

To improve transparency and to ensure the tool can be used by the entire research community, EFISCEN has been re-implemented in Java as EFISCEN 4.1. The model and its source code are now freely available.

– Releasing EFISCEN as an open source tool increases its transparency and thereby the credibility of the results we obtain from the model. By going open source, EFISCEN is available to a larger community and we are confident this will contribute to even more innovative use and development of the model, says Dr Hans Verkerk, who has used the model in his doctoral studies and various research projects.

Open sourcing EFISCEN means that users can run the program, study and change the program in source code form, redistribute exact copies and distribute modified versions.

The model is available from the EFISCEN webpage at http://efiscen.efi.int.

Celebrating journals keep growing

The two SNS-supported scientific journals are quietly celebrating anniversaries in 2016. The first issue of *Scandinavian Journal of Forest Research* (SJFR) saw the light in 1986. Twenty years later, wood industry topics were added to the portfolio with *Wood Material Science and Engineering* (WMSE), with the first issue launched in March 2006.

The editors were interviewed in previous issues of News & Views. In No 2 (2015), Johanna Witzell was presented as the new editor of SJFR. She stressed the "*rewarding opportunity to contribute to the process of publishing, which is the core of science*". In No. 5 (2012), Dick Sandberg was interviewed. He has been the chief editor of WMSE since 2009, and he stated: "*the health of Wood Material Science and Engineering is very good*".

Both of the journals are seeing increasing numbers of submissions, with some 250 articles per year entering the editor's in-box of SJFR. WMSE is also growing and may need to expand to more issues per year.

Short summaries of selected articles can be found on the SNS webpage: www.nordicforestresearch.org/journals/

30 years
1986-2016

10 years
2006-2016

SNS and NKJ combine offices

The cross-sectoral cooperation between SNS and NKJ (*Nordic Joint Committee for Agricultural and Food Research*) has the option to be even more strong now that NKJ is hosted by Sweden. The NKJ secretary Per Hansson shares office facilities with SNS at SLU in Alnarp.

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NKJ webpage: www.nordicagriresearch.org

Per Hansson, secretary of NKJ, the Nordic Joint Committee for Agricultural and Food Research. Photo: Mats Hannerz.

New secretary of SNS

Elin Andreasson (left) replaces Inga Bödeker (right) as secretary. Photo: Mats Hannerz.

Dr. Inga Bödeker, who has been one of SNS' two secretaries, has started a new job as scientific officer at Project Manager Jülich in Germany, where she will, *inter alia*, be an adviser to applicants within the energy field for Horizon 2020. She is replaced in the secretariat by Elin Andreasson, who will be the executive officer for the coming period of Sweden's chairmanship.

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Match-making day 2016

SNS and NKJ (*Nordic Joint Committee for Agricultural and Food Research*) invite to their new match-making day. The purpose is to allow researchers, government officials and industry stakeholders to meet, strengthen their networks and spark brilliant ideas for cross-sectoral cooperation in the forestry, agricultural and food sectors. The output will be the basis for the text of a coming network call in 2017.

The match-making day takes place on 15 September 2016 in Vantaa, Finland. More information can be found on the SNS webpage.

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More info about SNS:

www.nordicforestresearch.org

News & Views is a newsletter from SNS containing short, popularized articles covering Nordic forest research and forestry. Articles presenting SNS-supported activities are prioritized. The newsletter is published eight times per year, and is available for download from the SNS and Scandinavian Journal of Forest Research websites.

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Nordic Forest Research (SNS)

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